20081210 - VROM

> Retouradres Postbus 30945 2500 GX Den Haag

COVRA
[redacted]
Postbus 202
4380 AE Vlissingen

Directoraat-Generaal Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
DGM/RB 2008122570

Bijlage(n)
TRF

Datum 10 december 2008
Betreft Technical Requisition File berekening ontmantelingskosten kerncentrale Dodewaard

Geachte [redacted],

Bijgevoegd vindt u de, in samenwerking met VROM, COVRA en GKN, door Tractebel opgestelde Technical Requisition File (TRF). Deze TRF zal als uitgangspunt gebruikt worden voor een nieuwe berekening van de ontmantelingskosten van de voormalige kernenergiecentrale Dodewaard.

Graag verneem ik van u of u met de inhoud ervan akkoord kunt gaan.

Hoogachtend,

De directeur Risicobeleid,

[redacted]

archiefkopie

Paraaf
[redacted]

> Retouradres Postbus 30945 2500 GX Den Haag

COVRA
[redacted]
4380 AE Vlissingen

Directoraat-Generaal Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
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Hoogachtend,

De directeur Risicobeleid,

[redacted]

Project : GKN - EVALUATION OF DECOMMISSIONING OF THE DODEWAARD NPP

Subject : New Decommissioning Cost Estimate - Technical Requisition File

Rev.	yy	mm	dd	Stat.	Written	Verified	Approved	Validated
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Tractebel Engineering
SUEZ

Avenue Ariane 7 - B-1200 Brussels

R	D	C

Dest.

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*** This document is fully electronically signed on 13/11/2008.**

Kerncentrale Dodewaard: New Decommissioning Cost Estimate - Technical Requisition File

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Appendixes

1. Subject

This document presents the scope of the Services to be performed by NIS Ingenieurgesellschaft mbH in the frame of the new decommissioning cost estimate for the "Kerncentrale Dodewaard", hereinafter referred to as "KCD new Decommissioning Cost Estimate".

NIS has already provided decommissioning cost estimates in 1994 in the frame of two scenarios: immediate dismantling after reactor final shutdown in 2004 and deferred dismantling scenario, i.e. dismantling 40 years after reactor final shutdown.

A second decommissioning cost estimate was performed by NIS in 1999 in the frame of the deferred dismantling scenario, i.e. to cover the costs for preparation of the "safe enclosure", the "safe enclosure" period (40 years) and the dismantling phase.

The goal of the Services is to provide for a KCD new Decommissioning Cost Estimate. Such estimate is to be established using the inputs - at their best knowledge - of following parties: GKN (B.V. Gemeenschappelijke Kernenergiecentrale Nederland), VROM (Volkshuisvesting, Ruimtelijke Ordening en Milieu), and COVRA (N.V. Centrale Organisatie Voor Radioactief Afval).

A working group, constituted by representatives of these parties and of TE, has set-up the present Technical Requisition File (TRF) that takes into account the inputs and contributions of each involved party. This document is intended to be approved by NEA and by VROM Secretary General before the new Decommissioning Cost Estimate is launched.

The KCD new Decommissioning Cost Estimate will be based on a scenario, assumptions and methods that have to be detailed in a Preliminary Decommissioning Plan (PDP). This PDP shall comply with the table of contents provided in appendix 1 to the present document. Sufficient details will be given in the PDP allowing the involved parties to fully understand how the decommissioning costs are obtained and be in the position to assess their robustness, in compliance with the Dutch Laws and context specificities, and taking into account all KCD conditions.

The KCD new Decommissioning Cost Estimate will be evaluated in the frame of an "Early decommissioning scenario" or "**Reference Scenario**". Under this scenario, it is assumed that the actual KCD dismantling works start in 2015. This cost estimate will:

- be performed using CORA/CALCOM programmes, taking advantage of the return of experience from past and on-going D&D projects (in particular in Germany);
- address the concerns expressed previously by the Task Force (TOK) having reviewed the previous cost estimates;
- take into account an updated status of KCD (using the most recent physical and radiological data inventories);
- take into account new boundary conditions;
- address the uncertainties that may affect the decommissioning cost in order to identify a reasonably conservative upper limit of the KCD decommissioning cost.

The Contractor will define the Best Estimate, i.e. an estimate of the decommissioning cost as really expected based on an agreed upon scenario and boundary conditions, taking into account the return of experience of actual decommissioning projects. In addition, the Contractor will estimate a Reasonably Conservative Estimate that should constitute an upper decommissioning cost in the worse case, i.e. with all uncertainties impacting negatively the decommissioning cost.

Besides the former cost, the decommissioning cost of a "**Deferred decommissioning scenario**" will be extrapolated from the decommissioning cost estimate under the Reference Scenario. Under this scenario, the actual KCD dismantling works start in 2045 (40 years after the beginning of the "Safe Enclosure" Period, i.e. July the 1st, 2005).

2. Scope of the Services

The scope of the services includes the following tasks:

Task1: Preparation of the Preliminary Decommissioning Plan including estimates of the decommissioning costs under the Reference Scenario:

- Task 1.1.1 : Using best estimate assumptions, including clearance levels as defined in the "Kernenergiewet";
- Task 1.1.2 : Using best estimate assumptions, but with IAEA RS-G-1.7 [10] clearance levels;
- Task 1.2.1 : Using reasonably conservative uncertainties, with the clearance levels as defined in the "Kernenergiewet";
- Task 1.2.2 : Using reasonably conservative uncertainties, including IAEA RS-G-1.7 clearance levels.

Task 2: Estimation of the Decommissioning cost under the Deferred Decommissioning Scenario:

- Task 2.1 : Using best estimate assumptions, including clearance levels as defined in the "Kernenergiewet";
- Task 2.2 : Using best estimate assumptions, but with IAEA RS-G-1.7 [10] clearance levels.

3. Technical Requirements

3.1. Introductory Remark

The Preliminary Decommissioning Plan is to be prepared by the Contractor on behalf of GKN and, therefore, has to adequately reflect GKN's point of view.

3.2. Preliminary Decommissioning Plan

The Preliminary Decommissioning Plan shall comply with the table of contents provided in appendix 1 to the present document.

In general, by comparison with the reports provided by NIS in 1994 [1] and 1999 [2], more details are requested in the PDP to better clarify the scenario, assumptions and methods that are being used to build up the decommissioning cost estimates. The requested level of details must enable GKN/COVRA/VROM/TE to fully understand how the decommissioning cost is obtained, in compliance with the Dutch Laws and context specificities, taking into account all KCD conditions, and provide evidence that they are robust. Furthermore, enough details will also be given to allow for an independent verification for the whole or for parts of the calculations.

More precisely, the remarks outlined in Appendix 2 apply for the Preliminary Decommissioning Plan.

The concerns, that were expressed by the TOK having reviewed the 1999 cost estimate study (see [3]), have to be taken into account, as indicated in Appendix 3.

3.3. Decommissioning Concept

The decommissioning concept will be proven and based on sound and up-to-date techniques. The selection criteria for the chosen decontamination and dismantling techniques will be given. While the legislation has to be fully complied with, including, as far as the personnel exposure is concerned, the ALARA concept, the overall costs will be minimized as far as possible.

Following considerations apply:

- The removal, in one piece, of the Reactor Pressure Vessel (with its internals) will not be considered as this is not an option compatible with the size of the waste packages acceptable for disposal in a deep geological repository ([4]). The dismantling of the RPV and internals will be needed in order to accommodate the maximum size of acceptable waste packages i.e. KONRAD containers, with size up to 1.6 m x 1.7 m x 1.7 m, although with a mass limited to 15 tons. As an option, the Contractor shall consider the possibility that the KONRAD containers mass is limited to 20 tons. If, under such condition, the number of KONRAD containers can be reduced significantly, COVRA will check acceptability of the 20 tons (handling tools and storage building slab acceptable load) and the Contractor shall finalize its report accordingly;
- The same considerations apply for other large components like for instance some pumps and heat exchangers;

- The decontamination and dismantling activities will need new equipment. As a matter of principle, the new needed equipment shall be installed at KCD (see hereafter). Corresponding new licence will be needed. The decommissioning waste, to be super-compacted, will be processed as far as possible and economically justified[1], with the COVRA super-compactor. For melting, existing foreign waste treatment facilities are to be considered. It will be part of the scope of NIS to define the decommissioning waste production rates, in order to allow COVRA verifying whether its existing facilities for reception, processing and interim storage are large enough or if additional capacities are needed;

- Among others, NIS shall consider the need for new equipment and facilities at KCD:

  - **D&D equipment**: The Turbine Hall seems adequate for the location of centralized dismantling and decontamination facilities, as well as for radiological measurement of decontaminated items[2] and a radioactive waste packing station. Should this building appear not large enough, NIS shall consider the possibility to create an extension along the West side wall of the Turbine Hall;

  - **Liquid waste treatment systems**: In the Waste Water Treatment Building (part of the Auxiliary Building), a new evaporator package (electricity heating, air cooling) should be installed;

  - **Sanitary Rooms**: In the Auxiliary Building, the sanitary rooms are to be extended to allow accommodating the expected number of workers for the D&D activities;

  - **Free Release Measurement Facility** (FRMF): A FRMF is needed where the materials would be measured for official free release, after having been already measured in the controlled area as candidate for free release. Buffer place upstream (on the supervised site) and downstream (outside of the supervised area) are to be considered. FRMF could be located South-West of the site;

  - **Waste cementation**: NIS will evaluate the following possibilities and recommend the best solution:

    1. The COVRA existing Mobile Cementation Facility (Moss 200):

       1.1 is transported to KCD and used there to cement the waste;

       1.2 remains at COVRA and the waste to be cemented is transported to COVRA;

    2. A new cementation facility is built at KCD.

---

[1] It should be noted that in the COVRA facility, standard 90-l drums are super-compacted by a 15 MN super-compactor, and the pucks are placed in galvanized 200-l drums and further encapsulated in cement.

[2] A second measurement, used as official free release measurement, could be performed elsewhere in a dedicated free release measurement facility.

In order to illustrate the description given here before and to orient some technical solutions:

- a drawing and explanations related to the new buildings that would be erected in the frame of the decommissioning preparation are given in Appendix 4 (based on [5]);
- a text related to the waste evaporator and the use of decontamination agents is given in Appendix 5 (based on [6]).

3.4. Boundary Conditions

The boundary conditions for the Reference Scenario will be implemented in the CORA-CALCOM programmes.

The boundary conditions to be used for the Reference Scenario are gathered in Appendix 6.

3.5. Uncertainties

Preliminary uncertainties have been identified and are given in Appendix 9 (based on [8]). The Contractor shall evaluate them on the basis of the specific conditions of the project and on the basis of the return of experience of other decommissioning projects: he will propose any modification that would appear more appropriate so that a reasonably conservative decommissioning cost may be estimated with due justification.

4. Results

The results will cover the issues specified in the PDP Table of Contents, in particular:

- Activated Materials – Contaminated Materials:
  - Primary, secondary and tertiary masses;
  - Number of waste packages for final repository and distribution of their production in function of time along the decommissioning;
  - Radiological characterisation of the waste packages;
- Primary masses and building data for buildings located outside the controlled area;
- Required manpower distributed over the whole decommissioning project (per qualification, for GKN and, for the decommissioning works, for the General Contractor);
- Collective dose;
- Costs, per year, per working package, per cost type;
- List and characteristics of new facilities to be foreseen to carry out KCD decommissioning;
- List and quantities of waste streams to be processed outside KCD;
- Time-schedules: Simplified/summarized time-schedule and detailed time-schedule.

5. Documentation - Language

The results of the performed work will be documented in two separate reports, one for each Task.

For Task 1, the report will be completed by a read-only CD-ROM with the corresponding CORA-CALCOM databases and tools as used for the KCD new Decommissioning Cost Estimate. All results files will be provided as Excel or Access Files on a separate CD.

The reports will be finalised by NIS after final discussion with GKN/COVRA/VROM/TE. They shall be written in English.

Twenty-five printed copies of the reports have to be provided by the Contractor together with an electronic copy. Electronic copies of the reports will be delivered also in Word format (not only in PDF). Excel tables will be included in the reports as images, but the Excel source files will be delivered as well.

6. Visits, Meetings and Results Presentation

When useful for the quality and completeness of the services, the Contractor is offered to visit KCD as often as may be necessary (see point 12 of Appendix 2).

Formal meetings are to be held for an efficient progress of the project. At this stage, it is proposed to have (in the assumption of overall 8 months project duration):

- Kick-off meeting (possibly at KCD or including a visit to KCD);
- 4 meetings (2 progress and technical meetings, 1 meeting for discussion of the comments on the preliminary PDP, 1 meeting for discussion of the preliminary decommissioning costs);
- Final Presentation meeting of the project results.

7. Confidentiality

The Contractor shall keep strictly confidential any information received from GKN in the frame of the present project and shall not disclose results of the project to third parties without prior written consent of GKN.

8. References

[1] NIS document "Costs of decommissioning of the nuclear power plant at Dodewaard", No. 1363/3179/0, Hanau, October 1994

[2] NIS document "Costs of decommissioning of the nuclear power plant at Dodewaard", No. 5229/CA/F 0005151, 10 November 1999

[3] Taskforce Ontmanteling Kerncentrale Dodewaard "Deskundigenverslag met betrekking tot de werkzaamheden en de finale besluitvorming van de taskforce aangaande de ingeschatte kosten voor de Veilige Insluiting en de latere ontmanteling van de kerncentrale Dodewaard – Aanvullende besluiten na bijkomende informatie en verdere bemerkingen", [redacted] 30 April 2007

[4] "Verslag van de derde bespreking over "Kosten Ontmanteling KCD" met COVRA en ministerie van VROM", E-mail [redacted] 6.07.2008.

[5] "GKN response to action 3.3 of the Working Group Cost of dismantling KCD", E-mail [redacted] 10.07.2008

[6] "GKN response to action 3.12 (evaporator) of the Working Group Cost of dismantling KCD", E-mail [redacted] 11.07.2008

[7] "Cost of decommissioning KCD, action 3.14, Release limits", E-mail [redacted] 16.07.2008

[8] "Cost of decommissioning KCD, action 3.8 Appendix 2 figures", E-mail [redacted] 22.07.2008.

[9] COVRA document "TARIEVEN OPHAALDIENST (ingangsdatum 1 januari 2008) voor standaard afval"

[10] IAEA Safety Guide No. RS-G-1.7 "Application of the Concepts of Exclusion, Exemption and Clearance", Vienna, 2004

[11] "Missing tariffs waste containers appendix 7", E-mail [redacted] 07.11.2008

[12] "Prijzen vaten", E-mail [redacted] 13.11.2008

Appendix 1
Preliminary Decommissioning Plan

Table of Contents

Chapter 1: Introduction

Description of the general context, object and nature of the decommissioning plan, of the specific situation in terms of legislation, basic assumptions, etc.

Chapter 2: Description of the Plant

Technical and historical description of the Plant. Mainly plant history, incidents and accidents if any (contaminations, ...).

Chapter 3: Radiological Inventory of the Plant

The radiological inventory of the plant, associated to the physical inventory, reflects the state of the plant at the moment the decommissioning plan is issued. The natural radiological decay is being considered while developing the decommissioning plan.

Chapter 4: Project Organisation

The assumptions made for the project organization are given.

Chapter 5: Decommissioning Strategy

Section 5.1- Analysis of Possible Strategies includes all estimates and evaluations that are necessary to define a strategy in the long and/or short term. The criteria that influence the strategy choice, given hereafter and when relevant, are used as a basis to the study and to the definition of the strategy.

1. Nature of the site
2. Future use of the site
3. Plant characteristics
4. Workers, Population and Environment protection
5. Radioactive waste
6. Future evolution of the decommissioning techniques

Note: Texts related to points 1 to 5 will be provided by GKN in due time when the Contractor is drafting the PDP.

Section 5.2 - Description of the Selected Strategy describes strategic options and scenarios selected for a detailed analysis, in particular from the economics point of view.

Section 5.3 – Reference Scenario includes the reference scenario selected by the Operator.

Chapter 6: Maintenance Description

According the selected strategy defined here before, the Operator describes in this chapter the technical means and the safety measures needed during the decommissioning. This description is of the conceptual type for the initial plan.

Chapter 7: Decontamination and Dismantling Techniques

This chapter gives an analysis of the technical feasibility of the decontamination and dismantling as well as the identification of the techniques that may be used potentially.

The chosen techniques are described as well as the reasons thereof. The way those techniques will be validated is indicated. For the selection of the techniques, personnel safety and costs management are taken into account, as well as dose and release of radioactive material into the environment.

This chapter comprises sections **7.1 – Non-contaminated and Non-activated Objects, 7.2- Contaminated Objects** and **7.3 Activated Objects.**

Chapter 8: Waste Management

A qualitative and quantitative estimate of the decontamination and dismantling waste is provided. Classification of this waste is also provided according to the criteria defined by COVRA. This classification includes the physical and radiological characteristics of the waste, based on the radiological characterization of the various components as gathered in the DIS.

The radioactive waste (including decommissioning waste) are characterized, removed, treated, conditioned and disposed of in conformity with the procedures applicable, at the moment they are produced, for the other radioactive waste such as the operational waste (according to COVRA waste classification).

The exemption is declared in conformity with the applicable rules, i.e. by the Health and Physics Department at the plant, in agreement with the Control Authorities. After free release, the Operator removes them in accordance with the rules applicable to industrial waste.

The exemption methodology is described, including possible recycling.

The corresponding needed installations are described (techniques and equipment for the radioactivity measurements and their characterisation).

Furthermore, adequate description of the radiological measurements at large will be given in order to clarify what is really included in the cost estimate.

The treatment and conditioning methods applied to the primary masses and to the secondary masses as well as their final destination are detailed.

Chapter 9: Planning

Overall planning for the different decommissioning steps according to the chosen strategy, building per building, and, in some buildings, area per area where relevant.

Chapter 10: Decommissioning Costs

The global decommissioning costs are given as well as their yearly distribution and their distribution amongst the different working packages. All costs are given as overnight costs.

Notes:

The decommissioning cost estimates should be "complete" and enough details should be given in order to justify the completeness of the costs, i.e. to specify what is included and what is not included. Therefore the Contractor shall check, with reference to the Interim Technical Document developed jointly by work of the EC, the IAEA and the OECD/NEA "A PROPOSED STANDARDISED LIST of ITEMS FOR COSTING PURPOSES in the DECOMMISSIONING OF NUCLEAR INSTALLATIONS", that all relevant items for costing purpose have indeed been considered in his decommissioning costs estimates. Should it not be the case for some items, the Contractor shall exhaustively list these items with an appropriate justification.

Appendix 2
Remarks to be taken into Account for the Drafting of the PDP

1. The PDP will be based on the equipment and materials database developed for Dodewaard NPP (DIS: "Dodewaard Inventaris Systeem").

2. The uncertainties will be clearly identified and justified in the PDP.

3. The radiological measurement techniques have to be described in chapter 7 of the PDP and the corresponding assumptions on basis of which the costs are evaluated will be given.

4. The Contractor will provide, for each type, the number of waste packages to be produced (for primary, secondary and tertiary masses) and check that their doses rates are below the maximum dose rate limit (contact dose rate < 2 mSv/h).

5. The Contractor shall explicitly take into account the secondary and tertiary waste (quantities, treatment/conditioning methods, resulting waste packages types, quantities, and associated costs).

6. The transportation costs for waste will be updated with other boundary conditions. The Contractor will pay attention to the dose rate limits and to the radioactivity contents limits for the waste packages for transportation purpose that shall comply with the "ADR" regulation. Where necessary, use of inner shielding or (when possible) of temporary outer shielding will be analysed. Useful packing volume and transportation costs will adequately be adapted when necessary.

7. In order to perform safely the D&D activities, new equipment/facilities and/or refurbishment of existing equipment/facilities will be needed. This will be the case, among others, for new liquid and solid waste management facilities, handling devices, ventilation systems, site security, etc. It should also be noted that there is no more cooling system available at the site, and that a new Reactor Building door will have to be installed. The Turbine Building door is still in place and can be reused, but the wall in front of it has to be removed. Old electrical cables and transformers cannot be used anymore and are partly dismantled. A new transformer must be erected in the Site Entrance Building and E-facilities where enough place is available. Moreover, the sanitary facility has to be expanded.

   In a general way, the Contractor will have to consider the actual situation of the Plant, in order to define which systems and equipment may be reused directly, after refurbishment, or if new systems and equipment will have to be ordered.

   Moreover, all needed investments:

   - specific non standard D&D tools,
   - waste treatment and conditioning facilities,
   - radiological measurements facilities, including initial characterization, characterization during and after D&D, free release measurements, …

- etc,

will be adequately described in order:

- to justify that all what will be necessary is indeed taken into account,
- to allow to check adequateness of the selected systems and equipment or infrastructures,
- to allow to check adequateness of the corresponding costs.

In particular the D&D methods and tools will be more detailed than in [1] and [2], and the corresponding choices justified, even if optimization possibilities/needs are left open for the Final Decommissioning Plan.

8. The Contractor shall propose:

   - A simplified time-schedule, showing the main D&D steps;
   - A detailed time-schedule covering the whole D&D period.

   The Contractor shall justify the proposed time-schedule and show that it is robust. In particular, the size of the rooms, the possibilities to handle and move on the dismantled parts and waste packages will be given full consideration.

9. The Preliminary Decommissioning Plan will mention the references of the technical notes on the basis of which they are built. This should be in particular the case for the RPV and biological shield activation studies.

10. Aspects related to asbestos removal shall be explicitly dealt with in the PDP, based on the existing inventory, and/or shall be taken into account in the uncertainties.

11. On the basis of boundary conditions given in points 3 to 7 in Appendix 6, NIS will define the number and qualification of GKN staff needed during the D&D activities preparation and implementation, as well as the number and qualification of the decommissioning personnel of a General Contractor. The Operator considers that a small GKN staff will be in charge of the control of the site and responsible for the Health Physics, while the General Contractor will perform all decommissioning work. Note: Health Physics may be sub-contracted, but in any case, GKN remains responsible. By law, the presence of at least one GKN health physicist is requested.

12. The Contractor attention is drawn on the fact that he has to be sufficiently acquainted with the actual situation of the Plant and to pay necessary visits at the Plant to check full adequacy of the proposed solutions and of their implementation costs, identifying among others which systems and equipment can be reused, with or without refurbishment, and which new equipment/systems are needed. It should be noted that during PSE it was assumed that no existing equipment could be reused, with the exception of the Turbine- and Reactor Building cranes. Nevertheless, electrical cables and handling ropes of the Turbine- and Reactor Building cranes are to be changed. Another exception might be the storage tanks, but the connecting valves must be checked. If needed for the new decommissioning cost estimate, the Contractor is allowed to take photographs of the Dodewaard plant and site.

Appendix 3

1999 Study Concerns to be taken into Account for the Drafting of the PDP

1. Accuracy of the equipment and materials database

The equipment and materials database developed for Dodewaard NPP (DIS: "Dodewaard Inventaris Systeem") is sufficiently complete to be able to infer reasonably well substantiated cost estimates of the dismantling activities.

The comment about the accuracy of the inventory will be dealt with through Tasks 1.2.1 and 1.2.2, using the uncertainties proposed in Appendix 9.

Asbestos is dealt with in point 3 here after.

2. Licensing of new radioactive waste packages

In the previous study, financial provisions for the qualification, in The Netherlands, of waste containers that are qualified in Germany were not included.

2.1. Licensing of transport packages (type B)

According to international regulation, a type B transport-package that is certified in an "ADR"-country (Germany, France, and Belgium for instance) is accepted in all other ADR-countries, therefore also in The Netherlands, for all transport-modes, except air-transport. This rationale is not valid for the transport of fissile material. Certification must stem from 1996 or later. Of course, for the actual transport, a license is needed, which is a rather straightforward procedure when above mentioned conditions are satisfied.

2.2. Licensing of waste (storage or disposal) packages

The KONRAD containers, that are licensed in Germany, can be used for transportation, storage at COVRA and final disposal. To enable these uses, a license application shall have to be introduced at VROM but the corresponding costs are out of the scope of this project.

Further to the license extension of COVRA facilities, dated 17.10.2003, following MOSAIK containers types may be stored on COVRA site:

- Types II-15 EI and II-15 U EI;
- Type II-15 P/U.

3. Removal of asbestos

Although the cost of asbestos removal has been deliberately left out of the previous cost estimate, an accurate asbestos inventory in the Dodewaard installations is available.

Starting from this inventory, the Contractor shall validate the cost estimate of [redacted] (1999 figure), estimated by GKN through the involved masses on the basis of past experiences. This additional cost must be updated for inflation and accounted for in the KCD new Decommissioning Cost Estimate.

4. Depth of activation in reactor vessel pit

The characterization programme performed by GKN has enabled to generate a precise cartography of the activation of the biological shield. This cartography is synthesized in figure 2 of the document entitled "Status of the Dodewaard Plant Annual Report 2007 (as per June 30th 2007)" (NUKEM report 6849/CA/F 007749 9/00 – August 31, 2007), which is updated yearly. The last available issue of that report will have to be used.

5. Duration of dismantling planning

The duration of the dismantling planning as defined in the previous study, which foresees 3 years of preparation and 4 years of dismantling activities, was questioned by the Task Force (TOK).

The 3 years of preparation include the preparatory work of dismantling as well as 6 months for the Dutch Authorities to issue the dismantling license. In practice, the Environmental Impact Assessment Report (EIAR) and the Safety Analysis Report (SAR) will be prepared in advance and contacts will be taken with the Authorities before these documents are submitted to the Authorities. The 6 months period starts when these documents are submitted to the Authorities. The 4 years of dismantling activities were estimated on a continuous working base.

It is proposed that the comments related to the non-sustainability of the planning, because of the too limited available space, are to be adequately addressed by the Contractor in the PDP (see Appendix 2, remark n° 8). In that frame, the Contractor is invited to pay enough visits to the KCD plant (see also remark 12 in Appendix 2).

In conclusion, the Contractor shall define sustainable time-schedules for the preparation and dismantling phases, with due justification.

Appendix 4

Drawing and Explanations related to the New Buildings in the frame of the Decommissioning Preparation

Reference is made to the drawing given here after (Note: This drawing is for information only and is not to scale).

It should be noted that site security equipment, cables and (waste-) waterlines are situated in the land and will be affected while erecting new buildings. The current ring road at the plant is unsuitable for extreme heavy traffic.

<u>Explanations related to new buildings:</u>

- Number 12: Entries to Turbine building

  Currently all entries are closed by brick walls. These can be easily removed. The main entry door is still in place and can be reactivated.

- Number 13: New waste conditioning building

  As it is expected that some heat exchangers and pumps will be disposed of in one piece, a facility must be in place to put cement in the waste containers. The existing waste building will be decommissioned. This area will also act as a hold up area for drums waiting to be transported to COVRA. The building size has to be defined. Decontamination and cutting of material to acceptable sizes and first check for free release, sorting for melting or sorting for direct disposal will be done in the former turbine building (Turbine and generator are to be removed at start of decommissioning).

- Number 14: Office building

  Currently there is no office building on site and paperwork is done in the room which is officially the entrance to the sanitary area. There is an office space in the auxiliary building. As an alternative, this room can be used, even combined with the former control room. During final dismantling of the buildings, a temporarily office must be set up.

- Number 17: Building for free release measurements

  In this building there must be ample space for very-low level radioactivity checks. This building is as far away as possible from other contaminated buildings. It might be separated from the site by a special fence.

- Number 18: Extension of sanitary area

  Currently the sanitary area is very small and consists of one shower (contaminated side) and no shower or personal cleaning facilities in the clean area. There is only one toilet. Number of lockers is limited.

- Number 19: Entry to the Reactor building

  At this location there used to be a door to transport components from this building to the outside. The door has to be reinstalled.

[redacted]

LEGENDA SAFE ENCLOSURE GKN DODEWAARD

Existing Plant

1 Bridge
2 Site entrance building and E-facilities
3 Truck entrance
4 Reactor building
5 Ventilation building
6 Waste building
7 Auxillary building, sanitary area
8 Entrance to SE
9 Turbine building
10 Coolingwater building
11 Jetty
15 Parking area
16 River area

New buildings / doors

12 Former entries Turbine building
13 Waste conditioning building
14 Office building
17 Building for free release measurements
18 Extencion of sanitary area
19 Former entry Reactor building

Appendix 5
Waste Evaporator and Decontamination Agents

1. Introduction

- At the third meeting of the working group, it was stated by COVRA that the RPV cannot be removed in one piece. As a result, cutting of the vessel needs to be done. Therefore, water is needed to flood the vessel (50 m^3), the drywell (100 m^3), the refuelling pond (300 m^3) and the storage pond (400 m^3). This water must be treated after use in the reactor building before release to the river.
- Storage capacity for (waste) water is available in the centrally located wastewater treatment room. Tanks involved are LVA-1 (60 m^3), LVA-2 (60 m^3), DHS-1 (60m^3), AWO-1 (60 m^3), SSW-1 (120 m^3), WWB-T1-T2-T3 (3*6 m^3) and VWB-T1-T2 (2*12 m^3).
- The wastewater treatment area is centrally located in the buildings. Pipelines from the Reactor building are still in place, however all pipelines from the Waste building are cut at two places.
- Shielding is already available.
- Material condition of the tanks, pipelines, valves and pumps in the waste water treatment area is good, but everything must be checked.
- The electrical system in the waste water treatment area is demolished, cannot be restored, so must be renewed.
- From the sanitary area, some contaminated water must be expected during the decommissioning. Currently the storage capacity for this water is 2*2 m^3, which is far too less for the period of final decommissioning.
- The existing evaporator is located in a building that is contaminated and must be decommissioned.
- The existing evaporator is heavily clogged, and can not be restarted.
- The cooling water lines to the river are cut while the former Cooling water building is partly dismantled and cannot be re-used.

2. Defined problem

During KCD dismantling a flow of (slightly) contaminated wastewater will occur. This water must be treated before being released.

As precipitation by a chemical plant and / or a centrifuge or decanter needs a lot of space and attention, a simple solution for treating and storage of wastewater should be adopted.

3. Proposals

- Reactivate parts of the former wastewater treatment area, like some valves, pumps, pipelines and tanks. Make the operation of the system simple and manual.
- Remove all redundant equipment in this room, especially the former LVA demineraliser, in this way creating space for a new, small evaporator. (Materials to be stored temporarily in the lower part of the Turbine building before final decommissioning. As this material is not heavily contaminated it can act as a pilot for the start of dismantling).
- Cooling of the evaporator should be done by air cooling. The coolers can be erected just above the evaporator, that is on top of the former control room (auxiliary building), or outside in the yard close to the new sanitary area building.
- Connect existing sanitary water storage tanks to former sanitary wastewater tanks in the wastewater treatment room by new pipeline.
- Use VWB-T1-T2 as water release tanks.
- Set-up a new release line, directly to the river to avoid hold-up of radioactive materials in the existing cooling water outlet channel.

Note: this is comparable to the situation at KWL at this moment. Due to the amount of water generated, a new evaporator was installed by Siemens as a turnkey project.

Use of decontamination agents:

Currently there is no large storage area for spent decontamination agents. In case the wastewater treatment area is reactivated as described before, some storage capacity is created but storage capacity is limited, while evaporator capacity is also limited. This implies the use of chemical decontamination and rinsing should also be limited. Therefore the use of "chemical cleaning" should be limited to the use of steam and carbon dioxide ice blasting.

Currently no facility for ice blasting or steam cleaning is available on site. Tests in the past by using carbon dioxide ice for cleaning were effective.

4. Conclusions

The "chemical decontamination" should be limited to the use of carbon dioxide ice and steam, in order to limit the amount of wastewater to be treated, while reactivation of (parts of) the wastewater treatment area is necessary in order to deal with expected wastewater amounts. A small evaporator must be installed. A new release line directly to the river has to be arranged.

Appendix 6

Boundary Conditions for Reference Scenario

1. Non-radioactive concrete rubble is to be reused or sent to a landfill.

2. Costs related to the Authorities have to be included and represent some [redacted]

3. The yearly costs for the Safe Enclosure period are [redacted] This amount includes the costs for personnel, insurances, taxes, administrative fees and GKN management activities. These costs are applicable not only during the SE period, but also during the dismantling period.

4. The KCD personnel during the SE period, includes:
   - three agents in charge of operation,
   - one equivalent full-time administrative agent.

5. It is assumed that, apart of the activities to be performed by the KCD staff (including the relations with the Authorities, with COVRA, etc), all the planning and execution of the D&D works will be performed by an external General Contractor, in the frame of a single contract.

6. The General Contractor staff wages, to be used for the calculation of the decommissioning cost, are based on relevant wages of German companies active in D&D activities.

7. GKN staff wages for its personnel and for the supervisors/controllers to be hired to be considered for the decommissioning cost estimate shall be based on relevant German wages.

8. The decommissioning cost shall cover all expenses related to the dismantling preparation phase as well as for the dismantling phase.

9. Both absolute costs and net present value costs are calculated; the discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk) is 4%.

10. The reference date for the price level of the cost calculation is taken as 01.01.2009.

11. VAT is not included in the costs calculations.

12. The radiation exposure has to be maintained ALARA. In any case, the radiation exposure per person is limited to 20 mSv/year.

13. All materials in the controlled area are supposed as being radioactive, unless measurements indicate that the contamination is below the clearance levels. Two cases will be considered by NIS:

- The clearance levels are those specified in the "Kernenergiewet", e.g. clearance limits are:
  - 1 Bq/g for ^{60}Co;
  - 10 Bq/g for ^{152}Eu and for ^{154}Eu;
- IAEA RS-G-1.7 clearance levels have to be complied with:
  - 0.1 Bq/g for ^{60}Co;
  - 0.1 Bq/g for ^{152}Eu and for ^{154}Eu.

14. The costs of incineration and melting of radioactive waste (including transport) are based on actual costs of existing European facilities. In this case, they will be specified and justified by the Contractor.

15. The COVRA waste management costs to be considered in the present study are given in Appendix 7 (based on [9], [11] and [12]).

16. The cleaning of the personnel contaminated clothes (overalls, masks, etc.) shall be sub-contracted to an external service company. In principle, there is no need for a new dedicated laundry at the site.

17. The goal of the decontamination and dismantling activities is to reach green field. The dismantling includes the removal of the buildings, of all the various underground structures, including among others the foundation piles, the cooling water inlet structures, and bringing the soil of the site at the same level as the surroundings.

18. The discharges limits and conditions for radioactive effluents are dealt with in Appendix 8 (based on [7]).

19. The site security must meet the rules defined by VROM.

20. The existing on-site infrastructure is not suitable for decommissioning because most pipelines are cut, the old electrical system has been destroyed and the evaporator is broken and cannot be repaired anymore. Recovery of existing equipment is limited to some of the storage tanks.

Appendix 7

COVRA Waste Management Costs

1. COVRA Tariffs for Waste Processing (2008)

Note: The tariffs, applicable for 2009, will be provided by COVRA. The new decommissioning cost estimate shall take these tariffs into account.

1.1. Solid Waste

Type of Waste	2008 Cost (Euros)
Compactable Waste in standard 90-l drums	10 1 c [redacted]
Super-compaction cost, per drum	
Super-compaction cost to increase with a supplement depending of the puck height: • For 90-l drum surface dose rate ≤ 0.2 mSv/h, per puck cm • For 90-l drum surface dose rate > 0.2 mSv/h, but ≤ 2 mSv/h, per puck cm	
Super-compaction cost to increase with a supplement depending of the liquid release through the compression, per litre	
Non-compactable waste, per standard 90-l drum	
• For 90-l drum with a surface dose rate ≤ 0.2 mSv/h	
• For 90-l drum with a surface dose rate > 0.2 mSv/h, but ≤ 2 mSv/h	

1.2. Liquid Waste

Type of Waste	2008 Cost (Euros)
Liquid Class I (non-organic) • Per standard 60-l drum • Per standard 30-l drum	[redacted]
Liquid Class II (organic) • Per standard 60-l drum • Per standard 30-l drum	

2. Empty Containers

Solid Waste

Type of container	Outer dimensions (in mm)	Wall thickness (in mm) / material	Cost (Euros)
1000-l container (*)	Φ: 1000; h: 1250	180 / concrete	[redacted]
1000-l container(*)	Φ: 1000; h: 1250	180 / magnetite concrete	
200-l drum (*)	Φ: 580; h: 920	1.5 / galvanised steel	
90-l drum(**)		1 / steel	

Liquid Waste

Type of container	Cost (Euros)
60-l drum (**)	[redacted]
30-l drum (**)	

(*): see [12].

(**): container made available by COVRA.

3. Transportation, Interim Storage at COVRA, and Disposal

(See appendix "TARIEVEN GECEMENTEERD AFVAL" to [11]).

Type of container	Cost (Euros, 01.01.2008)
200-l container, with a surface dose rate ≤ 0.2 mSv/h	[redacted]
200-l container, with a surface dose rate >0.2 ≤ 2.0 mSv/h	
200-l container, with a surface dose rate >2 ≤ 2.5 mSv/h	
200-l container, with a surface dose rate >2.5 ≤ 4.0 mSv/h	
200-l container, with a surface dose rate >4 ≤ 10 mSv/h	
1000-l container, with a surface dose rate ≤ 0.2 mSv/h	

1000-l container, with a surface dose rate >0.2 ≤ 2.0 mSv/h	[redacted]
1500-l container, with a surface dose rate ≤ 0.2 mSv/h	[redacted]
1500-l container, with a surface dose rate >0.2 ≤ 2.0 mSv/h	[redacted]
MOSAIK- containers Type II-15 EI, Type II-15 U EI, Type II-15 P/U	[redacted]
KONRAD-container, Type II (1.6 x 1.7 x 1.7 m; max 15,000kg)	[redacted]

Note: General and Technical conditions for the transfer to COVRA of standard radioactive waste are given in following COVRA's documents:

- ALGEMENE VOORWAARDEN (ingangsdatum 1 januari 2008) in zake de overdracht van radioactief afval aan COVRA;
- TECHNISCHE VOORWAARDEN (ingangsdatum 1 januari 2008) voor overdracht van standaard radioactief afval aan COVRA.

Appendix 8

Release Limits of Radioactive Effluents

1. Introduction

During the final dismantling of the plant it is expected the former ventilation system used during power operations will be partly restored, while the ventilation system used for the "Waiting period" will be partly dismantled. Also combinations of the two systems might be used. However, during all circumstances, ventilation air will only be released via a HEPA filter to avoid the release of particles.

For the arising amount of wastewater a treatment before release to the river is foreseen, to limit the release of radioactive materials.

Release limits for air and water must be defined.

2. Gaseous Effluents

As there is no fuel on site it is not possible to release noble gases and iodines. It is believed there is still some tritium (H-3) and carbon 14 (C-14) trapped in the concrete, presumably by chemical bindings, like CaHCO3. Also some C-14 might be still present in the former liquid waste storage tanks (spent resins). However, during the last years of operating the Safe Enclosure, the release of H-3 and C-14 is very low or zero. This is backed-up by the control measurements performed by the National Institute for Public Health and Environmental Health (Governmental Body, Dutch name RIVM). Recently GKN started discussions with the Regulator to be dismissed from performing these analyses. (Motivation: releases if any are very low, and these radioactive isotopes cannot be trapped). During dismantling there is a chance that some small amounts of C-14 and H-3 will be released. GKN will not apply for a release limit for C-14 and/or H-3.

It should be noted that for German decommissioning projects, no limits on H-3 and C-14 releases are in place, and no measurements performed.

For the final dismantling only Co-60, Cs-137, potentially some Cs-134, and Eu-152/154 might become airborne. There might be some other trace elements as well. All these elements can become airborne as particles, and will be trapped by the HEPA filters.

The limit for aerosols was the same for Operation, Preparation for Safe Enclosure, and Waiting Period, being 1 GBq per calendar year.

GKN will apply for the same aerosol limit for the period of final dismantling.

This limit was never reached during the preparation period of the Safe Enclosure ("Buitenbedrijfstelling") and the Waiting period up till now. Actually, no aerosols were being released at all. The calculated aerosol release is in fact below the detection limit of the equipment (MDA).

3. Liquid Effluents

Water releases during the period of operation were limited by a limit value for total beta/gamma, tritium and total alpha releases. Total alpha was never detected during the last ten years, as there have been no fuel leakages in the last ten years, except from two pinholes that created a minor release of noble gases. In the early 70's, a real fuel leakage did occur (loss of lower end plug), in this way releasing some alpha activity in reactor water. According to GKN the plant is free of alpha emitting nuclides. This is backed-up by the analyses of samples during the preparation for Safe Enclosure.

For reasons explained above, GKN believes it is not opportune to have tritium in water sampled and measured.

During operation the release limit for total beta/gamma was 100 GBq per calendar year. At that time GKN released partly treated sump water (drains), laundry and sanitary water not being treated at all, and water from the evaporator. The release limit was never reached. It is proposed to have most of the occurring wastewater being treated by an evaporator. Therefore GKN will apply for the same release limit as the one used during operations.

4. Summary

GKN will apply for the following release limits.

Air: aerosols 1 GBq per calendar year, no sampling and analyses for H-3 and/or C-14.

Water: total beta/gamma 100 GBq. No sampling for H-3 and / or alpha.

Methods of sampling and analyses will be discussed during preparation of the license. Expected is the use of (amended) KTA rules, as is done currently and was done in the past. Currently the use of KTA rules is described in section E of the Nuclear License. These German rules for water and air releases have been accepted by all Dutch NPPs, however, some adaptations to the Dutch situation were accepted by the Regulator.

Appendix 9

Uncertainties

#	Uncertainty	Margins to be Included in the PDP	
1.	Physical Inventory	Activated parts	Mass + 10 %
		Main components	Mass + 5 %
		Biological shield	Mass above release level: + 10 %
		Contaminated systems	Mass + 5 %
		Contaminated equipment	Mass + 5 %
		Building masses	Mass + 5 %
		Stairs, platforms, other structures	Mass + 5 %
2.	Radiological inventory and decontamination efficiency	For the activated and/or contaminated waste: assume +10 % increase of the radioactive waste.	
3.	Decontamination of concrete	A 10 % increase of the calculated efforts for the decontamination of the concrete surfaces.	
4.	Dismantling efficiency	Increase the needed man-hours per kg in the calculation by 5%.	
5.	Boundary Conditions	No uncertainty on waste management costs to be considered.	
6.	Costs of external services and deliveries	1 % on top of average long term inflation rate as provided by the Dutch Central Statistics Agency CBS ("Centraal Bureau voor de Statistiek").	
7.	Personnel costs	Supposed to increase of 3 %/year (based on the figure of 3%/year for the industry in The Netherlands).	
8.	Investments	Increase of 5 %/year.	
9.	Taxes and insurances	No uncertainty is to be considered.	
10.	Overall time schedule	The total project duration is increased by three additional months.	

Notes:

The margins related to points 1 to 3, 5 to 10 are specified by GKN. For points 7 and 8, margins were adapted after dialogue between GKN, VROM and COVRA. The margin related to point 4 is chosen by NIS. Following justification is provided:

1. Physical Inventory

   Activated parts: Although the activation calculations were backed up by sampling, some mistakes must be taken into account.

   Main components: Main components masses were taken from original drawings and minor mistakes might occur.

   Biological shield: Although a huge sampling program followed the calculated activation of the biological shield (and in most cases measurements did meet calculations), some scatters might be found, especially in the drywell, that can influence the total mass. The mass of the biological shield itself should be correct, as it was easily calculated from the drawings.

   Contaminated systems: the DIS gives full information on all contamination in systems, including the masses. The DIS was built by a group of Physics and Health Physics, assisted by lab technicians who did the gamma spectroscopy.

   Contaminated equipment: see contaminated systems. Contaminated equipment is part of DIS.

   Building masses: All building masses were taken from original drawings. Therefore the uncertainty to consider is only related to possible calculation errors.

   *Stairs, platforms, other structures: S*ee building masses.

2. Radiological inventory and decontamination efficiency

   The proposed figure is typical for uncertainties in radiological measurements, in particular at low radioactivity levels.

3. Decontamination of concrete

   Although decontamination of concrete can be done relatively easily, it is often cheaper to dispose of the rubble rather than to decontaminate it. Based upon experiences in the past and the operational record of the plant, GKN considers that concrete contamination is at the surface. However, at some locations, it might be a bit deeper due to cracks. Due to lack of real measurements results, a level of 10% can be added.

4. Dismantling efficiency

   The margin related to the dismantling efficiency is chosen by NIS on the basis of the return of experience of actual decommissioning projects. In principle, no uncertainty should be added, because, by definition, the Best Estimate case should give an estimate of the cost as really expected. Nevertheless, in the frame of an estimate of what could be the upper cost in the worse case, 5 % is considered as a maximum to be taken into account.

5. Boundary conditions

   The waste management costs to be used for the present project are defined in agreement with or by COVRA.

6. Cost of external services and deliveries

   Although prices do go up, it is assumed only inflation must be taken into account. However in order to be on the safe side, it is proposed to add one percent to the average long term inflation figure.

7. Personnel costs

   It is assumed the average pay rise in The Netherlands will stabilize at current levels. This is roughly 3% each year for the industry.

8. Investments

   For investments in equipment the same applies as described under "Personnel Costs".

9. Taxes and Insurance

   It is considered that taxes and insurance costs will continue to be stable in the coming years, as these were in the past. Under such assumption, correction for inflation only is deemed necessary.

10. Overall time schedule

    Licensing process: Although there is always a possibility that the license will be discussed in court, the terms for court hearings and decisions are given by law. No delay expected. The time period of 6 months is used (as discussed in point 5 of Appendix 3).

    Dismantling the RPV: The dismantling should be planned based upon results of previous dismantling, in order to have a realistic planning. Considering this, no delays are foreseen.

    Site release: The same applies for site release as for RPV dismantling.

    A total project contingency of three months can be added to the total project time. Incentives could be included in the contract for the General Contractor to perform the decommissioning according to planned project duration and budget.

    Note: Paperwork will continue for some period of time after the dismantling is complete, including record keeping, and storage of records (contracts are already put in place with "Rijksarchief Gelderland" and "Nationaal Archief").

20081217 - COVRA

COVRA NV
Centrale Organisatie Voor Radioactief Afval

Spanjeweg 1 (Havennummer 8601)
Industrieterrein VLISSINGEN-OOST

Correspondentieadres:
Postbus 202
4380 AE VLISSINGEN

Telefoon : 0113-616666
Telefax : 0113-616650
E-mail : info@covra.nl

Ministerie VROM
Directoraat-Generaal Milieu
Directie Risicobeleid / IPC 645
10 2 e [redacted]
Postbus 30945
2500 GX DEN HAAG

Ons kenmerk: [redacted]080556 Uw kenmerk: -- Datum: 17 december 2008

Onderwerp Ontmantelingskosten KCD

Geachte [redacted],

In antwoord op uw brief van 10 december betreffende de TRF Dodewaard kan ik bevestigen dat de TRF in gezamenlijk overleg van VROM, COVRA en GKN is opgesteld. COVRA beschouwt de TRF dan ook als een goede basis om tot herrekening te komen van de ontmantelingskosten Dodewaard.

Hoogachtend,

CENTRALE ORGANISATIE VOOR RADIOACTIEF AFVAL(COVRA) N.V.

[redacted]

Directeur

SCAN01/000079212

VROM / DGM
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COVRA NV, Centrale Organisatie Voor Radioactief Afval
KvK Middelburg, dossiernr. 22029665

20090119 - VROM

10-2-2011

> Retouradres Postbus 30945 2500 GX Den Haag

B.V. NEA
10 2 e [redacted]
Postbus 46
6669 ZG Dodewaard

Directoraat-Generaal Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB 2009004167

Bijlage(n)
Brief COVRA d.d. 17 dec 2008

Datum 19 JAN. 2009
Betreft Akkoord COVRA met TRF als uitgangspunt voor berekening ontmantelingskosten kerncentrale Dodewaard.

Geachte 10 2 e [redacted]

Tijdens het overleg tussen NEA en VROM d.d. 9 december 2008 is afgesproken COVRA nog een schriftelijk akkoord te vragen voor het toepassen van de in dit overleg vastgestelde Technical Requisition File (TRF) als uitgangspunt voor de berekening van de ontmantelingskosten van de voormalige kerncentrale Dodewaard.

Zoals uit een bijgevoegde kopie van de reactie van COVRA d.d. 17 december 2008 valt op te maken is COVRA akkoord met dit voorstel.

Hoogachtend,
De directeur Risicobeleid

[redacted]

20090930 - De Brauw

Advocaten
Notarissen
Belastingadviseurs

DE BRAUW
BLACKSTONE
WESTBROEK

Claude Debussylaan 80
Postbus 75084
1070 AB Amsterdam

[redacted]

Tevens per telefax 070-3391286
De Minister van Volkshuisvesting,
Ruimtelijke Ordening en Milieubeheer
Postbus 30945
2500 GX Den Haag

va 5/10
ambtl

Datum 30 september 2009

Uw ref. RB/2009036788
Onze ref. M6856974/1/10690409/tk

[redacted]
Advocaat
10 2 e [redacted]

Betreft: Voorstel tot wijziging Kernenergiewet (30 429)

Excellentie,

Uw brief van 29 september 2009 ontving ik heden in goede orde.

U refereert aan een gesprek dat heeft plaatsgevonden tussen "bestuurders van GKN" en vertegenwoordigers van het Ministerie. Ik neem aan dat u doelt op het gesprek van woensdag 26 augustus jl. Zijdens GKN namen daaraan deel [redacted] en [redacted]. Beiden zijn niet bestuurder van GKN. Zoals u weet is B.V. Nederlands Elektriciteit Administratiekantoor enig aandeelhouder en bestuurder van GKN. De [redacted] is directeur van NEA, [redacted] is voorzitter van de Raad van Commissarissen van NEA. Tijdens het voornoemde gesprek is door uw Ministerie toegezegd dat de landsadvocaat gevraagd zou worden om advies in deze, en ik ga er dan ook vanuit dat uw brief van 29 september 2009 mede op advies van de landsadvocaat is geschreven.

Enerzijds is verheugend te zien dat uw Ministerie nu eindelijk erkent dat de strafbaarstelling in de wet van wat u noemt de huidige bestuurders van GKN "ongelukkig" is, en dat u overweegt in het wetsvoorstel een wijziging op dit essentiële punt aan te brengen. Het is een essentieel punt, omdat de verplichting financiële zekerheid te stellen voor amovering een hoeksteen van het wetsvoorstel is, en het wetsvoorstel in feite alleen relevant is voor GKN, omdat de Staat van andere kerncentrales eigenaar is of op basis van een convenant het punt van de financiële zekerheidstelling al heeft geregeld. GKN begrijpt in dit licht niet dat u schrijft te overwegen dit kernpunt aan te passen, maar dat GKN tegelijkertijd van uw Ministerie begrijpt dat het wetsvoorstel (blijkbaar ongewijzigd) hals over kop in stemming wordt gebracht in de Tweede Kamer op 1 oktober aanstaande (morgen). Ligt het niet voor de hand dat de Minister een beslissing neemt over de wijziging van een kernpunt in het wetsvoorstel voordat de Tweede Kamer erover stemt, in plaats van erna? GKN neemt aan dat de Tweede Kamer graag van de Minister zal willen vernemen of het wetsvoorstel op dit punt wordt gewijzigd, of niet.

In uw brief blijft verder onduidelijk wat de betekenis van de verplichting tot financiele zekerheidstelling is, als de strafbaarstelling van de bestuurders van GKN voor het niet naleven van deze verplichting wordt verwijderd. Moet GKN uit uw brief begrjipen dat de verplichting tot het stellen van financiële zekerheid in het geval van GKN enerzijds wel blijft gelden, maar dat anderzijds geen handhavingsactie ter zake van die verplichting jegens GKN zal worden ondernomen indien uw Ministerie het standpunt inneemt dat binnen GKN onvoldoende fondsen aanwezig zijn? Indien dit het geval is, waarom wordt het dan toch nuttig geacht die verplichting voor GKN te handhaven?

U stelt in uw brief ook vast, naar ik begrijp, dat het wetsvoorstel niet inhoudt dat NEA aansprakelijk is of kan worden gesteld voor een eventueel tekort in GKN. Aangezien uw eerdere correspondentie en de toelichting op het wetsvoorstel niet duidelijk zijn op dit punt, is dit voor GKN en NEA een uiterst belangrijke vaststelling.

U schrijft tot slot dat u nader zal onderzoeken in hoeverre "de aandeelhouders (en de partijen daarachter)" op grond van het civiele recht aangesproken kunnen worden voor een eventueel tekort in GKN. Ik merk op dat GKN slechts één aandeelhouder heeft, te weten NEA. Wat u bedoelt met "de partijen daarachter" is niet duidelijk. Voor zover u bedoelt te gaan onderzoeken of NEA aansprakelijk gesteld kan worden voor tekorten in GKN, verwijs ik u naar de brief van GKN aan u van 10 februari 2009. Zoals op blz. 3 daarvan is aangehaald, heeft zelfs de Minister van Economische Zaken - in een brief aan de Minister van VROM van 14 maart 2002 - reeds in niet mis te verstane bewoordingen duidelijk gemaakt dat NEA niet aansprakelijk is.

Hoogachtend,

[redacted]

20091022 - VROM

Ruimte en Milieu
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

B.V. NEA
10 2 e [redacted]
Waalbanddijk 112a
6669 ZG Dodewaard

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2009058475

Uw kenmerk
M6856974/1/10690409/tk

archiefkopie

Afschrift aan
[redacted]

Paraaf 10 2 e [redacted]
dRB

Paraaf
BJZ

Datum
Betreft Discussie ontmantelingskosten kc Dodewaard

Geachte [redacted],

Naar aanleiding van de laatste brief van uw advocaten (d.d. 30 september 2009) het volgende:

Het wetsvoorstel tot wijziging van de Kernenergiewet is inmiddels aangenomen door de Tweede Kamer, inclusief een vierde nota van wijziging, waarvan de strekking is dat voor wat betreft de strafbaarstelling van het niet nakomen van de verplichting tot het stellen van financiële zekerheid voor GKN een uitzondering wordt gemaakt. Daarmee is tegemoet gekomen aan een belangrijk pijnpunt voor GKN, zoals besproken in ons laatste gesprek van 26 augustus 2009.
In dit gesprek is verder vastgesteld dat beide partijen hun (elkaar bekende) standpunten handhaven, en dat er verdere voortgang kan worden gemaakt met de acties naar aanleiding van de Strategienota van GKN. Ik vraag me in dit licht echter af wat een verdere discussie tussen de Minister en uw advocaten op dit moment kan bijdragen aan deze voortgang. Ik stel daarom voor deze discussie met de advocaten voorlopig te beëindigen, en onze gesprekken in het kader van de *Strategienota* voort te zetten.

Hoogachtend,

[redacted]

secretaris-generaal

SCAN01/00007923

20100225-1 - GKN

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GKN B.V. Gemeenschappelijke Kernenergiecentrale Nederland

DEPONEREN
d.d.: 06 APR 2010

Archief VROM Centraal
zaak | doss
Datum: 3 maart 2010
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Te behandelen door | datum | paraaf
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Na behandeling retour archief
Deponeren dd.

Het ministerie van Volkshuisvesting
Ruimtelijke Ordening en Milieubeheer
[redacted] Secretaris-Generaal
Rijnstraat 8
2515 XP DEN HAAG

X Ak

Uw kenmerk	Ons kenmerk	Behandeld door	Doorkiesnummer
[redacted]	DR10-005	[redacted]	[redacted]

Onderwerp	Datum
Overleg VROM-NEA/GKN op 3 feb. 2010	25 februari 2010

Geachte [redacted],

In goede orde heb ik uw concept verslaglegging van de bespreking van 3 februari 2010 ontvangen. [redacted] en ik zijn (zeer) teleurgesteld over de inhoud van dat concept, dat het besprokene noch juist noch volledig weergeeft. U vindt hierbij een versie met onze suggesties, die zijn gebaseerd op onze eigen interne verslaggeving. Daarnaast wil ik door deze brief mijn zorgen kenbaar maken over het uitblijven van door u toegezegde informatie, die voor ons cruciaal is.

De bespreking van 3 februari 2010 heeft plaatsgevonden op basis van een memorandum dat tevoren door [redacted] en mij in overleg is opgesteld. In dat memorandum is door NEA en GKN duidelijk uitgesproken dat voor hen (i) niet acceptabel is dat VROM weigert het resultaat van het door de Staat inmiddels afgeronde onderzoek naar de aansprakelijkheid van NEA voor eventuele tekorten in GKN mede te delen, (ii) niet acceptabel is dat COVRA in het kader van de thans door COVRA, GKN en de Staat uitgevoerde analyse van ontmantelingskosten een bedrag voor eindberging heeft genoemd dat vele malen hoger is dan het bedrag in 1999 zonder enige onderbouwing of verklaring, en (iii) niet acceptabel is dat GKN nog langer gebonden blijft aan een zeer restrictief beleggingsstatuut terwijl VROM en Financiën met [redacted] een ruimhartige regeling bespreken voor [redacted]

Tijdens de bespreking van 3 februari 2010 zijn door VROM op alle drie de bovengenoemde punten - terecht - toezeggingen gedaan. Er is toegezegd dat VROM alsnog haar juridische argumenten voor de kennelijk gehandhaafde stelling dat NEA aansprakelijk is voor tekorten in GKN aan NEA zou verstrekken. Dat was voor ons een absoluut vereiste. VROM handhaaft dit standpunt nu bijna 10 jaar, zonder enige vorm van onderbouwing. In de Strategienota van 2007, die door VROM is onderschreven, heeft NEA er nog eens expliciet en dringend aandacht voor gevraagd dat dit standpunt van VROM nooit is onderbouwd, strijdig is met grondbeginselen van het civiele recht - zoals de beperkte aansprakelijkheid van een aandeelhouder voor de schulden van zijn vennootschap -, en uitdrukkelijk en bij herhaling is weersproken door het ministerie van economische zaken. Destijds heeft VROM tot grote teleurstelling van NEA al geweigerd het standpunt toe te lichten. Het moet duidelijk zijn dat met VROM niet verder kan worden gesproken zonder dat VROM de juridische argumentatie voor de stelling dat NEA aansprakelijk is, op de kortst mogelijke termijn aan NEA openbaart. Wij verzoeken u dringend die argumentatie te verstrekken op of voor 15 maart aanstaande.

Waalbandijk 112a
6669 MG Dodewaard
Postbus 40
NL-6669 ZG Dodewaard
Telefoon (0488) 41 88 11
Telefax (0488) 41 21 28

ABN AMRO
Rek.nr. 534423566
Handelsregister Rivierenland
Nr. 09031421
BTW nr. NL 009749494B05

Bij brief van 12 januari jl. heeft GKN dringend aan COVRA verzocht om toe te lichten en te onderbouwen hoe het kan zijn dat zij de kosten voor eindberging thans ruim 8 maal zo hoog inschat als in 1999, na aanvankelijk een bedrag van 16 maal de inschatting van 1999 te hebben genoemd. Tot op heden heeft GKN geen uitleg ontvangen, noch een onderbouwing voor de thans ingeschatte kosten. Het zal duidelijk zijn dat GKN en NEA hoe dan ook geen verantwoordelijkheid dragen voor deze inschatting en de afwijking van de inschatting van 1999. Tijdens onze bespreking van 3 februari jl. hebt u toegezegd COVRA om uitleg te vragen. Tot op heden is ook daaruit niets voortgekomen. Wij concluderen daarom dat het bedrag voor eindberging voor zover het de schatting van 1999 overtreft, als irrelevant en niet onderbouwd terzijde dient te worden geschoven.

Een cruciaal element voor het bedrag dat in 2045 binnen GKN aanwezig zal zijn voor de amovering, is het beleggingsrendement dat tot dat moment op de gereserveerde gelden kan worden gehaald. Daarom hebben wij op 12 januari 2010 een voorstel aan VROM gedaan om een beleggingsstatuut toe te passen dat gezien de lange beleggingshorizon, de wens risico-avers te blijven en toch een interessant rendement te kunnen halen, aanvaardbaar zou moeten zijn. Wij hebben nog niets vernomen. Wij hebben verder tijdens onze bespreking van 3 februari jl. de toezegging van VROM gekregen dat wij informatie zouden krijgen over de ruimte die aan [redacted] 10 2 wordt toegezegd in het kader van de opbouw van haar amoveringsreserve voor [redacted] Ook die informatie hebben wij thans, bijna een maand later, nog niet ontvangen.

'Wij beschouwen niet langer als aanvaardbaar dat NEA en GKN enerzijds constructief en intensief aan het werk zijn sinds 2007 om in overleg met VROM en COVRA nieuwe berekeningen van de benodigde amoveringsreserve te maken, zonder dat VROM en COVRA zich anderzijds inspannen om een even constructieve en redelijke opstelling te kiezen. NEA herhaalt hier nog maar eens, hetgeen zij in meerdere brieven in 2009 en in de Strategienota uitgebreid heeft toegelicht, dat NEA hoe dan ook geen aansprakelijkheid draagt voor eventuele tekorten in GKN. Het is daarom ronduit onbegrijpelijk te noemen dat VROM zich niet met NEA en GKN actief inspant om te bezien hoe de in GKN aanwezige gelden enerzijds en de voor amovering benodigde fondsen anderzijds elkaar in 2045 het best zouden kunnen benaderen. Het is VROM en via VROM de Nederlandse Staat die uiteindelijke de wrange vruchten van dat gebrek aan inspanning zal plukken, niet NEA.

Ik zie alle bovengenoemde, door VROM toegezegde, informatie graag voor 15 maart a.s. tegemoet.

Met vriendelijke groeten

[redacted]

Bestuurder Gemeenschappelijke Kernenergiecentrale Nederland B.V.

Bijlage: GKN verslag vervolgoverleg VROM-GKN dd 3 februari 2010

Vervolgoverleg VROM-GKN op 3 februari 2008

Aanwezig namens VROM
Secretaris-generaal van VROM [redacted];
Dossierverantwoordelijke [redacted];
Juriste [redacted]

Namens GKN aanwezig
[redacted];
[redacted].

Ter voorbereiding had [redacted] een memo gemaakt voor de SG, dat hij aan [redacted] heeft voorgelegd en waarin [redacted] de nodige aanvullingen heeft gedaan.

[redacted] begint te zeggen dat hij niet over de juridische kant wil praten. In zijn ogen zijn wij één traject ingegaan om het bedrag voor de amovering van de KCD te bepalen, om daarna de discussie te hebben wie dat gaat betalen. Onze reactie ziend reageert hij door te zeggen dat aan het eind van de bespreking de juridische kant wel aan bod kan komen. [redacted] maakt een kort statement dat voor ons de juridische kant toch doorslaggevend is en dat in ieder geval voldoende tijd moet overblijven om dit te bespreken. [redacted] heeft ruim een uur en zegt toe hiervoor open te staan.

[redacted] vraagt hoever wij staan met het onderzoek naar de kosten. [redacted] antwoordt dat wij voor vrijgave grenzen de Duitse wetgeving (die door de Nederlandse wetgever zal worden gevolgd) volgen en dat wij nastreven dat het niet-radioactieve afval zoveel mogelijk wordt gerecycled. In dat kader hebben wij het gespecialiseerde aannemingsbedrijf [redacted] ingeschakeld. Een belangrijke onzekerheid zit echter bij de kosten van de eindberging van Covra. Covra noemde in eerste instantie [redacted] extra, daarna is is dat [redacted] geworden hetgeen zonder onderbouwing werd vastgelegd in een drieregelig briefje. Terwijl Covra terzake in 1999 berekeningen maakte van zes bladzijden worden we nu afgescheept met één niet onderbouwd bedrag. [redacted] vindt dat onacceptabel gegeven het feit dat Covra een door de Staat gecontroleerde monopolist is en geeft zijn ambtenaren opdracht Covra een heldere en transparante berekening te overleggen aan GKN. Geertsema vervolgt met de opmerking dat er in begin december een eerste compleet conceptrapport is uitgebracht met een totaalbedrag aan amoveringskosten van [redacted], uitgaande van afbraak in 2015 tegen huidige prijzen (contant [redacted]). Een aantal aspecten dienden echter opnieuw te worden bezien. Met name een meer efficiënte routing in het kader van de vaststelling van de kosten van de ontmanteling tot en met de groene weide. Ook de kosten van de eindberging moeten opnieuw worden bezien. [redacted] vraagt hoeveel hiervoor was gereserveerd in 1999. 10 2 e [redacted] antwoordt [redacted]. Nu in 2009 zou dat EUR [redacted]. De stijging kan hij niet begrijpen.

[redacted] stelt dat het uiteindelijke bedrag ergens tussen de [redacted] en [redacted] zal liggen. Voor de totaliteit echter exclusief de kosten van de jaarlijkse Veilige Insluiting die tussen [redacted] en [redacted] per jaar bedragen..

Dat is dan afgezien van de kosten van de verwerking van verrijkte brandstof (afgerond in 2009), het hoog radioactieve afval dat in 2010 wordt terugvervoerd, de levering aan derden van het uranium, dat ook in 2009 is opgelost [redacted] 10 1 b

[redacted] concludeert dus dat hij verwacht dat wij eind maart zullen zien dat er een bedrag voor de amovering en eindberging uitkomt ergens tussen de [redacted] en [redacted]. Hij vraagt hoeveel er thans gereserveerd is.

[redacted] antwoordt, dat er [redacted] is gereserveerd voor amovering inclusief Veilige Insluiting. In totaal bedragen de reserveringen [redacted]. Mogelijk valt er uit de andere reserveringen nog geld vrij wat kan worden toegevoegd aan de reservering voor amovering.

Vervolgens brengt [redacted] het punt van het rendement ter sprake. We moeten ons niet rijker rekenen dan verantwoord. [redacted] brengt daar tegenover in, dat [redacted] in een vergaand stadium is van overleg met Financiën om wel op lange termijn een rendement van 4% te realiseren. [redacted] vindt dat interessant. Zijn ambtenaren bevestigen dat dit overleg loopt met [redacted]. Indien dergelijke afspraken met [redacted] gemaakt worden verdient GKN een zelfde behandeling. Hij vraagt zijn ambtenaren te rapporteren over de uitkomst van het overleg met [redacted]

Vervolgens komt de vraag aan de orde wie het eventuele tekort moet betalen. [redacted] vindt de KEW niet zo interessant. De brief van mevrouw [redacted] zegt in ieder geval dat de wijziging van de KEW geen aansprakelijkheid van NEA veroorzaakt. Het gaat volgens [redacted] er om of, toen de bakstenen werden geregeld, de branche van haar verplichting is ontslaan omdat er toen een bedrag van ongeveer [redacted] in GKN was gestopt. Heeft de branche daarmee haar verplichtingen om in de toekomst bij te storten afgekocht? Die discussie wil [redacted] voeren met de branche.

Wij reageren daarop dat dit dan een heel koud gesprek gaat worden, dat het geen enkele zin heeft om die discussie te gaan voeren zonder dat "het juridische been is bijgetrokken". De Staat ontkomt er niet aan om haar juridische argumentatie te geven. Dat zij dat niet zou mogen is onbegrijpelijk. [redacted] begrijpt dit en neemt op zich dat wij de juridische argumentatie gaan ontvangen.

Wij vragen of ter zake [redacted] wordt ingeschakeld. [redacted] vindt dat helemaal niet nodig. Hij redeneert: [redacted] wilde destijds GKN overdragen aan Covra zonder bijbetaling, maar Covra zei dat zij deze verantwoordelijkheid niet op zich kon nemen zonder bijbetaling. De consequentie was dus dat GKN gewoon van de sector blijft tot 2045. En als er in die periode een tekort blijkt, is de sector daarvoor aansprakelijk, want de sector heeft ook het voordeel van de centrale gehad. Op onze argumenten, dat de sector in de tijd dat de kerncentrale Dodewaard actief was, de publieke sector was en het voordeel dus destijds aan het publiek is toegekomen, terwijl nu de elektriciteitsproductiebedrijven in de periode na sluiting tot heden zijn geprivatiseerd, weigert [redacted] in te gaan.

Ter sprake komt dat volgens de nieuwe KEW op 1 april 2011 een voldoende bedrag moet worden afgestort en dat het nut van de exercitie van de afgelopen drie jaar is dat er dan geen verschil van mening is over hoe hoog het uiteindelijke bedrag zou moeten zijn. Aan het eind van de vergadering erkent [redacted] dat indien VROM geen goede argumenten zou hebben dat de sector dit bedrag zou moeten betalen, VROM niet ten onrechte moet gaan procederen. VROM zal dus de argumenten op grond van de splitsingswet en de afspraken met betrekking tot de bakstenen in 2000 aan GKN presenteren. Daarna kan GKN nog reageren voordat er een vervolggesprek gaat plaatsvinden met wat hij nog noemt "de sector".

De conclusie is dat er drie "to do's" op het bord liggen van VROM:

1. Covra ertoe zetten dat zij GKN een heldere onderbouwing geeft van het bedrag van [redacted] voor de eindberging;
2. Rapporteren over de uitkomst van het overleg tussen [redacted] enerzijds en het Ministerie van Financiën anderzijds over de wijze van belegging van de reservering resulterend in een netto rendement van 4%;
3. Juridische argumentatie aan GKN sturen.

20100225-2 - GKN

MoM of the 6th meeting on New Decommissioning Costs Estimate KCD

Location: COVRA offices, Nieuwdorp
Date: February 25, 2010
MoM by: [redacted]

Participants:
VROM: [redacted]
COVRA: [redacted]
GKN: [redacted]
Tractebel: [redacted]
NIS: [redacted]

Introduction

The 6th meeting on decommissioning costs of KCD was held on February 25, 2010 at COVRA's offices.

Discussion

1 MoM and action list of 5th meeting.
The MoM and action list of the 5th meeting were agreed, and the action list was updated. This list is added to this MoM.

2 Task 1 Report.
NIS prepared a draft of both task 1 and task 2 report. These reports were thoroughly discussed. A list of remarks made by Tractebel Engineering was discussed. Remarks as agreed will be incorporated in the next report. Some of the more important issues discussed were:
-A justification must be added to section 7.3 and 7.7, explaining why certain decontamination and dismantling techniques are used (or not used)
-Some of the wording of the executive summary will be changed. The words "reasonable conservative" will be change to" conservative". This will apply throughout the report. In the executive summary the "reasonable conservative assumptions" wording and figures will be removed from the tables. There will be a new wording only explaining that this calculation was done. For details one has to look into the report. It was stated that the calculated 26, 4% is in line with other decommissioning studies which give 25% as the average figure for uncertainties in the project. GKN re iterated, the uncertainty figure calculated is the total of all uncertainties. The total cost of the project is the calculated best estimate price.
-On the discussion on super compaction of waste either on site or at COVRA's it was decided the assumptions of the report will not be changed (that is super compaction on site) but as it is clear now that due to the extended decommissioning period there is a costs benefit to transport waste to COVRA for treatment, a special note will be added to the report. This note will indicate that at the time of execution of the decommissioning project, this issue should be revisited. The potential savings could be up to [redacted]

3 Task 2 report
-It was agreed the same changes as discussed for the Task1 report would apply mutatis mutandis for the task 2 report.
-A text will be added explaining that task2 report is based upon extrapolation of task 1 report.
VROM asked for an explanation of the fact that while there is a linear equation between the figures in the tables 10-12 (Kew limits) and 10-20 (IAEA limits) in the task 1 report, this is not the case for the task 2 report. (**Action** 6.1, NIS)

4 Sketches

The new proposals made by NIS after the site visit, include the use of the former control room as office area and canteen. The former electrical switch room will be used as entry point for the controlled area and dressing room. The free release building and storage of new containers and drums will be situated at the south west corner of the site.
Parties agreed to these proposals. This new layout is a saving of roughly [redacted].
Some discussion started on the possibility of erecting new buildings on site before a decommissioning license was in place. This will be discussed in a separate meeting between GKN and VROM and is not part of this report. A potential gain of time up to 3 to 6 months is possible.

5 How to proceed / Next meetings
It was agreed NIS will update the task 1 and task 2 reports. Parties will hand in their comments by email. NIS will prepare the Comparison Report (this study versus NIS1999 study), in the original agreed format (that is all items discussed, even if there are little or no changes).
Parties will comment on that report by email as well.
After collecting all comments, GKN will consult parties on the need for another meeting.
A preliminary date for this meeting was agreed to be April 22, 2010 at GKN Dodewaard.

Attachment

<u>List of Actions New Decommissioning Costs Estimate KCD per 25 February 2010.</u>

Number	Description	By	Status
Previous Project 4.2	GKN to describe the GKN organisation during decommissioning phase.	GKN	OK. Superseded by Action 3.2
Previous Project 4.3	GKN to write chapter 5.1. of the PDP	GKN	OK. GKN will use text from current Safety Report. Text will be in Dutch (as is required for license application)
1.1	Prepare, comment and issue Purchase Order	Tractebel, NIS, GKN	OK DR09-002
1.2	Send in storage prices and conditions of waste	COVRA	OK, email
1.3	Prepare lay-out and table of contents of comparison report	NIS	OK
1.4	Hand in costs for GKN employees, hourly rate	GKN	OK *(Sec. note :during meeting 4 of previous project it was decided to use German wages for this item!)*
1.5	Set up new planning scheme	NIS	OK schedule March 2, 2009
1.6	Preparation of Skeleton document for discussion on basic assumptions on erecting buildings, decon techniques	NIS	OK
2.1	Set up organization chart for dismantling project	NIS	OK, but proposal denied. See above, previous project 4.2
2.2	Hand in wages of security guards	GKN	OK email by GKN
2.3	Discuss location of new buildings, flow of waste, drums, and personnel	NIS, GKN	OK
2.4	Hand in specific mass of magnetite casks	Covra	OK. [redacted]: 3300 kg/m3
2.5	Check costs of landfill / road hardening by rubble	GKN, VROM	OK. Discussed with [redacted] company. Separate action for GKN and VROM as dumping of material is in principle not allowed
2.6	Check what kind of preparation work can be performed using current license	VROM	OK, seems possible, see email [redacted] of 1/7/2009. *3rd meeting:* after examination at VROM it seems a questionable approach. 6^{th} *meeting*: may be combined with license application for C-14. Bilateral between GKN and VROM. Not

FINAL
MoM 6th meeting New Decommissioning Costs estimate KCD.

3.1	Calculate costs for storage of KONRAD TYP2 containers based upon preliminary amount of canisters to be produced	COVRA	OK, email to be included in this report.
3.2	Prepare Organization chart	GKN	OK Done
4.1	GKN to write an abstract of identified contamination incidents	GKN	OK, Abstract included in Costs estimate report
4.2	GKN to contact [redacted] 10 2 e on prices for material, demolition period and wages	GKN	OK. [redacted] handed in prices. GKN forwarded prices to NIS.
4.3	GKN to hand over information on electricity consumption and tariff	GKN	OK. GKN handed over new price per kWh to NIS. NIS incorporated prices in report.
4.4	NIS to distribute a paper including NIS references and experiences on decommissioning costs calculations	NIS	OK. Paper distributed. Information added to report
5.1	Correct mass differences between table 2.2 and 2.3	NIS	OK Done

5.2	To sent in comments on chapter 6	VROM	OK VROM personnel do not fully agree to proposed text, but can accept it for current report
5.3 a	Sent in documentation 180/200 L drums to COVRA	NIS	OK No documentation available
5.3 b	Study information of 5.3 a and decide if 180/200 L drums are acceptable	COVRA	OK Not acceptable. All packages must have at least 5 cm of concrete at outside.
5.3 c	Recalculate situation for 90/220 L drums with super compaction at COVRA	NIS	OK Super compaction at COVRA's cheaper under assumed circumstances.
5.4	Re issue draft (possibly including new sketches based on opportunities of existing buildings	NIS	OK Done
6.1	Explain Non linear relation between task 1 and task 2 report in tables 10-12 and 10-20	NIS	

20100406-1 - VROM

Ruimte en Milieu
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

B.V. NEA
10 2 e [redacted]
Waalbanddijk 112a
6669 ZG Dodewaard

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2010010251

Uw kenmerk
DR10-005

Datum 06 APR 2010
Betreft Overleg inzake ontmantelingskosten

archiefkopie

Geachte heer [redacted]

Hierbij stuur ik u een kopie van mijn brief aan GKN, waarvan de inhoud voor zich spreekt.

Paraaf
[redacted]

Paraaf
dRB

Hoogachtend,
de secretaris-generaal,

[redacted]

20100406-2 - VROM

Ruimte en Milieu
Ministerie van Volkshuisvesting,
Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

B.V. GKN
10 2 e [redacted]
Waalbanddijk 112a
6669 ZG Dodewaard

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2010008230

Uw kenmerk
DR10-005

archiefkopie

Datum 06 APR 2010
Betreft Overleg inzake ontmantelingskosten

Geachte heer [redacted]

Ik heb uw brief d.d. 25 februari 2010 over ons overleg op 3 februari in goede orde ontvangen. Bij deze geef ik kortheidshalve puntsgewijs een reactie op uw brief:

- U wijst mij in uw brief op mijn toezegging COVRA om uitleg te vragen over de inschatting voor de kosten van eindberging, en de afwijkingen daarvan t.o.v. de inschattingen van 1999. COVRA heeft u de gevraagde analyse per brief inmiddels doen toekomen.

- U refereert voorts aan het op 12 januari aan VROM voorgelegde voorstel voor een aangepast beleggingsstatuut van GKN, en geeft aan dat ik heb toegezegd dat GKN/NEA informatie krijgt over "*de ruimte die EPZ wordt toegezegd in het kader van de opbouw van de amoveringsreserve voor de KCB*". In dit kader moet ik u melden dat er momenteel hierover nog overleg plaatsvindt met EPZ, en ik het daarom niet opportuun acht deze informatie op dit moment met GKN te delen. Wanneer het overleg is afgerond, zal ik u deze informatie verstrekken. Inmiddels is een reactie op het concept-beleggingsstatuut aan u verzonden. Ik verwijs kortheidshalve naar de inhoud ervan.

- Daarnaast wijst u mij op mijn toezegging mijn argumentatie te verstrekken met betrekking tot mijn positie inzake de aansprakelijkheid van NEA. Ik geef u hierbij in overweging dat ik reeds meerdere malen heb aangegeven dat ik van mening ben dat de vervuiler dient te betalen: Het kan niet zo zijn dat de maatschappij opdraait voor de kosten van het opruimen van het (radioactief) afval van een onderneming. Voorts zal het u niet onbekend zijn dat ik van mening ben dat de verantwoordelijkheid voor de kosten van ontmanteling van de centrale te Dodewaard niet is afgekocht in de Overgangswet ElektriciteitsProductieSector (OEPS). De OEPS stelt slechts de verdeling van en de verantwoordelijkheid voor de in deze wet genoemde niet-marktconforme kosten vast, die door de elektriciteits-productiebedrijven dienden of dienen te worden voldaan.

Portefeuille Milieu
Directie Risicobeleid

Kenmerk
RB/2010008230

Onder uitdrukkelijk voorbehoud van mijn en uw juridische positie is, op initiatief van GKN, een exercitie gestart die uiteindelijk moet leiden tot een gezamenlijk beeld van de kosten van ontmanteling van de centrale te Dodewaard. Inmiddels zijn concept-resultaten van deze exercitie beschikbaar, en maak ik mij, na vergelijking van deze cijfers met de jaarverslagen van GKN, zorgen over hoe GKN in de toekomst aan zijn verplichtingen denkt te kunnen voldoen. Graag zou ik dan ook van GKN vernemen hoe zij voornemens is in de toekomst aan deze verplichtingen te voldoen.

Gezien het bovenstaande komt voor mij de B.V. NEA, als rechtsopvolger van Sep, en als moeder-maatschappij van vergunninghouder GKN destijds betrokken bij het reserveren van gelden voor de ontmanteling van de centrale te Dodewaard, weer in beeld. Daarbij ga ik er vanuit dat NEA, gezien zijn cruciale rol en verantwoordelijkheden in dit geheel, voldoende oog heeft voor de (toekomstige) belangen van zijn aandeelhouders, zijnde de elektriciteitsproductiebedrijven.

Alles overwegende acht ik het daarom wenselijk en noodzakelijk dat NEA de aansprakelijkheid voor eventuele tekorten in de B.V. GKN erkent, omdat zeker gesteld moet worden dat de ontmantelingskosten, volgens het beginsel dat de vervuiler betaalt, volledig voor rekening komen van GKN en de partijen die GKN als werkmaatschappij hebben opgericht en het economisch belang daarvan altijd hebben gedragen. Ik wil de mogelijkheid uitsluiten dat deze partijen zich in de toekomst - bijvoorbeeld in het geval van onvoldoende solventie van GKN - zouden kunnen onttrekken aan hun verantwoordelijkheid de in hun samenwerkingsverband gebruikte kernenergiecentrale te ontmantelen en de kosten daarvan te dragen.

Ik hoop op een goede afronding van dit geheel, en ben graag bereid om, samen met u, in overleg te treden met de aandeelhouders van de B.V. NEA om uw probleem op te lossen.

Een kopie van deze brief stuur ik naar de B.V. NEA.

Hoogachtend,
de secretaris-generaal,

[redacted]

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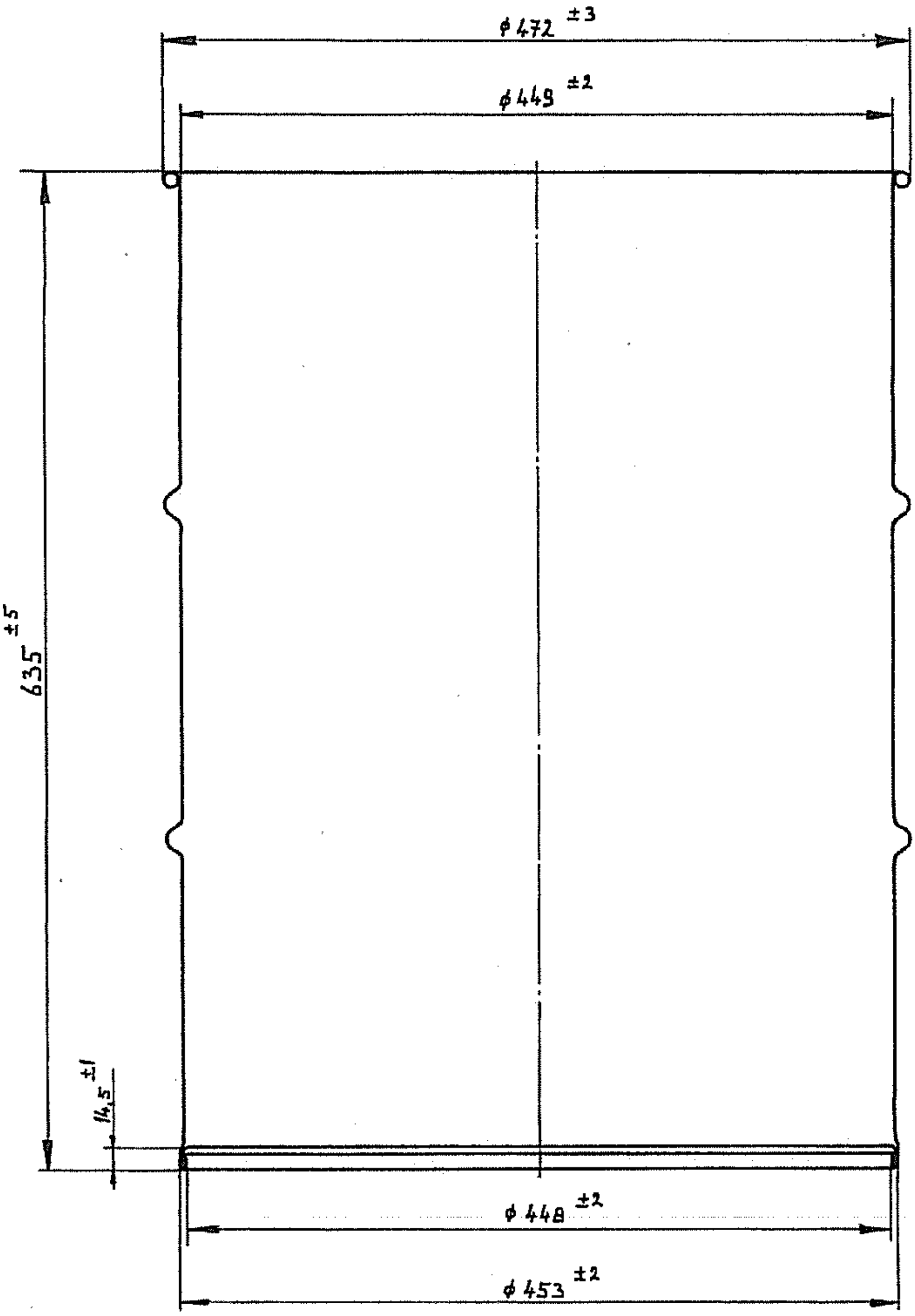

Figure 8-9: 90-l Drum for super-compaction

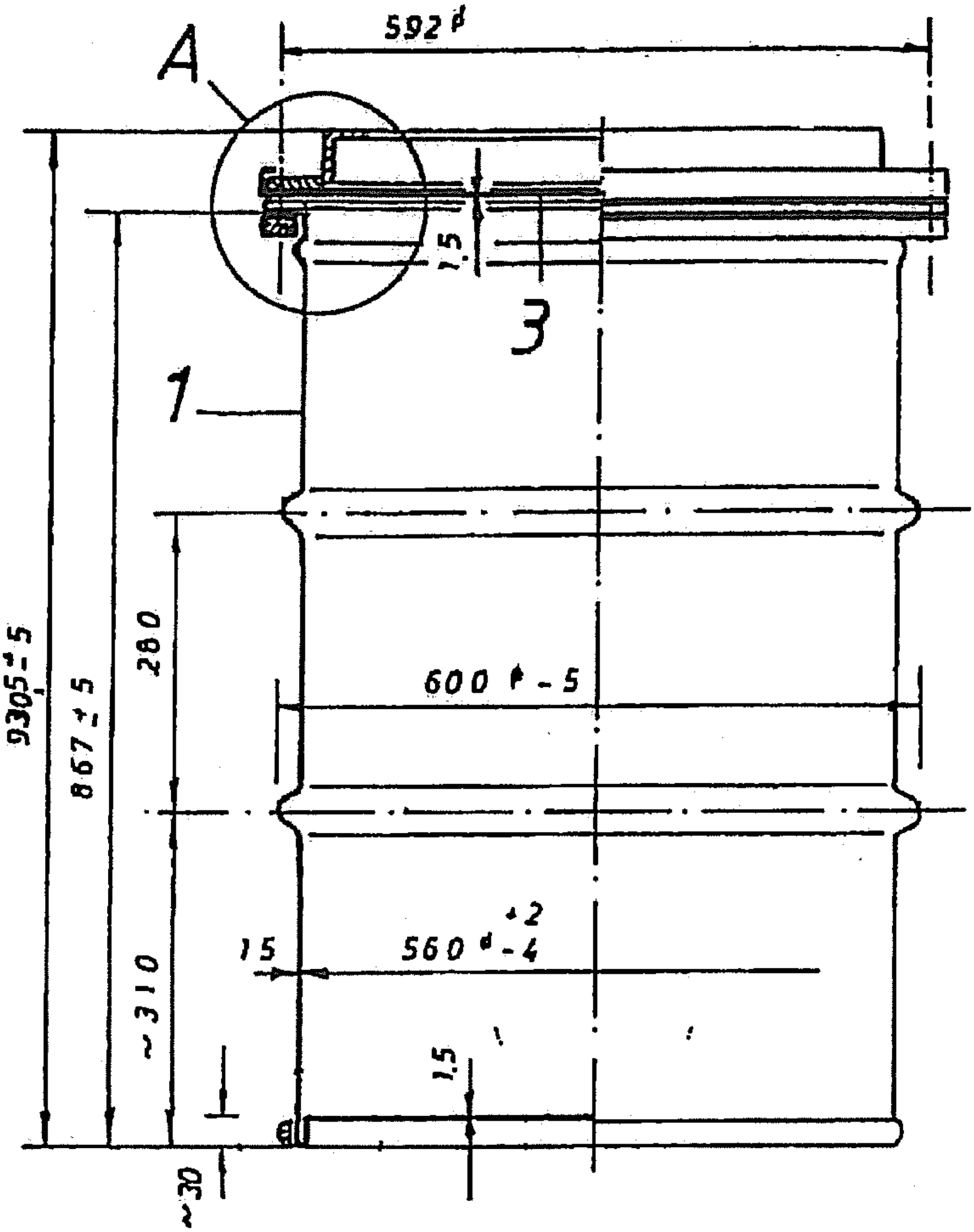

Figure 8-10: 200-l Drum

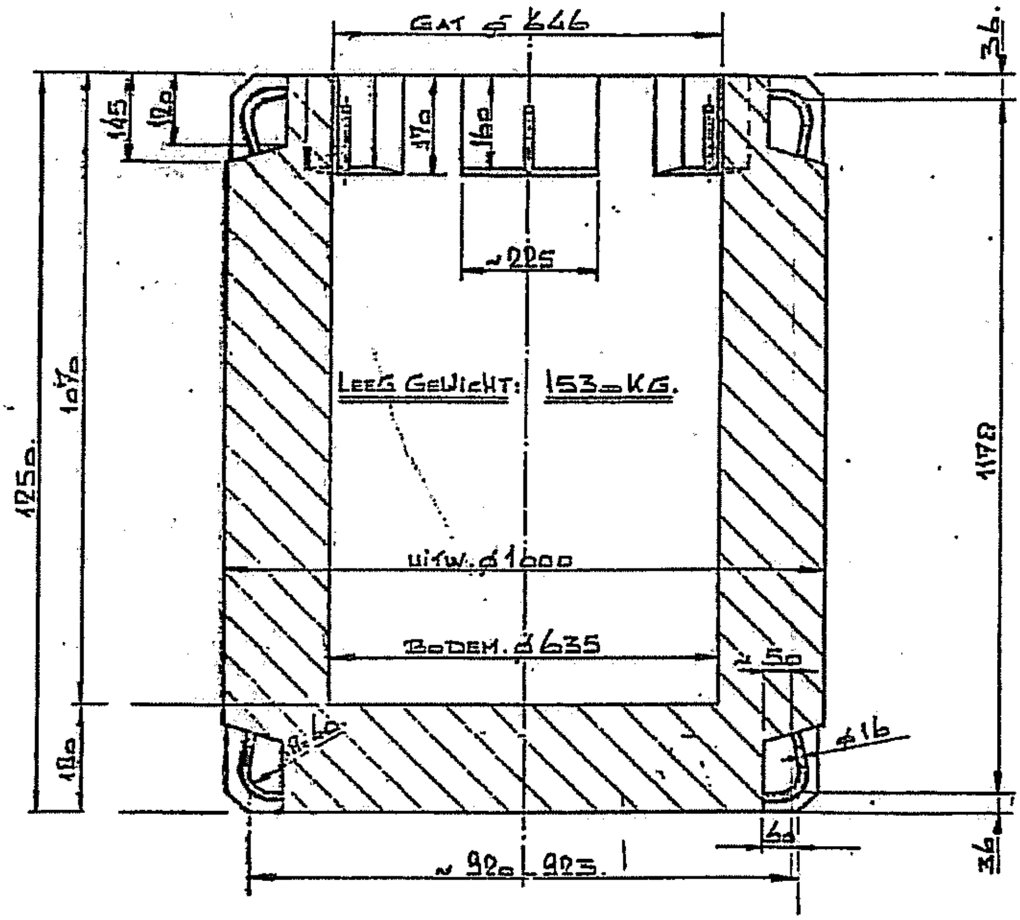

Figure 8-11: 1000-l Container

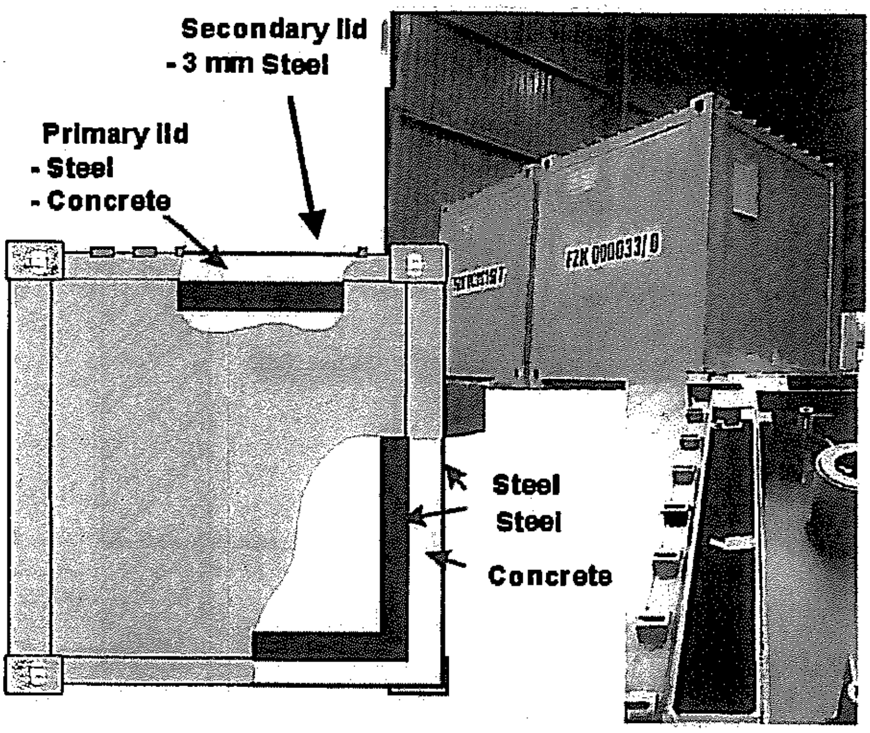

Figure 8-12: KONRAD Type II - Container (Picture by courtesy of Siempelkamp)

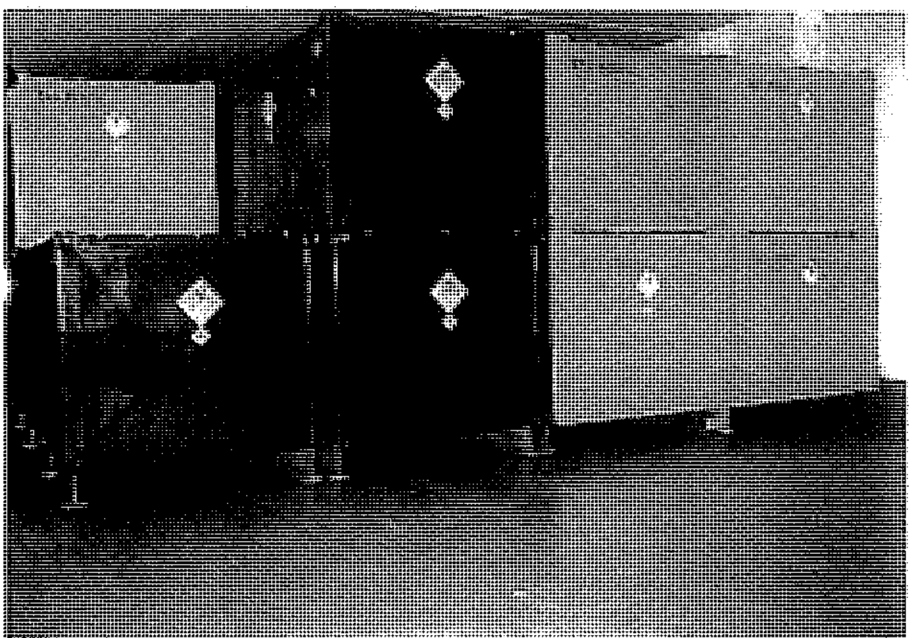

Figure 8-13: Storage of KONRAD Type II - Container (Picture by courtesy of GNS)

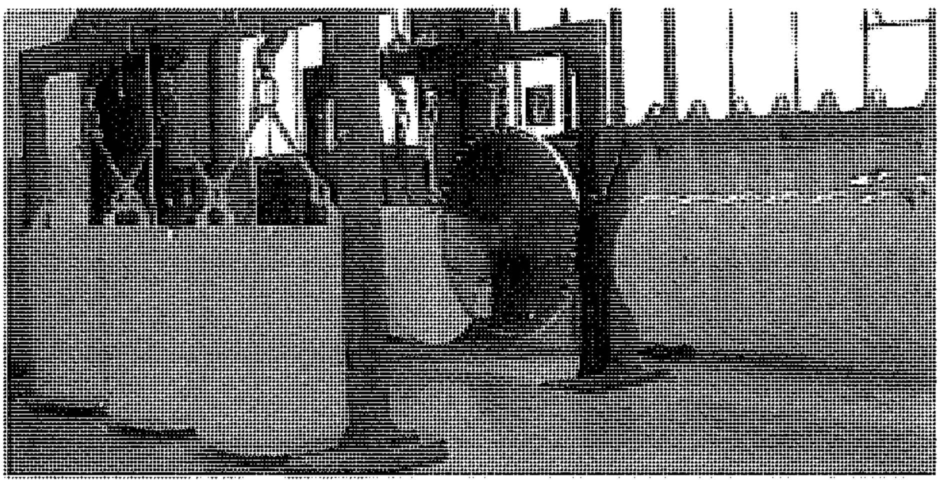

Figure 8-14: MOSAIK Type II - Containers (Picture by courtesy of Siempelkamp)

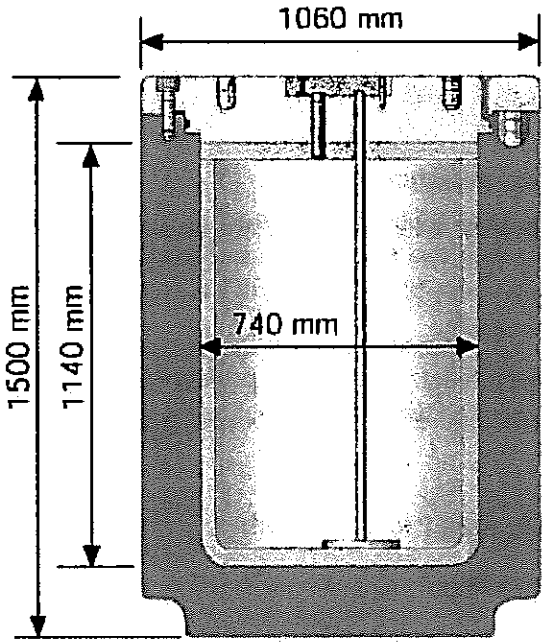

Figure 8-15: Cross-Section MOSAIK Type II - Container (Picture by courtesy of GNS)

9 Planning

9.1 Scope of present study

The present study includes the following tasks:

- Task 1.1: Best estimate, i.e. an estimate of the decommissioning costs as really expected based on an agreed scenario and boundary conditions. Two sub-tasks are examined:
    - Task 1.1.1: Best estimate assumptions, including clearance levels as defined in the Dutch "Kernenergiewet";
    - Task 1.1.2: Best estimate assumptions, including "IAEA RS-G-1.7" clearance levels.
- Task 1.2: Conservative estimate that constitute an upper decommissioning cost in the worst case. Two sub-tasks are examined:
    - Task 1.2.1: Conservative uncertainties; including clearance levels as defined in the Dutch "Kernenergiewet";
    - Task 1.2.2: Conservative uncertainties; including "IAEA RS-G-1.7" clearance levels.

The following statements apply accordingly to all tasks and sub-tasks. Where additional information is necessary it is given.

9.2 Work Breakdown Structure (WBS)

The decommissioning project KCD is structured in a hierarchical organisation in accordance (but not identical) with the IAEA "Standardized List of Cost Items for Decommissioning". The Work Breakdown Structure (WBS) is mandatory for the planning activities as well as for the cost estimate.

The WBS "describes" the project. The overall project is divided in subprojects, tasks, etc. until the lowest level is reached where the individual activities can be calculated.

Example:

04 Dismantling Controlled Area (Contaminated)

04.01 Reactor building

04.01.01 Planning and Engineering

04.01.02 Attendant Measures

04.01.03 Execution

The WBS is adapted and the individual activities are defined according to the needs of the plant specific decommissioning plan.

9.2.1 Level 1: Working packages (WP)

The first level divides the decommissioning project in several separate working packages defined in the IAEA List of Standardised Cost Items but completed by some more working package items. Additionally the order of the working packages is following the course of a real decommissioning project (the projects allow a time schedule with reasonable time bars in the first level, IAEA original list of projects have time bars in all the same length). Following working packages are defined:

- WP 01: Pre-Decommissioning Actions;
- WP 02: Licensing Procedure;
- WP 03: Preparatory Work;
- WP 04: Dismantling Controlled Area (contaminated) – CA-C1;
- WP 05: Dismantling RPV Internals;
- WP 06: Dismantling RPV;
- WP 07: Dismantling Drywell;
- WP 08: Dismantling Biological Shield;
- WP 09: Dismantling Remaining Systems and Components (contaminated) – CA-C2;
- WP 10: Clearance of Building Structures;
- WP 11: Waste Processing, Transport, Storage and Disposal;
- WP 12: Conventional Demolishing;
- WP 13: Site Restoration and Landscaping;
- WP 14: Asbestos Removal;
- WP 15: Project Management, Engineering and Site Support;
- WP 16: Site Security, Surveillance and Maintenance;
- WP 17: Authorities.

Some working packages are like a subproject (for example: Dismantling RPV), others are like an ongoing task for a department (like: Waste Processing, Transport, Storage and Disposal). The content of the working packages is described in section 9.4.

9.2.2 Levels 2, 3, etc.

The levels 2, 3, etc. are not pre-defined. This means that for example number "01" at level 2 can mean whatever the CALCOM user needed: pre-planning, shutdown of systems, or anything else.

These levels are used to refine the structure and to make it so detailed that it contains all activities that are needed to plan the decommissioning project.

As far as possible, the same or similar structures are used for similar activities.

9.3 Generic Sequence for the decommissioning project

The generic sequence for the decommissioning project is schematically shown in Figure 9-1.

Regarding the course of the activities the following general strategy has been chosen to realise the project.

- First, the planning and licensing has to be performed in order to receive the decommissioning and dismantling license for NPP Dodewaard. It is planned that only one "Kernenergiewet" (Kew) license and one "Water" license (Wvo) are needed for the decommissioning. A construction license is needed for the erection of temporary buildings. The licenses are prepared before the end of Safe Enclosure period. After submitting all necessary licensing documents (e.g. Safety Report, Environmental Impact Assessment Report) to the authorities the Dutch authorities will need 6 month to issue the dismantling license.
- Parallel to the licensing process, the planning of the new buildings and new installations will start. The erection of the new buildings can start when the dismantling license is available.
- The dismantling starts with the preparation of the treatment areas and the transport routes for the dismantled components.
- When the treatment areas are installed the dismantling of the contaminated equipment will start with dismantling in the reactor building on level 36 m to get the space for the remote controlled dismantling equipment for the dismantling of the activated parts (RPV internals, RPV, etc.).
- After installation of the remote controlled equipment the dismantling of the RPV internals starts as soon as possible followed by the RPV and the internals of the drywell.
- The Biological Shield and the remaining systems in the controlled area which are not needed anymore are dismantled afterwards.
- Parallel to these actions in the reactor building the dismantling of the systems in the turbine building and the rest of the controlled area are performed.
- The dismantled activated parts (e.g. RPV internals and RPV) will be packed directly into appropriate containers while the dismantled contaminated components are transported to the new installed treatment area in the turbine building for further treatment, packaging or release after corresponding measurements.
- When all installations are removed the building structure will be decontaminated and released.
- At the end of the project the buildings themselves are demolished and the complete site will be restored (including removing of the piles).

This leads to the simplified/summarized time schedule shown in Figure 9-2 and to a more detailed time schedule in Figure 9-3. A complete time schedule will be delivered on a CD, which will be provided together with the present study.

9.4 Content of the working packages

The numbering of the WPs is user-defined, but NIS uses a standard numbering system which makes comparisons between different projects more easy. This NIS internal standard is followed in the present study.

9.4.1 WP 01: Pre-Decommissioning Actions

The first working package includes the activities to place a contract with a Main Contractor, e.g.:

- Definition of final plant status;
- Specification of the decommissioning project;
- Tender documents;
- Call for tenders;
- Negotiations;
- Contract awarding.

At the beginning of the project, the conceptual planning has to be made, which will help to find the right decision regarding the decommissioning strategy. Furthermore, it describes the concepts of the different works to be done. The relevant Authorities will be informed. For example following activities have to be performed:

- Check of documentation;
- Verification / collection of technical data (technical and radiological status of the plant);
- Strategy analyses;
- Structure of documentation;
- Planning of the staff and the general course of the works;
- Final decommissioning plan;
- Definition of WBS;
- Cost estimates.

The working package will already start before the end of Safe Enclosure period.

9.4.2 WP 02: Licensing Procedure

All documents and reports which are necessary to apply for the decommissioning license have to be prepared. During the licensing procedure a lot of discussions with the experts and the authorities will take place. Besides a lot of technical documents the following documents have to be prepared:

- Environmental Impact Assessment Report;
- Safety Report.

Additionally the 6 month before the authorities will issue the license are taken into account in this working package (no costs).

Besides the decommissioning license there are also other licences which are necessary and have to be applied for, e.g.:

- Construction license;
- Waste water and gaseous release licenses.

At the end of the working package all necessary licenses are available. In the present study it is assumed that the end of Safe Enclosure period and the issuing of the license will be at 01.07.2015.

9.4.3 WP 03: Preparatory Work

The activities on site of the working package "Preparatory Work" are starting after granting the license. Some planning works, negotiations with sub-contractors, etc. will be carried out still during the end of the Safe enclosure period.

The necessary investments are described in section 7 and section 8.

Furthermore the following activities (including the investments) are planned and studied under WP 03:

- Modification of control room and former visitor room to get new office rooms;
- Installation of equipment in the offices;
- Modifications in the waste building to prepare mechanical and electrical work shops;
- Installation of equipment in the work shops;
- Erection of new free release building and entrance buffer;
- Modification and installation of new entrance to the controlled area;
- Modification and installation of new sanitary area;
- Installation of HP equipment; e.g.:
    - Radiological laboratory equipment;
    - Monitoring equipment;
    - Other HP equipment (e.g. measuring devices).
- Modification / Installation of electrical equipment;
- Modification / Installation of ventilation system;
- Preparation of treatment areas with necessary dismantling of systems and components (within Turbine building);
- Modification of buildings;

– Installation of treatment equipment; e.g.:
  - Decontamination equipment;
  - Cutting equipment;
  - Super-compaction station;
  - Immobilization/Cementation facility;
  - Free release measurement facility.
– Preparation of transport routes inside the buildings with necessary dismantling of disturbing installations;
– Modification of buildings (e.g. enlarging of openings);
– Installation of handling devices, e.g. cranes.

Additionally all necessary planning work, attend measures and commissioning of the modifications and installation are considered in the working package.

9.4.4 WP 04: Dismantling Controlled Area (contaminated) – CA-C1

WP 04 covers the dismantling work in the controlled area for all components and equipment other than electrical equipment, ventilation systems and steel construction which will be dismantled at the end of the project (see WP 09: Dismantling Remaining Systems and Components (contaminated) – CA-C2). During the detailed design phase the partition between WP 04 and WP 09 will be done on the basis of detailed analyses on which systems can be dismantled under WP 04 and which will be needed until the end of the project. For the purpose of the present study the above mentioned distribution has been taken into account.

For the planning of the sequence of the dismantling activities and the estimate of the corresponding costs following assumptions have been made:

– Dismantling building by building;
– Dismantling "top to bottom", i.e. starting at the highest level of the building going down to the lowest level;
– Dismantling of peripheral equipment first (e.g. motors, valves, piping) followed by large components (e.g. pumps, tanks, heat exchangers).

Some examples (not all steps) within the respective buildings are given below:

– Reactor building:
  - Level 36,0 m: Div. components;
  - Level 36,0 m: Condenser;
  - Level 36,0 m: Refuelling machine / bridge;
  - Level 31,2 m: Room 04 components;

- Level 28,2 m: Pumps;
- Level 19,2 m: Room 11.1/11.2 overflow pipes;
- Level 17,2 m: Room 09 heat exchangers;
- Level 13,2 m: Div. components;
- Level 13,2 m: Room 05C-F tanks;
- Level 10,0 m: DVV east;
- Level 10,0 m: DVV west;
- Level 10,0 m: Room 02/02A components.

– Waste building:
  - Level 17,2 m: Div. components;
  - Level 17,2 m: Room 13/13A components;
  - Level 13,2 m: Room 12A/B components;
  - Level 13,2 m: Room 12A/B pumps;
  - Level 13,2 m: Room 12A tanks (AWO T3 & T4);
  - Level 13,2 m: Room 12B heat exchanger;
  - Level 10,0 m: Room 01A-F tanks (AOT T7 to T12).

– Auxiliary building:
  - Level 19,2 m: Div. components;
  - Level 19,2 m: Room 10 pumps;
  - Level 13,2 m: Room 01 tanks.

– Ventilation building:
  - Level 19,2 m: Div. components.

– Turbine building:
  - Level 22,2 m: Generator;
  - Level 22,2 m: Turbine;
  - Level 17,2 m: Room 08 to 11 components;
  - Level 13,2 m: Div. components;
  - Level 13,2 m: heat exchangers;
  - Level 13,2 m: Room 06 large pipes;
  - Level 10,0 m: Room 04 div. components;

- Level 10,0 m: Condensers.

In addition to the dismantling activities also attendant measures (building by building) have been taken into account like:

- Implementation planning;
- Supervision;
- Radiation protection;
- Internal transport;
- Accompanying decontamination.

9.4.5 WP 05: Dismantling RPV Internals

WP 05 contains the activities to dismantle the RPV internals. This includes:

- Call for tenders / Negotiations / Contract awarding;
- Detailed planning of remote controlled equipment and dismantling;
- Design, procurement, and testing of special tooling/equipment for remote dismantling work;
- Simulation of complex work on models and training of staff;
- Installation of equipment in the Reactor building;
- Dismantling of the RPV internals from the top to the bottom (without water);
- Directly packaging into suitable containers (e.g. MOSAIK-type);
- Attendant measures:
  - Implementation planning;
  - Supervision;
  - Radiation protection;
  - Internal transport;
  - Accompanying decontamination.

9.4.6 WP 06: Dismantling RPV

The working package "Dismantling RPV" includes the dismantling, cutting and packaging of the RPV. The RPV dismantling is carried out in dry conditions and in parallel with the dismantling of the Drywell internals. The cutting occurs from the top to the bottom in defined rings. First, ring by ring, the surrounding equipment inside the drywell is removed before the RPV rings are cut. The costs for the removal of the drywell components are considered in WP 07 "Dismantling Drywell". The attendant measures as described in section 9.4.5 have also been taken into account.

9.4.7 WP 07: Dismantling Drywell

WP 07 contains the activities of the dismantling of the drywell internals and the drywell wall. The dismantling is carried out from the top to the bottom in dependency on the dismantling of the RPV (see section 9.4.6). Also the attendant measures are considered.

9.4.8 WP 08: Dismantling Biological Shield

The working package includes the dismantling of the biological shield. Only the activated part of the biological shield is considered in this WP, the not activated part will be demolished with the building structures under conventional conditions.

The biological shield is dismantled by cutting pieces from the activated part of the biological shield. The activation calculations have revealed that there is no significant difference between the regions where concrete is activated and where reinforcement steel is activated. This means that if the activation level is above the limit for clearance, then both steel and concrete are above the limit. By consequence a separation of (activated) steel from (not activated) concrete is not meaningful. So the pieces can be cut directly to suitable dimensions for packaging.

The actual cutting work is done remotely controlled in dry conditions. Access to the biological shield is minimised and limited to the installation and adjustment of the tools for drilling holes and for wire cutting of the pieces. The pieces are cut to dimensions suitable for packaging in KONRAD-Containers.

Attendant measures like implementation planning, supervision, radiation protection, internal transports, accompanying decontamination have been taken into account.

In case of task 1.1.2 more concrete structures are above the clearance levels and have to be dismantled under controlled area conditions. This leads to a longer duration for the dismantling of the biological shield.

9.4.9 WP 09: Dismantling Remaining Systems and Components (contaminated) – CA-C2

As mentioned in section 9.4.4 the WP 09 includes the dismantling of the remaining systems and components after removing the other contaminated and all activated parts of the plant. The work is carried out building by building from the highest level down to the lowest but the last level will be level B (level of treatment area and exit to surrounding area). For the purpose of the present study the remaining electrical equipment, ventilation systems and steel constructions have been taken for the planning of the duration and sequence as well as the cost estimate.

9.4.10 WP 10: Clearance of Building Structures

The WP 10 includes:

- Decontamination of the building structures after the removal of all potentially radioactive inventory;
- Clearance measurements to demonstrate that the remaining structures are below the clearance limits;

- Clearance measurements to demonstrate that the outside areas (structures outside the controlled area, roads, earth) are also below the clearance limits;
- Official clearance procedure for the respective area or for the site.

After the official clearance procedure the respective area or site is free from nuclear regulations. All further activities on site are conventional measures (e.g. building demolishing).

The sequence of the building decontamination and the release measurements of the building structures are in the same order as described in section 9.4.9, i.e. phase out from the point most far away from the exit to the exit of the Turbine building and its extensions.

9.4.11 WP 11: Waste Processing, Transport, Storage and Disposal

Working package 11 comprises activities aiming for the preparation of the dismantled components either for final disposal as radioactive waste, or for clearance and recycling, i.e.:

- On-site treatment:
  - Cutting;
  - Decontamination;
  - Shredding of cables;
  - Super-compaction;
  - Packaging;
  - Immobilization/Cementation of containers;
  - Release measurements.
- Attendant measures:
  - Supervision;
  - Radiation protection;
  - Internal transports;
  - Accompanying decontamination.
- External treatment, like incineration and liquid waste treatment;
- Container costs for radioactive waste:
  - Press drums;
  - 200-l containers;
  - 1000-l containers;
  - MOSAIK-Containers;

- KONRAD Type II-Containers.

– Transport, Interim storage at COVRA, and Disposal (used in the present study):
  - 200-l containers, with surface dose rate <= 0,2 mSv/h;
  - 200-l containers, with surface dose rate > 0,2 <= 2 mSv/h;
  - 200-l containers, with surface dose rate > 2,5 <= 4 mSv/h;
  - 1000-l containers, with surface dose rate > 0,2 <= 2 mSv/h;
  - MOSAIK-Containers;
  - KONRAD Type II-Containers.

9.4.12 WP 12: Conventional Demolishing

WP 12 considers the conventional part of plant decommissioning. It involves:

– Call for tenders / Negotiations / Contract awarding;

– Detailed planning;

– Licensing procedure (no costs);

– On-site supervision;

– Demolition of buildings;

– Removal of foundation piles;

– External treatment of concrete rubble;

– Reuse of building rubble/reinforcement.

The cost estimates are based on data given by a Dutch company:

– Staff qualifications and corresponding wages (see Table 4-1);

– Specific factors for transport and treatment of concrete rubble and steel (see Table 10-5).

9.4.13 WP 13: Site Restoration, Cleanup and Landscaping

After removing of all buildings the site has to be restored to the conditions before a nuclear power plant was built. Therefore following activities are planned:

– Site restoration (removing of ground);

– Refilling of pits and port with ground;

– Transport and treatment of remaining ground.

The costs are evaluated using specific cost factors given by a Dutch company experienced in this area /11/. The staff costs are included in these factors.

9.4.14 WP 14: Asbestos Removal

From previous investigations it is known that an accurate asbestos inventory in the Dodewaard installations is available. Asbestos was found in both contaminated and conventional installations or building structures.

Companies well experienced in asbestos removal suggest not speeding up the removal too much as this lead to higher incident and accident rates. Therefore, for the purpose of the present study it is considered that the asbestos will be removed in parallel to the dismantling of the contaminated equipment and later during conventional building demolition. The asbestos removal is not on the critical path of the project.

Following aspects have been taken into account for the cost estimate in the present study:

- Verification of asbestos locations;
- Additional investigations;
- Analyses of additional samples;
- Technical specification and tender;
- Asbestos removal work (incl. erection of scaffolds, tents, etc.)
  Spot by spot has to be decided how to do it, because this will be different from location to location;
- Follow-up of the work.

9.4.15 WP 15: Project Management, Engineering and Site Support

This WP includes general project tasks, which have to be administrated by both GKN and the Main contractor. During the project the operating expenses (staff and specific yearly costs) can be reduced. Table 9-1 shows how this has been taken into account in the present study.

9.4.15.1 GKN

- Site / Plant management;
- Finance and accountancy (e.g. administration of bills);
- Staff management;
- Secretary / Archive:
  - Correspondence;
  - Documentation.
- Quality assurance and quality control;
- Licensing coordinator / Contacts with authorities;
- Site procedures / Preparation of internal instructions;
- Supervision of the project;

- Follow up the project schedule;
- Commercial activities.

9.4.15.2 Main contractor

- Project management;
- Finance and accountancy;
- Staff management;
- Secretary / Archive:
  - Correspondence;
  - Documentation of operating data;
  - Documentation of dismantling activities;
  - Documentation of staff dosimetry;
  - Documentation of residual materials;
  - Documentation of radioactive waste;
  - Documentation of release measurements;
  - Transport documentation;
  - Etc.
- Quality assurance and quality control;
- Preparation of internal instructions;
- Supervision of the project;
- Follow up the project schedule;
- On-site coordination;
- Commercial activities;
- IT-Services (Hardware and Software);
- Revenues for sold components and scrap.

9.4.16 WP 16: Site security, surveillance and maintenance

Following tasks in WP 16 have to be carried out also with a GKN part and a Main contractor part. During the project the operating expenses (staff and specific yearly costs) can be reduced. Table 9-1 shows how this has been taken into account in the present study.

9.4.16.1 GKN

- Plant operation;
- Provision of Electricity;
- Provision of water (e.g. showers, cementation);
- Routine measurements;
- Balancing of radioactivity discharged in the air and in the sewage;
- Operation of radiological laboratory (only routine measurements);
- Implementation of in-service inspections at radiation protection equipment;
- Site maintenance:
  - Work shops;
  - Mechanical equipment incl. recurring checks;
  - Electrical equipment incl. recurring checks;
  - Civil engineering incl. recurring checks.
- Survey of occupational safety;
- Other costs (insurance, mail, communication, office material, medical service, etc.);
- Guarding of the site.

9.4.16.2 Main contractor

- Plant operation;
- Laundry costs (external);
- Sanitary area;
- Entrance to controlled area;
- Individual monitoring with operation of personal dosimetry and body counter;
- Environmental monitoring;
- Operation of radiological laboratory;
- Implementation of in-service inspections at radiation protection equipment;
- Activity calculations of waste containers;
- Radiological processing of radioactive transports;
- Site maintenance:
  - Work shops;
  - Mechanical equipment incl. recurring checks;

- Electrical equipment incl. recurring checks;
- Civil engineering incl. recurring checks.

– Survey of occupational safety;

– Maintenance and implementation of in-service inspections of fire protection equipment;

– Maintenance and implementation of in-service inspections of the site security equipment;

– Housekeeping;

– Outdoor area / terrain;

– Canteen;

– Cleaning;

– Other costs (mail, communication, office material, etc.).

9.4.17 WP 17: Authorities

This working package contains the expenses for the authorities during the whole decommissioning project [redacted]

9.5 Tables

Description of Tasks	Percentage in Period			
	A	B	C	D
WP 15: Project Management, Engineering end Site Support				
GKN:				
Site / Plant Management	100%	100%	100%	100%
Finance end accountancy	0%	100%	100%	100%
Secretary / Archive	0%	100%	100%	100%
Quality Assurance	0%	100%	100%	0%
License coordinator	0%	100%	100%	0%
Sita procedures	0%	100%	100%	0%
EDV / IT	100%	100%	75%	50%
Main Contractor:				
Project Management	100%	100%	100%	0%
Finance and accountancy	0%	100%	100%	0%
Secretary / Archive	100%	100%	100%	0%
Quality Assurance	0%	100%	100%	0%
EDV / IT	100%	100%	75%	0%
WP 16: Site Security, Surveillance and Maintenance				
GKN:				
Workshops (Mech., Electr., Civil)	0%	100%	75%	0%
Laundry costs (external service)	0%	100%	75%	0%
Provision of Energy	0%	100%	75%	0%
Provision of Water	0%	100%	100%	0%
Radiological Protection/Health Physics	0%	100%	100%	0%
Fire Protection (external service)	0%	100%	100%	0%
Guards	0%	100%	100%	0%
Other Cost:				
Insurance	0%	100%	75%	0%
Mail, Communication	0%	100%	75%	50%
Office material	0%	100%	75%	50%
Staff training	0%	100%	50%	0%
Medical Service	0%	100%	75%	0%
Main Contractor:				
Operation Entrance Controlled Area	0%	100%	100%	0%
Operation Nuclear Laundry / Substitution Clothes	0%	100%	100%	0%
Operation Nuclear Sanitary	0%	100%	100%	0%
Generation of operational / working orders	0%	100%	100%	0%
Maintenance / Mechanical	0%	100%	50%	0%
Maintenance / Electrical	0%	100%	50%	0%
Maintenance / Civil Engineering	0%	100%	50%	0%
Radiological Protection/Health Physics	0%	100%	100%	0%
Housekeeping	0%	100%	100%	0%
Plant Outdoor Area	0%	100%	100%	0%
Canteen	0%	100%	100%	0%
Cleaning Staff (Conventional)	0%	100%	100%	0%
Other Cost (e.g. Mail, Communication, Office material)	0%	100%	75%	0%

A = Start of Project until Granting the Licence
(Main Contractor: After being selected by GKN until the license is granted)
B = After Granting the Licence until End of Dismantling the Biological Shield (BS)
C = End of Dismantling BS until end of Building Decontamination
D = During Building Demolition and Site Recovery

Table 9-1: Reduction of manpower requirements and specific costs in WP 15 and 16

9.6 Figures

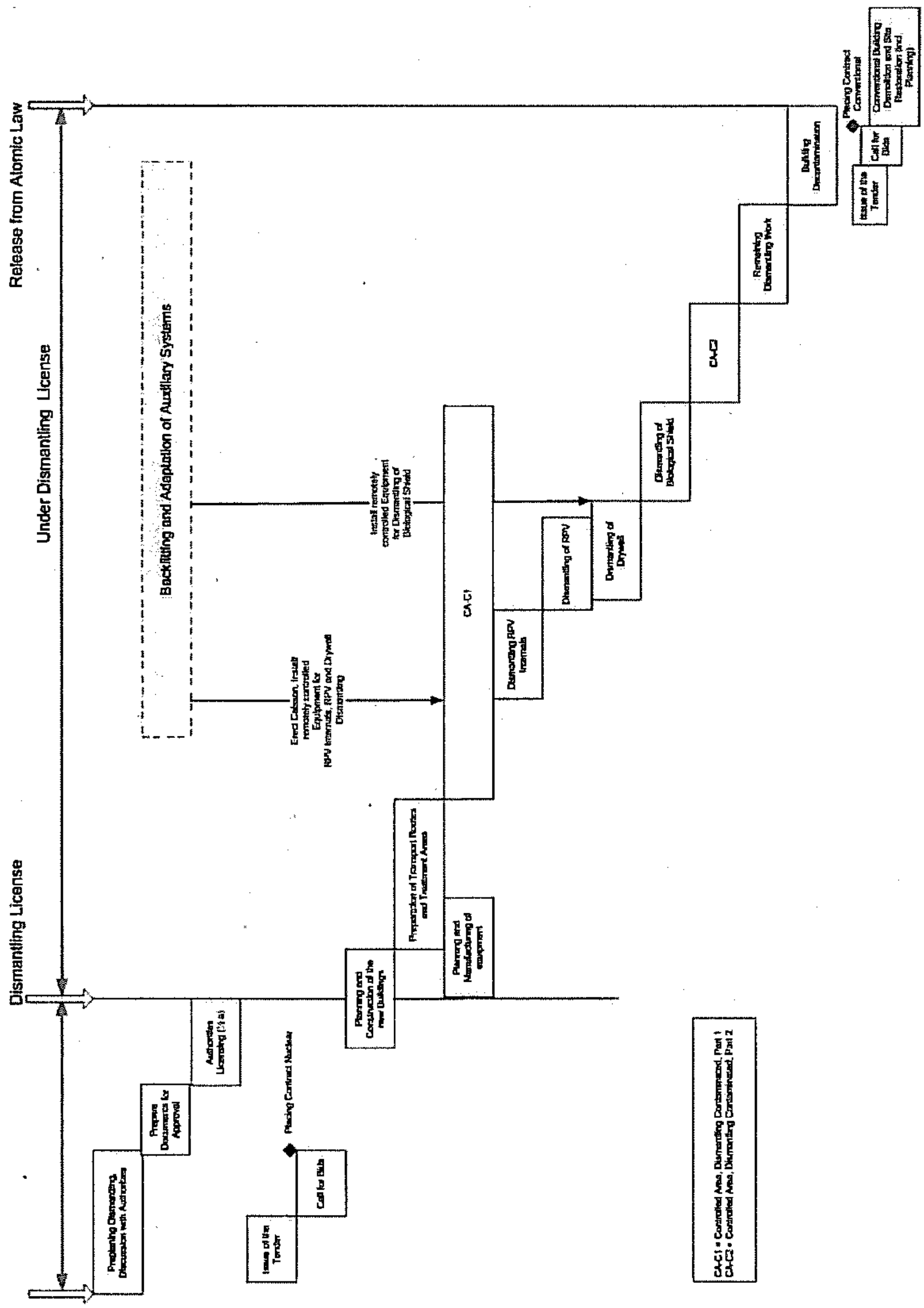

Figure 9-1: Generic sequence for the decommissioning project

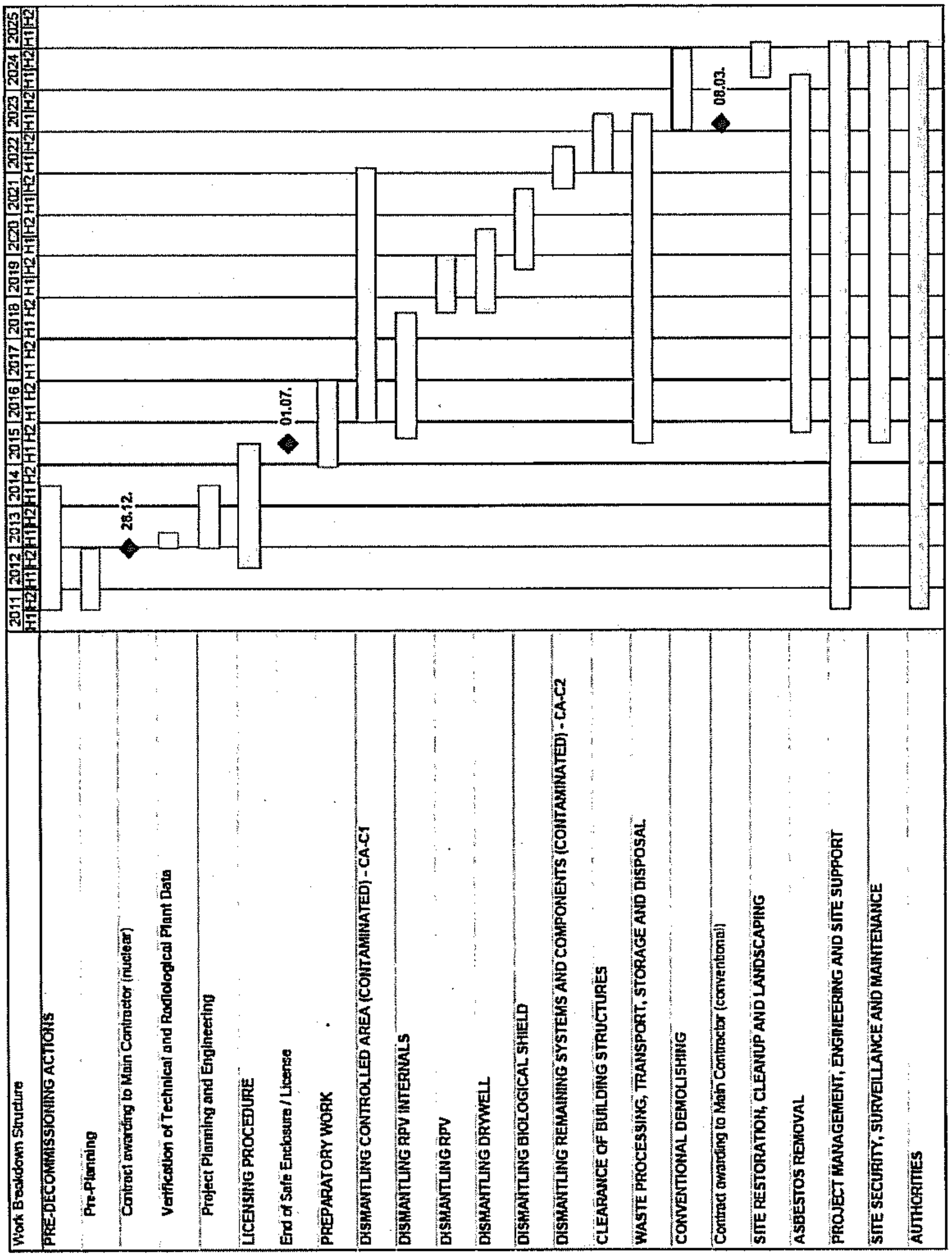

Figure 9-2: KCD Decommissioning – Time schedule (overview)

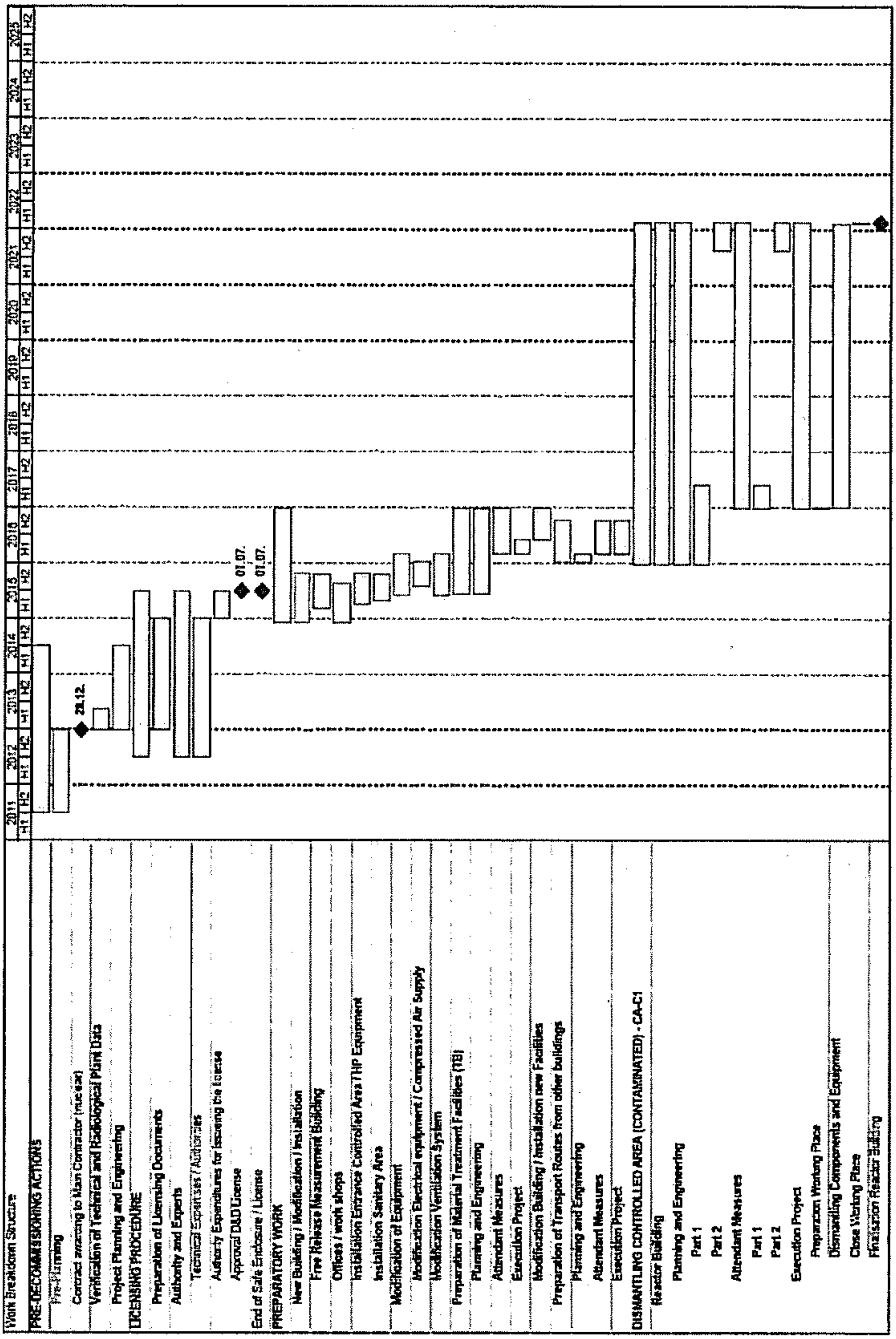

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Figure 9-3: KCD Decommissioning – Time schedule (detailed)

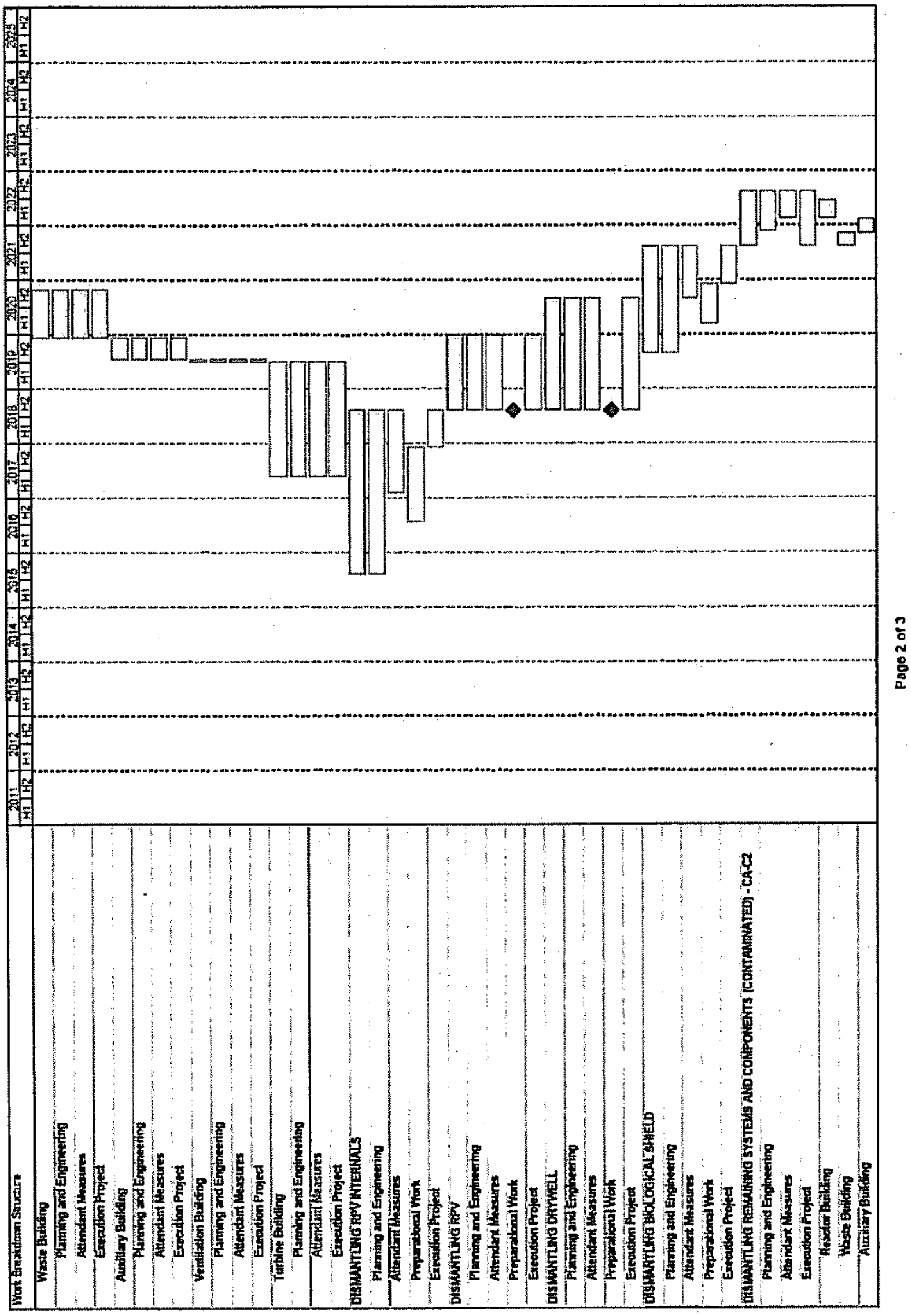

Figure 9-3: KCD Decommissioning – Time schedule (detailed); continued

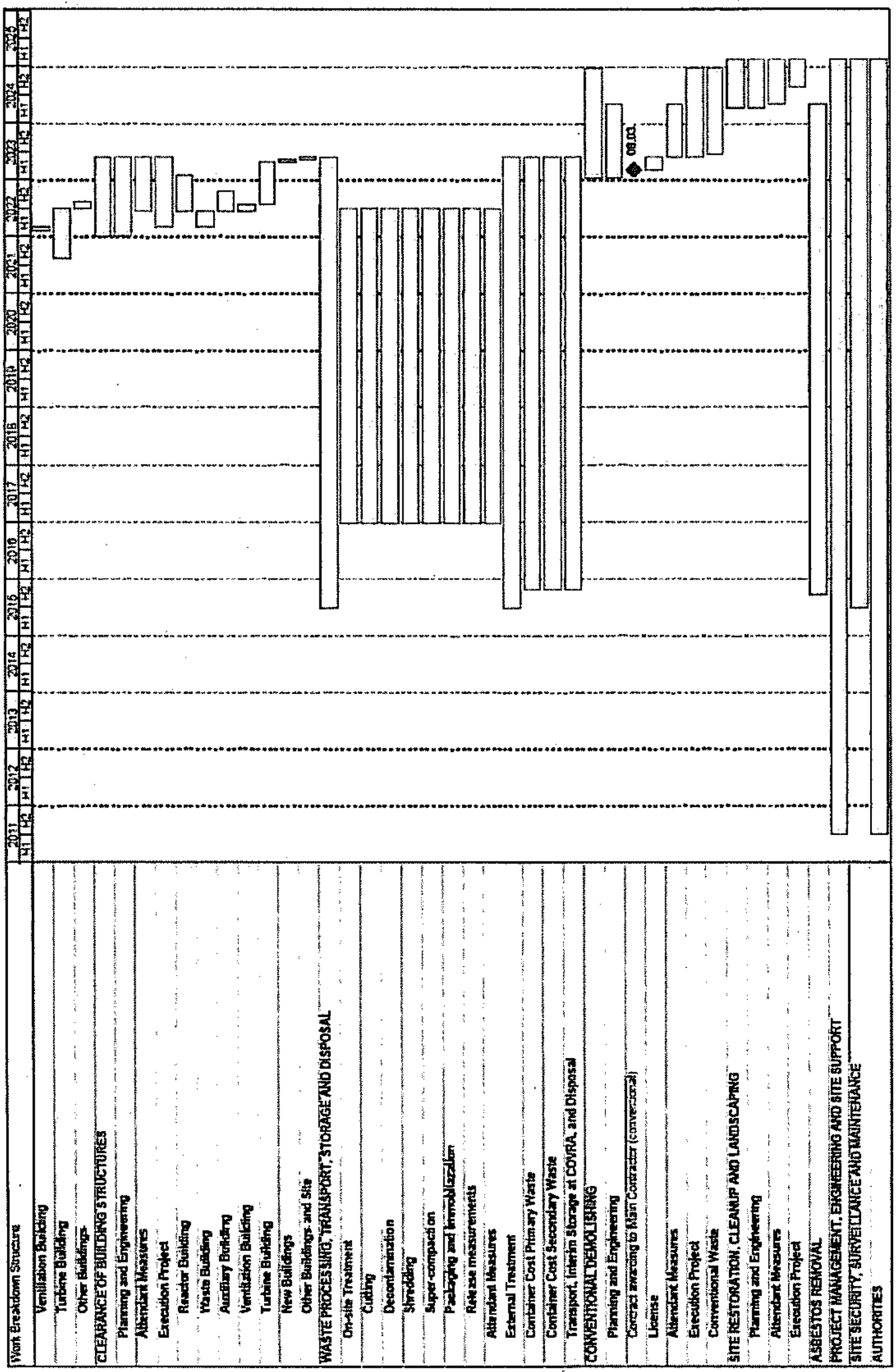

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Figure 9-3: KCD Decommissioning – Time schedule (detailed); continued

10 Decommissioning Costs

10.1 Introduction

For almost 30 years now NIS has been involved in nuclear decommissioning projects and has analyzed 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 /7/.

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 decommissioning 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 decommissioning 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 decommissioning 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 in Karlsruhe were calculated in 1995 and updated in 2007. In 2008 the owner 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 decommissioning 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 decommissioning 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.

10.2 Audits

10.2.1 Quality Assurance – Regular Audits

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.

10.2.2 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;
- January till September 2007: Extensive audit by PricewaterhouseCoopers (in the course of the year-end audit of two German utilities by PwC).

10.3 Computer Code CORA & CALCOM

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. The CORA & CALCOM 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 decommissioning project/costs.

10.3.1 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.

Based on the technical and the radiological data of the plant inventory CORA calculates the needed waste management data, containing:

- Material distribution – radioactive waste, reusable non radioactive material (also after decontamination);
- Packaging data – numbers and types of needed waste containers;
- Calculation of the needed repository volume;
- Calculation of the expected secondary waste during the decommissioning period;
- Balances of the radioactive inventory;
- Collection of room data (surfaces, contamination, properties of surfaces).

CORA calculates the expected amount of secondary waste depending on the mass of the existing component in two ways:

- Secondary waste generated during the dismantling work: clothes, gloves, foils, cleaning material, joint material;
- Secondary waste generated during the treatment of components: decontamination.

The results are presented by several lists.

10.3.2 CALCOM: Project Cost Estimate and Planning Module

CALCOM basically provides possibilities for:

- Project planning;
- Project management structure setup and maintenance;
- Management of project schedule;
- Resource management;
- Cost Estimates;
- Data exchange with MS-PROJECT or Primavera P6 project management software.

10.3.2.1 Project Management Structure Setup

The structure of a project management plan is hierarchical and can be defined considering the needs of individual facilities and the actual boundary conditions for the decommissioning project. It is compliant with the standardised OECD/IAEA Decommissioning Cost Items[1]. The number of hierarchical levels is – theoretically – unlimited, but experiences revealed, that a maximum of 8 levels is adequate to setup a project plan even for large decommissioning projects.

CALCOM allows to define and to calculate working tasks at any level of the project structure. The setup of project structure may start with preliminary planning at superior hierarchy levels and may be subsequently refined by defining sub levels providing more detailed planning data for these levels. The superior level will then summarise the results for the subsidiary tasks.

The module will provide for the possibility to enter, store, edit and extract from the centralised DB the following data regarding the project management structure:

- Task name and description;
- Start date, finish date, duration;
- Predecessor and successor of working task (one to many);
- Level in project hierarchy;
- Status;

[1] EC/IAEA/OECD: A Proposed list of terms for Costing Purposes in the Decommissioning of Nuclear Installations

- Milestones;
- Work progress;
- Remarks;
- Dependencies and relationships between tasks.

10.3.2.2 Project Cost Calculation and Resource Management

The base of the cost calculation is the technical and radiological inventory of the plant, which is normally set-up during mass and radiological data collection campaign and evaluated using the Registration Module (see above). 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, final repository).

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

- 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 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 (m^2) of a building area, will be used in combination with a specific working factor (Mh/kg or Mh/m^2) 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 (Mh/Mh).

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 decommissioning 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.

10.3.2.3 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-hr factors can be used for the calculation of the dismantling effort; factors for Man-hr (radiation protection) / Man-hr (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 30 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 fine-tuning for each individual activity depending on the different circumstances.

10.4 Basic Assumptions

10.4.1 Boundary Conditions

Since the PDP is generated for the decommissioning of the KCD NPP starting in 2015 several boundary conditions must be assumed yet. Basis for the present study is the Technical Requisition File (TRF) /6/ given by the client. The enclosed list gives some important definitions for the present cost estimates.

1. The goal of the decontamination and dismantling activities is to reach green field. The dismantling includes the removal of the buildings, of all the various underground structures, including among others the foundation piles, the cooling water inlet structures, and bringing the soil of the site to get the same level as the surroundings.

2. Non-radioactive concrete rubble is reused or sent to a landfill. Following specific cost figures, given by a Dutch company (see /11/ and Table 10-5), are used:
   - Transport and treatment of rubble (concrete, bricks) €/ton
   - Transport and treatment of steel €/ton
   - Removal, transport and treatment of soil I €/ton
   - Delivery of clean soil €/ton

3. The PDP is based on the equipment and materials database developed for Dodewaard NPP (DIS: "Dodewaard Information System).

4. Costs related to the Authorities have been included and represent [redacted]

5. The costs for GKN management and site support activities are considered (e.g. requirements by Dutch law on Health physics and security).

6. All planning and execution works will be performed by two external main contractors (one for the "nuclear" part and one for the conventional part) each in a frame of a single contract.

7. The wages used (GKN and Main contractor for the nuclear part) are based on relevant wages of German companies active in decommissioning activities. The wages used for conventional demolition are given by a Dutch company /11/ experienced in this area.

8. The decommissioning costs cover all expenses related to the dismantling preparation phase as well as for the dismantling phase.

9. A conservative estimate that constitutes an upper decommissioning cost in the worst case, i.e. with all uncertainties impacting negatively the decommissioning costs is performed. The uncertainties are defined in Appendix 9 of the TRF /6/.

10. 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.

11. All materials in the controlled area are supposed as being radioactive, unless measurements indicate that the contamination is below the clearance levels. Two cases are considered as discussed and agreed with the Regulator:

a) The clearance levels are those specified in the "Kernenergiewet", e.g. 1 Bq/g for Co-60, 10 Bq/g for Eu-152 and for Eu-154

b) IAEA RS-G-1.7 clearance levels to be complied with 0,1 Bq/g for Co-60 and 0,1 Bq/g for Eu-152 and for Eu-154

The surface specific clearance levels are taken from the German "Strahlenschutzverordnung" (Radiation Protection Ordinance) /5/, e.g. 1 Bq/cm² for Co-60, Eu-152 and for Eu-154, and agreed with the Dutch Regulator.

12. The costs of incineration of radioactive waste (including transport) are based on actual costs of existing European facilities. The specific cost figure is given in Table 10-5. The figure does include all transports, incineration and packaging (200-l drums) of the produced waste.

13. The COVRA waste management costs given in the Appendix 7 of the TRF /6/ updated to 2009 costs by E-mail (dated 25. Feb. 2009) have been used. The costs for "Transport, Interim Storage at COVRA, and Disposal" for KONRAD Type II containers are based on an E-Mail from COVRA dated 7. Oct. 2009 /10/. The COVRA waste management costs used are also given in Table 10-5 to Table 10-7.

14. The cleaning of the personnel contaminated clothes (overalls, masks, etc.) are subcontracted to an external service company (no laundry at the site). GKN has specified the cost for leasing clothes /12/. For the amount specified the clothes are collected every month, washed and returned. The given prices are in € per piece:
- Overalls €
- Lab-coats €
- Overshoes €
- Socks €
- Underwear shirts €
- Underwear shorts €
- Towels €
- Bag for collecting laundry €

The yearly costs for the external laundry service is assumed to be € (see Table 10-3). The cost figure is used during the whole decommissioning project (except building demolition and site recovery).

15. The discharges limits and conditions for radioactive effluents are given in Appendix 8 of the TRF /6/. GKN will apply for the following release limits:
- Air: Aerosols 1 GBq per calendar year, no sampling for H-3 and / or C-14.
- Water: Total Beta/Gamma 100 GBq. No sampling for H-3 and / or Alpha.

It is assumed that the emissions are below these limits in any case.

16. The site security meets the rules defined by VROM.

17. The existing on-site infrastructure is not suitable for decommissioning because most pipelines are cut, the old electrical system has been destroyed and the evaporator is broken and cannot be repaired anymore. Recovery of existing equipment is limited to some of the storage tanks.

18. The asbestos inventory in the KCD installations has been taken into account.

19. Both absolute and net present value costs are estimated; the discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk) is 4 % above inflation. This figure serves as a standard indexing number, as it was chosen in the past. Therefore, it is used in the present study as well, in order to make a comparison between studies possible.

20. The reference date for the price level of the cost estimation is taken as 01.01.2009.

21. VAT is not included in the costs.

10.4.2 Specific factors

Specific factors, i.e. cost factors or working factors are important for planning and calculation. These factors provide two opportunities:

- They allow a direct comparison between different decommissioning projects.
- The calculation is comprehensibly and easily adaptable to future knowledge.

The main cost factors for the PDP KCD are given below. All cost factors used are contained in the calculation database CALCOM.

The list of specific factors used is collected and evaluated during a cost estimation work of more than 30 years by NIS, starting with the first reactor which was completely dismantled; the German NPP Niederaichbach. The factors are adapted in periodically actualisations year by year based on the real experiences in the decommissioning projects Würgassen, Stade, Lingen, Mühlheim-Kärlich and Obrigheim.

10.4.2.1 Staff costs

The staff organisation and the staff costs (wages) are discussed in section 4. The hourly wages are shown in Table 4-1.

The wages are based on relevant wages of German companies active in D&D projects as agreed in the TRF /6/[2] and for conventional demolition on wages given by a Dutch Company experienced in this area /11/.

10.4.2.2 Working factors

Working factors are used for the calculation of the working effort and the amount of working hours. The working factors used for the PDP KCD can be divided into two groups:

- Mass, Surface, Volume, Number, etc. related factors which will be used with an plant specific indicator; mainly for dismantling and decontamination.
- Work related factors which will be used with a calculated work effort, mainly for attended measures, like planning, radiation protection or internal transport.

[2] Remark from NIS: These new wages are higher for some qualifications (e.g. Project Manager, Engineer) compared to only price escalated figures from the previous study. This leads to an increase in staff costs compared with the previous study (in a rough approach about l€).

Table 10-1 shows a selection of typical working factors used in the calculation for the PDP. The number of factors used is reduced to a number of basic factors which will be adapted during the calculation work within the CALCOM code. The factors shown in Table 10-1 are referenced to the actual decommissioning projects Greifswald, Würgassen, Stade and Obrigheim.

During the calculation in the CALCOM software the factors can be adapted to the local situation by additional factors. Table 10-2 shows possible local situations and the possible range of working factors. The adaptation or variation factors allow the consideration of the local situation:

- **Size of Component**: If a dismantling work has been carried out for a component or a batch of components with a low mass amount, the preparation of work site and some adjustment times of used equipment is much more influencing the total working time as for a component with a bigger mass amount. So the productivity of a dismantling work (kg/Man-hr) is higher in the case of a bigger working mass.
- **Accessibility**: If the work has to be carried out in less space circumstances the productivity will be lower as in good accessibility. No accessibility means also shielding measurements or at last remote control work. Special attention is paid to this aspect. During visits on site and detailed studies of drawings the situation was checked. This led to longer durations for the dismantling and for instance in the case of the large tanks in the waste building additional investments (special tools and necessary activities to reach the tanks) have been taken into account to dismantle and remove these tanks (e.g. tanks AOT-T1 to AOT-12) in a save way.
- **Protective Measures**: So as air breathing filters or full protective clothes will be lower the productivity of work. Factor above 1 means working in non controlled area.
- **Hoisting or Lifting Devices**: No lifting devices require more cutting work to smaller sizes. In maximum the cut pieces must be transported by manual work. If a device is available it could be a small one (Factor lower than 1) or a big one.
- **Scaffolding**: The work productivity will be lowered if the workers must use scaffoldings.

At last the specific factor used in the calculation is a multiplication of the basic factor from Table 10-1 and the adaptation factors from Table 10-2.

10.4.2.3 Specific cost factors

Specific cost factors are needed for consumables, invest cost, and for external service. The factors given are mainly defined as yearly costs or as mass related values. Table 10-4 and Table 10-5 give a survey on the factors used.

10.4.2.4 Waste packages

The container types used for the PDP KCD are defined in Section 8.4. Costs for the several containers were taken from the price lists of different German companies and COVRA. The cost figures given in Table 10-6 contain the containers which are analysed and evaluated during the cost estimate.

10.4.2.5 Transport, Interim Storage at COVRA, and Disposal

All radioactive waste has to be handed over to COVRA. The waste packages produced during the decommissioning of KCD will be transported to COVRA for Interim Storage and later for final disposal.

Besides the few MOSAIK-Containers (containing high activated parts of the RPV internals) all other containers are filled with cement for immobilization of the content.

For the purpose of the present study COVRA has provided specific cost figures per kind of container depending on the surface dose rate of the containers. The given figures are shown in Table 10-7.

10.5 Investments

Table 10-8 contains the list of investments as used in CALCOM for KCD. Waste packages (which are also calculated under "investments") are not included here.

10.6 Radiation exposure

The radiation exposure is not a direct cost item but the exposure is calculated together with the costs and therefore the results are presented here.

It is clear that the calculation of the expected radiation exposure as explained below can not replace the measurements and calculations to be performed during work preparation and during the dismantling work. The calculation with CALCOM is used by NIS to see if the calculation reveals any activities with an unexpected high result for the radiation exposure. If so, then special measures like remote controlled work, additional shielding, another technique, etc. can be considered (in such a case of course they must be considered also in the costs). For selected activities, typical values from real projects are known from our own experience or from literature, and NIS can compare the results of the CALCOM calculations with the data from experience.

The procedure is as follows:

First a set of dose rate classes are defined for different types of work in the controlled area. The dose rate class is defined as an average dose rate taking into account that the working time consists of:

- Time for work close to a component;
- Time for walking to reach or leave a working place;
- Time outside controlled area.

Based on dose rate figures stored in DIS and considering the above mentioned aspects the following classes were defined for the present study:

- Class 1: Outside controlled area 0,0 µSv/h;
- Class 2: Corridors 0,5 µSv/h;
- Class 3: Low level areas 2,5 µSv/h;
- Class 4: Medium level areas 5,0 µSv/h;

- Class 5: High level areas 10,0 µSv/h;
- Class 6: Upper level areas (e.g. RB-B, Rooms 5 C-F) 15,0 µSv/h.

One of these factors is assigned to each activity in the controlled area. CALCOM multiplies the man-hours for each activity with the factor from the dose rate class.

10.7 Results for Task 1.1.1: Best estimate (Kernenergiewet)

10.7.1 Decommissioning Costs

The cost estimates summarised in the following chapter use a best estimate strategy for all cost items such as cost per hour, cost for consumables, investments, work efficiency, etc.

The clearance levels from the Dutch Kernernergiewet are used.

More details on the cost estimation results are given in the CALCOM software which is a part of the NIS deliveries (read only CD).

The costs are estimated as an absolute value and a net present value. The net present value is estimated with 4 % real interest rate. The price level for the estimates is 01.01.2009.

The total decommissioning costs (absolute value) for KCD are) **M€**
(Net present value: **M€)**

The more detailed results are given for the absolute value only.

The decommissioning costs per working package and cost type are listed in Table 10-9. The percentage distribution to the cost types is shown in Figure 10-1. On the same level of detail (working package) Table 10-10 gives information about the yearly distribution of the costs. The total costs per year are shown in Figure 10-2.

In Table 10-11 the yearly costs are broken down to level 3 of the Work Breakdown Structure (WBS).

In Table 10-9 under working package 11 "Waste processing, Transport, Storage and Disposal" the "Container costs" and the costs for "Transport, Interim storage at COVRA and Disposal" are included as "Investment costs" and "Other costs" respectively. These costs are given in Table 10-12 separately for the different kind of containers.

A special task in the decommissioning project is the removal of asbestos. The total costs for this task are estimated to be €. The figure is not estimated with CALCOM but the result is implemented in CALCOM to show a complete picture of the decommissioning costs. Table 10-13 shows how the asbestos removal costs are estimated.

10.7.2 Man-power requirement and staff capacity

The man-power needed for the decommissioning of KCD is estimated to **778 man-years** in total.

The yearly distribution of the total man-power broken according to GKN staff and Contractors staff is shown in Figure 10-3.

Figure 10-4 to Figure 10-6 show the estimated man-power per year and qualification for GKN staff, Contractors staff (nuclear) and Contractors staff (conventional). The corresponding numbers are given in Table 10-14.

10.7.3 Radiation exposure per working package

Taking into account the dose rate classes described in Section 10.6, the required man-power and the estimated durations for the dismantling activities lead to a radiation exposure as shown in Table 10-15. The occupational dose is estimated in total with 2,5 Man-Sv.

10.8 Results for Task 1.2.1: Conservative Uncertainties (Kernenergiewet)

The Conservative Estimate constitutes an upper decommissioning cost in the worst case, i.e. with all uncertainties impacting negatively the decommissioning cost. The uncertainties that may affect the decommissioning cost are identified in Appendix 9 of the TRF /6/ and agreed in working group meeting. The items shown in Table 10-16 were identified as to be considered for a conservative estimate.

10.8.1 Physical Inventory

The masses of all activated parts and of the biological shield parts above clearance levels are increased by 10 %. All other masses have been increased by 5 %. This leads to a higher amount of waste and to longer durations for the dismantling.

10.8.2 Radiological inventory and decontamination efficiency

For the activated and/or contaminated waste a 10 % increase of the radioactive waste is assumed. This was implemented by changing the Distribution Factor Sets in Cora, i.e. the portions for radioactive waste have been adapted by a factor of 1,1. The portion for "clearance" was adapted to get again a total of 100 %. This leads to a higher amount of radioactive waste, i.e. more containers for disposal.

10.8.3 Decontamination of concrete

A 10% increase of the calculated efforts for the decontamination of the concrete surfaces was assumed. This was implemented by changing the work efficiency for the involved crew so that the duration of the work (and the related costs) was increased by 10%.

10.8.4 Dismantling efficiency

Most of the dismantling work is calculated by using the mass to be dismantled, a so-called staff set (a team, i.e. a number of people with different qualifications), and a dismantling efficiency factor which is based on experience and gives the needed man-hours per kg. To consider possible uncertainties in the dismantling efficiency, all needed "man-hours per kg" in the calculation were increased by 5%.

10.8.5 Costs of external services and deliveries

A 1% increase per year of the external costs for services and deliveries is assumed. This has been implemented by multiplying the yearly cost for all consumables and services by factors increasing every year by 1%.

10.8.6 Personnel costs

The estimated yearly Personnel costs have been multiplied by factors increasing every year by 2 % above inflation.

10.8.7 Investments

The estimated yearly Investments have been multiplied by factors increasing every year by 2 % above inflation.

10.8.8 Overall time Schedule

The impact of the increase of the total project time schedule by three months has been estimated by taking the year with the highest total costs, but without the not time depending costs (e.g. investments and disposal) and adding a quarter of these yearly cost to the total dismantling costs.

10.8.9 Results

To get the worse case for the decommissioning costs all impacts are added. This leads to total decommissioning costs for Task 1.2.1 of €
(Net present value: €)

The results are shown in Table 10-17.

10.9 Results for Task 1.1.2: Best estimate (IAEA)

Besides the clearance levels all other assumptions / boundary conditions are unchanged compared to Task 1.1.1 (Best estimate including clearance levels as defined in the "Kernenergiewet").

The clearance levels underlying the results given in this section are based on IAEA RS-G-1.7 /4/.

Compared to Task 1.1.1 the amount of radioactive waste has increased and it will need more time to dismantle the activated part of the Biological Shield. Due to the longer duration all time dependent activities are increased too (especially WP 15 and WP 16).

The costs are estimated as an absolute value and a net present value. The net present value is estimated with 4 % real interest rate. The price level for the estimates is 01.01.2009.

The total decommissioning costs (absolute value) for KCD are €
(Net present value: €)

The decommissioning costs per working package and cost type are listed in Table 10-18. On the same level of detail (working package) Table 10-19 gives information about the yearly distribution of the costs. The new figures for "Container costs" and costs for "Transport, Interim storage at COVRA and Disposal" are shown in Table 10-20.

The man-power needed for the decommissioning of KCD (Task 1.1.2) is estimated to **794 man-years** in total.

10.10 Results for Task 1.2.2: Conservative Uncertainties (IAEA)

The way to get the results for Task 1.2.2 is the same as described in section 10.8. The total costs are €
(Net present value: I€)

Table 10-21 shows the estimate figures.

10.11 Summary

An overview of the results of the new Decommissioning Cost Estimate KCD is given in the next two tables.

The first table gives an overview of the produced amount of radioactive waste, the necessary packages, the waste storage volume as well as the costs for transport, interim storage at COVRA and final disposal.

Task No.	Free Release Levels taken from	Uncertainty	Packed Mass [Mg]	Number of Disposal Containers [-]	Disposal Containers costs [M€]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal [M€]
1.1.1	KEW NL	Best Estimate	1383,8	2724		1560,5	
1.2.1	KEW NL	Conservative	1525,5	2980		1717,6	
1.1.2	IAEA	Best Estimate	1569,2	2772		1786,1	
1.2.2	IAEA	Conservative	1729,7	3035		1966,1	

The second table shows the results of the cost estimate considering the different tasks.

Task No.	Free Release Levels taken from	Uncertainty	Costs		
			Absolute Value [M€]	Conservative Estimate compared to Best Estimate	Net Present Value (4% above inflation) [M€]
1.1.1	KEW NL	Best Estimate			
1.2.1	KEW NL	Conservative	)	+ 26,4 %	
1.1.2	IAEA	Best Estimate			
1.2.2	IAEA	Conservative		+ 26,5 %	

*) Costs reflect the combined effects of all considered uncertainties.

In all tasks the actual dismantling work starts in 2015 while the planning and preparation starts 4 years earlier. The overall duration of the project (starting with planning and ending with "Green field" conditions) takes about 15 years.

10.12 Tables

Factor	Value
Dismantling Contaminated Components	0,0250 Man-Hour / kg
Dismantling Concrete Structures in Containment	0,0050 Man-Hour / kg
Dismantling Large Components	0,0100 Man-Hour / kg
Dismantling RPV Internals Remote Controlled	0,7000 Man-Hour / kg
Dismantling RPV Remote Controlled	0,0250 Man-Hour / kg
Dismantling Drywell	0,0800 Man-Hour / kg
Dismantling Biological Shield (activated)	0,0125 Man-Hour / kg
Dismantling Remaining Equipment	0,0085 Man-Hour / kg
Building surfaces: Decontamination and Release Measurements	0,7500 Man-Hour / m^2
Implementation planning	25 % of dismantling effort
Project management	20 % of dismantling effort
Supervision	15 % of dismantling effort
Radiation Protection	15 % of dismantling effort
Internal Transport	20 % of dismantling effort
Accompanying Decontamination	15 % of dismantling effort

Table 10-1: Typical working factors

Local Situation	Value of Factor Variation		Value of Factor Variation	
Size of Component	Small	0,2 - 1	Big	1 - 3
Accessibility	Bad	0,4 - 1	Good	1
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

Table 10-2: Adaptation of working factors to local situations

Clothes	Price per piece and month [€]	Assumed number per person and day	Number per person and month (21 days/month)	Price per person and month [€]	Price per person and year [€]
Overalls	10 1 c [redacted]				
Lab-coats					
Overshoes					
Socks					
Underwear shirts					
Underwear shorts					
Towels					
Bag for clollecting					
Total costs per person and year					
Average number of persons assumed [redacted]		Total cost per year:			
Costs per year used in the present study:					

Table 10-3: Evaluation of yearly costs for extemal laundry service

Factor	Value	
Authorities	[redacted]	€/year
Insurance		€/year
Guarding of the site (without staff on site)		€/year
Consumable Maintenance (Mech.)		€/year
Consumable Maintenance (Electr.)		€/year
Consumable Maintenance (Civil)		€/year
Consumable Workshop (Mech./Electr./Civil)		€/year
Staff training		€/year
Rad. Laboratory		€/year
Fire Protection Sytems Maintenance		€/year
IT Hardware		€/year
IT-Hardware Maintenance		€/year
IT-Software		€/year
Recurring Safety Checks (Electr.)		€/year
Recurring Safety Checks (Mech.)		€/year
Mail, Communication (GKN)		€/year
Mail, Communication (External contractors)		€/year
Laundry (External Service)		€/year
Medical Service		€/year
Office Material (GKN)		€/year
Office Material (External contractors)		€/year
Provision Electricity (Assumption: 1 MW incl. Heating)		€/year
Water (Connection to net)		€/year

Table 10-4: Specific cost factors (€/year)

Factor	Value	
Water used	[redacted]	€/m³
Water (release to Sewage system)	[redacted]	€/m³
Electricity (plain price, transport costs, transformer costs)	[redacted]	€/kWh
Consumable costs regular dismantling	[redacted]	€/kg
Consumable costs complex dismantling	[redacted]	€/kg
Consumable costs remote controlled dismantling	[redacted]	€/kg
Consumable costs demolition	[redacted]	€/kg
Consumable costs surface abrasion	[redacted]	€/m²
Consumables Cutting	[redacted]	€/kg
Consumables Immobilization	[redacted]	€/kg
Consumables Super-compaction	[redacted]	€/kg
Consumables Shredding	[redacted]	€/kg
Consumable costs RPV-Internals remote controlled dismantling	[redacted]	€/kg
Incineration	[redacted]	€/kg
Liquid waste treatment at COVRA (Liquid Class II per standard 60-l drum)	[redacted]	€/drum
Consumables Blasting Decontamination	[redacted]	€/kg
Consumables Release Measurement	[redacted]	€/kg
Selling Metal scrap	[redacted]	€/kg
Selling Copper scrap	[redacted]	€/kg
Selling Alu scrap	[redacted]	€/kg
Selling Lead scrap	[redacted]	€/kg
Transport and treatment of concrete rubble (conventional)	[redacted]	€/kg
Transport and treatment of steel (conventional)	[redacted]	€/kg
Refilling ground	[redacted]	€/kg
Remove and treatment of ground material (incl. Transport)	[redacted]	€/kg

Table 10-5: Specific cost factors (€/kg, €/m³, etc.)

Container type	Container costs [€]
Press drum	[redacted]
200-l drum	
1000-l container (NC) / 60mm Fe	
KONRAD Type II	
KONRAD Type II / 180mm NC	
KONRAD Type II / 180mm NC / 30 mm Fe	
MOSAIK Type II / 100mm Fe (Type B (U))	

Table 10-6: Costs for waste packages / containers

Container type	Costs per Container [€]
200-l container, with a surface dose rate <= 0,2 mSv/h	[redacted]
200-l container, with a surface dose rate > 0,2 <= 2,0 mSv/h	
200-l container, with a surface dose rate > 2,0 <= 2,5 mSv/h	
200-l container, with a surface dose rate > 2,5 <= 4,0 mSv/h	
200-l container, with a surface dose rate > 4 <= 10,0 mSv/h	
1000-l container, with a surface dose rate <= 0,2 mSv/h	
1000-l container, with a surface dose rate > 0,2 <= 2,0 mSv/h	
1500-l container, with a surface dose rate <= 0,2 mSv/h	
1500-l container, with a surface dose rate > 0,2 <= 2,0 mSv/h	
MOSAIK-container	
KONRAD-container Type II	

Table 10-7: Costs for transport, interim storage at COVRA, and disposal

No.	Description	Costs [€]	Associated WP
1	New free release measurement building	[redacted]	3
2	Clearance Measurement Facility incl. other measuring equipment		3
3	Storage areas / Internal transport equipment (fork lifts, lattice boxes, etc.)		3
4	Entrance Controlled Area and HP equipment		3
5	Modification Ventilation system		3
6	Modification Sewage water treatment (incl. Waste water release line)		3
7	Modification Hot Shower water treatment		3
8	Lifting devices (incl. handling ropes of Reactor- and Turbine building crane)		3
9	Modification electrical installations (incl. cranes) and pressurized air supply		3
10	Modification / Equipment electr. and mechanical work shops		3
11	Modification / Equipment offices		3
12	Modification / Equipment of radiological laboratory		3
13	Packaging Station (cementation)		3
14	Decontamination equipment (decontamination area)		3
15	Cutting devices (Cutting area: band saw, shredder, etc.)		3
16	Super-compaction station		3
17	Cutting and Manipulator equipment RPV internals (incl. Drywell internals)		5
18	Cutting and Handling RPV (incl. Drywell)		5
19	Cutting and Handling Biol. Shield		8
20	Dismantling equipment (tools, scaffolds, portable filters, tents, etc.)		3
21	Dismantling equipment for large components (TB)		4
22	Dismantling equipment for large components (WB)		4
23	Equipment for building and site decontamination		10
	Total		

Table 10-8: Investment costs used in the decommissioning cost esti[redacted]

WP No.	Working Package	Total costs [M€]	Staff costs [M€]	Investment costs / Revenues [M€]	Consumable costs *) [M€]	Other costs [M€]
01	PRE-DECOMMISSIONING ACTIONS					
02	LICENSING PROCEDURE					
03	PREPARATORY WORK					
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1					
05	DISMANTLING RPV INTERNALS					
06	DISMANTLING RPV					
07	DISMANTLING DRYWELL					
08	DISMANTLING BIOLOGICAL SHIELD					
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2					
10	CLEARANCE OF BUILDING STRUCTURES					
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL					
12	CONVENTIONAL DEMOLISHING					
13	SITE RESTORATION, CLEANUP AND LANDSCAPING					
14	ASBESTOS REMOVAL					
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT					
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE					
17	AUTHORITIES					
SUM						

*) "0,0" M€ means that the estimated costs are below 0,05 M€

Table 10-9: KCD Decommissioning costs per working package and cost type

WP No.	Working Package	Total [k€]	2011 [k€]	2012 [k€]	2013 [k€]	2014 [k€]	2015 [k€]	2016 [k€]	2017 [k€]	2018 [k€]	2019 [k€]	2020 [k€]	2021 [k€]	2022 [k€]	2023 [k€]	2024 [k€]	2025 [k€]
01	PRE-DECOMMISSIONING ACTIONS																
02	LICENSING PROCEDURE																
03	PREPARATORY WORK																
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1																
05	DISMANTLING RPV INTERNALS																
06	DISMANTLING RPV																
07	DISMANTLING DRYWELL																
08	DISMANTLING BIOLOGICAL SHIELD																
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2																
10	CLEARANCE OF BUILDING STRUCTURES																
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL																
12	CONVENTIONAL DEMOLISHING																
13	SITE RESTORATION, CLEANUP AND LANDSCAPING																
14	ASBESTOS REMOVAL																
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT																
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE																
17	AUTHORITIES																
Sum																	

Table 10-10: KCD Decommissioning costs per working package and per year

WBS	Working Packages with sub-levels	Total	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
		[k€]	[k€]	[k€]	[k€]	[k€]	[k€]	[k€]	[k€]	[k€]	[k€]	[k€]	[k€]	[k€]	[k€]	[k€]	[k€]
01	PRE-DECOMMISSIONING ACTIONS																
01.01	Pre-Planning																
01.01.01	Start of Project / Planning to Stop Safe Enclosure																
01.01.02	Project Specification / Tender documents																
01.01.03	Call for Tenders / Negotiations / Contract award																
01.02	Verification of Technical and Radiological Plant Data																
01.02.01	Check of documentation																
01.02.02	Technical Plant Status																
01.02.03	Radiological Plant Status																
01.03	Project Planning and Engineering																
01.03.01	Strategy Analyses																
01.03.02	Concept for a Decommissioning Documentation																
01.03.03	Final Decommissioning Plan (incl. Costs)																
01.03.04	Work/Cost Breakdown Structure																
01.03.05	Time Schedule																
01.03.06	Personnel Requirements and Radiation Exposure																
02	LICENSING PROCEDURE										[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
02.01	Preparation of Licensing Documents																
02.01.01	Safety Analysis Report																
02.01.02	Environmental Impact Assessment																
02.01.03	Technical Documents																
03	PREPARATORY WORK										[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
03.01	New Building / Extensions / Installations																
03.01.01	Free Release Measurement Building																
03.01.02	Offices / work shops																
03.01.03	Installation Entrance Controlled Area / HP Equipment																
03.01.04	Installation Sanitary Area																
03.02	Modification of Equipment																
03.02.01	Modification Electrical equipment / Compressed Air Supply																
03.02.02	Modification Ventilation System																
03.03	Preparation of Material Treatment Facilities (TB)																
03.03.01	Planning and Engineering																
03.03.02	Attendant Measures																
03.03.03	Execution Project																
03.03.04	Modification Building / Installation new Facilities																
03.04	Preparation of Transport Routes from other buildings																
03.04.01	Planning and Engineering																
03.04.02	Attendant Measures																
03.04.03	Execution Project																

Table 10-11: Detailed KCD Decommissioning costs per year

[redacted]

Van: 10 2 e [redacted]
Verzonden: donderdag 20 november 2014 9:16
Aan: 10 2 e [redacted]
[redacted]
Onderwerp: RE: GKN - begin met nieuw proces TRF / berekeningen ontmantelingsplan

Geachte 10 2 e [redacted],
Het is alweer even geleden dat een datum werd vastgesteld voor een bespreking over de voorgenomen Ontmantelingberekeningen 2016 van GKN.
De bespreking is vastgesteld op 27 november 2014, aanvang 15h00
GKN wil in deze bespreking u en uw collega's informeren over de ontwikkelingen rond de Ontmantelingsberekeningen 2016, de resultaten van de inmiddels gehouden gesprekken met NIS en COVRA en de voorgestelde werkwijze om tot een voor alle partijen acceptabel plan te komen. Ook willen wij de planning toelichten.

Namens de Overheid neemt, naast uzelf, [redacted] deel aan de bespreking. Tijdens mijn overleg met de [redacted], bleek dat het Ministerie van EZ er waarde aan hecht dat ook een vertegenwoordiger van het Ministerie van Financiën aan het overleg deelneemt. GKN juicht dit toe, maar heeft tot op heden nog niet vernomen of, en zo ja, wie van het Ministerie van FIN deelneemt aan de bespreking.
Ook is GKN nog geen vergaderlocatie bekend, graag vernemen wij de locatie.

Namens GKN zullen [redacted] en ondergetekende deelnemen.

Vriendelijke groet / Best regards,

BV Gemeenschappelijke Kernenergiecentrale Nederland (GKN)
(Joint Nuclear Power Plant of the Netherlands / Dodewaard NPP)

[redacted]

Mail: P.O. Box 40, 6669 ZG Dodewaard, The Netherlands.
Plant: Waalbandijk 112a, 6669 MG Dodewaard, The Netherlands. Phone plant: +31488418811.
Office: Wanraay 4, 6673 DN, Andelst, The Netherlands. Phone office: +31488470154. Fax office: +31488412128.
[redacted]. Url: www.kcd.nl

Van: [redacted]
Verzonden: woensdag 10 september 2014 16:12
Aan: [redacted]
Onderwerp: FW: GKN - begin met nieuw proces TRF / berekeningen ontmantelingsplan

Beste [redacted], ter info.

Vriendelijke groet, [redacted]

Van: [redacted]
Verzonden: woensdag 10 september 2014 15:51
Aan: [redacted]
CC: Onderwerp: RE: GKN - begin met nieuw proces TRF / berekeningen ontmantelingsplan

[redacted], ik neem volgende week contact op met GKN.

Groet, [redacted]

Van: [redacted]
Verzonden: woensdag 10 september 2014 9:43
Aan: [redacted]
Onderwerp: GKN - begin met nieuw proces TRF / berekeningen ontmantelingsplan

Beste [redacted],

[redacted] noemde jullie namen als aanspreekpunt voor GKN. Ik werd zojuist gebeld door [redacted]. GKN wil graag de opstart van de nieuwe Technical Requisition File / berekeningen tbv nieuwe ontmantelingsplan bespreken.

Mag ik jullie contactgegevens doorsturen aan [redacted] of nemen jullie zelf contact met hem op?

Vriendelijke groet,
[redacted]

[redacted]

[redacted]

....
Directie Energie & Duurzaamheid
Directoraat-Generaal Energie, Telecom & Mededinging
Ministerie van Economische Zaken
Bezuidenhoutseweg 73 | 2594 AC | Den Haag
Postbus 20401 | 2500 EK | Den Haag
[redacted]

20100416-1-101-150 - NIS

NIS

Siempelkamp
NIS Ingenieurgesellschaft mbH

TECHNICAL DOCUMENT

Document No.: 8229 / CA / F 008157 7 / 00

Title: ***GKN – Evaluation of Decommissioning of the Dodewaard NPP -New Decommissioning Cost Estimate-***

Task 1: Reference Scenario
Starting date of decommissioning: 2015
Clearance levels: KEW and IAEA

Customer: B.V. Gemeenschappelijke Kernenergiecentrale Nederland (GKN)

00	16.04.2010		10 2 e [redacted]	
Rev.	Release Date	BU / (Name) Prepared	(Signed) Reviewed	(Signed) Approved

Rev.	Chapter	Description of changes
00	All	First Edition

Executive Summary

The objective of the present study is to provide a new cost estimate for the complete dismantling of the "Kernenergiecentrale Dodewaard" (KCD) after Safe Enclosure (SE) called "KCD new Decommissioning Cost Estimate".

The KCD new Decommissioning Cost Estimate is evaluated in the frame of an "Early decommissioning scenario" called also **"Reference Scenario"**. Under this scenario, it is assumed that the actual KCD dismantling works start in **2015**. Licensing and preparation start about 4 years earlier.

The new cost estimate is performed in a frame of a Preliminary Decommissioning Plan (PDP). The sections of the present study represent a table of content for this PDP as given in Appendix 1 of the Technical Requisition File (TRF) /6/. The level of detail provides a full understanding how the decommissioning costs are obtained and shows that they are in compliance with Dutch Laws and context specifications taking into account all KCD conditions.

The scope of the present study includes the following tasks:

- Task 1.1.1: Using best estimate assumptions, including clearance levels as defined in the Dutch "Kernenergiewet" /3/;
- Task 1.1.2: Using best estimate assumptions, but with IAEA RS-G-1.7 /4/ clearance levels;
- Task 1.2.1: Using conservative uncertainties, including clearance levels as defined in the Dutch "Kernenergiewet" /3/;
- Task 1.2.2: Using conservative uncertainties, but with IAEA RS-G-1.7 /4/ clearance levels.

The present study is prepared by NIS Ingenieurgesellschaft mbH (NIS). For almost 30 years now NIS has been involved in nuclear decommissioning projects and has analyzed 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 /7/.

The main assumptions made in the present study are:

- Only dismantling costs (incl. licensing and preparation) are estimated. Operational costs for Safe Enclosure (SE) are not included. Based on present expenses the yearly costs for SE period are M€ per year.
- Costs related to Authorities are included with [redacted]
- The wages used (GKN and Main contractor for the nuclear part) are based on relevant wages of German companies active in decommissioning activities. The wages used for Building demolition and the Site recovery are given by GKN based on information from a Dutch demolition company.

- The goal of the decontamination and dismantling activities is to reach "Green field". The dismantling includes the removal of the buildings, of all the various underground structures, including among others the foundation piles, the cooling water inlet structures, and bringing the soil of the site at the same level as the surroundings.
- An updated status of KCD (using the most recent physical and radiological data inventories stored in Dodewaard Information System - DIS) has been taken into account.
- All materials in the controlled area are supposed as being radioactive, unless measurements indicate that the contamination is below the clearance levels.
- 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.
- The COVRA waste management costs given in the Appendix 7 of the TRF /6/ updated to 2009 costs by E-mail (dated 25. Feb. 2009) have been used. The costs for "Transport, Interim Storage at COVRA, and Disposal" for KONRAD Type II containers are based on an E-Mail from COVRA dated 7. Oct. 2009 /10/.
- Both absolute and net present value costs are estimated; the discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk) is 4 % above inflation. This figure serves as a standard indexing number, as it was chosen in the past. Therefore, it is used in the present study as well, in order to make a comparison between studies possible.
- The reference date for the price level of the cost estimate is taken as 01.01.2009. VAT is not included in the costs.

The results of the new Decommissioning Cost Estimate KCD ("Best estimate") are as follows. The first table gives an overview of the produced amount of radioactive waste, the necessary packages, the waste storage volume as well as the costs for transport, interim storage at COVRA and final disposal.

Task No.	Free Release Levels taken from	Packed Mass [Mg]	Number of Disposal Containers [-]	Disposal Containers Costs [M€]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal [M€]
1.1.1	KEW NL	1383,8	2724		1560,5	
1.1.2	IAEA	1569,2	2772		1786,1	

The second table shows the results of the cost estimate considering the different tasks.

Task No.	Free Release Levels taken from	Costs	
		Absolute Value [M€]	Net Present Value (4% above inflation) [M€]
1.1.1	KEW NL		
1.1.2	IAEA		

The report recognizes that uncertainties or risks may affect some items considered while defining the Best Estimate Cost. The considered items are: the physical and radiological inventories, the concrete decontamination and the dismantling efficiencies, the personnel costs, the investments costs and the project overall time schedule. Variations of these items were agreed upon, all leading to increase the decommissioning cost. The report provides the influence on the decommissioning cost of each of these variations as well as the combined effects of all these variations.

The overall duration of the project (starting with planning and ending with "Green field" conditions) takes about 15 years.

More detailed results can be found in the following sections of the study or on the CD (delivered in the frame of the present study).

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List of Abbreviations

Abbreviation	Description
AB	Auxiliary Building
AG	Afvalgebouw
ALARA	As Low As Reasonably Achievable
BS	Biological Shield
CA	Controlled Area
CALCOM	Calculation and Cost Management
CORA	Component Registration and Analysis
COVRA	N.V. Centrale Organisatie Voor Radioactief Afval
D&D	Decommissioning & Dismantling
DF	Distribution Factor
DIS	Dodewaard Information System
EWN	Energiewerke Nord GmbH
GKN	B.V. Gemeenschappelijke Kernenergiecentrale Nederland
GNS	Gesellschaft für Nuklear-Service mbH
HP	Health Physics
HTP	Hoofd Toegangs Poort
IAEA	International Atomic Energy Agency
KCD	Kernenergiecentrale Dodewaard
KEW	Kernernergiewet
NC	Normal Concrete
NG	Nevengebouw
NIS	NIS Ingenieurgesellschaft mbH
NL	The Netherlands
NPP	Nuclear Power Plant(s)
PDP	Preliminary Decommissioning Plan
PSE	Preparation for Safe Enclosure
QA	Quality Assurance
RB	Reactor Building
RG	Reactorgebouw
RPV	Reactor Pressure Vessel
SE	Safe Enclosure
TB	Turbine Building
TE	Tractebel Engineering S.A.
TG	Turbinegebouw
TRF	Technical Requisition File
VAT	Value Added Tax
VB	Ventilation Building
VG	Ventilatiegebouw
VROM	Volkshuisvesting, Ruimtelijke Ordening en Milieu
WAS	Water Abrasive Suspension
WB	Waste Building
WBS	Work Breakdown Structure
WP	Working Package

1 Introduction

The Dodewaard NPP (KCD) has been shut down on March 26th 1997. The dismantling strategy is a complete dismantling of the plant to Greenfield Conditions after a waiting period of several years as a so called Safe Enclosure (SE).

On April 23rd 2003, after the last spent fuel was transported from site, the phase Preparation for Safe Enclosure (PSE) started. This phase lasted till June 30th 2005. On July 1st 2005, the phase Safe Enclosure (SE) started. This phase is planned to last for 40 years.

After the SE phase the NPP will be completely dismantled to so-called Greenfield Conditions.

NIS Ingenieurgesellschaft mbH (NIS) has performed cost studies for the decommissioning of the Dodewaard NPP under different contracts.

The first one in 1994 /1/ in the frame of two scenarios: immediate dismantling after a planned final shutdown in 2004 and deferred dismantling scenario, i.e. dismantling 40 years after a planned reactor final shutdown.

A second study was performed in 1999 /2/ in the frame of deferred dismantling scenario, i.e. to cover the costs for Preparation for Safe Enclosure, the Safe Enclosure (40 years) and the Dismantling to "green field".

The objective of the present study is to provide a new cost estimate for the complete dismantling of the "Kernenergiecentrale Dodewaard" (KCD) after SE called "KCD new Decommissioning Cost Estimate". This new cost estimate is established using the inputs – at their best knowledge – of following parties:

- B.V. Gemeenschappelijke Kernenergiecentrale Nederland (GKN) supported by Tractebel Engineering S.A. (TE);
- Volkshuisvesting, Ruimtelijke Ordening en Milieu (VROM);
- N.V. Centrale Organisatie Voor Radioactief Afval (COVRA).

A working group constituted by representatives of these parties has set-up a Technical Requisition File (TRF) /6/ that takes into account the inputs and contributions of each involved party and serves as basis for the present study.

The KCD new Decommissioning Cost Estimate is evaluated in the frame of an "Early decommissioning scenario" called also **"Reference Scenario"**. Under this scenario, it is assumed that the actual KCD dismantling works start in 2015.

This cost estimate will:

- be performed using CORA/CALCOM programmes, taking advantage of the return of experience from past and on-going D&D projects (in particular in Germany);
- address the concems (see Appendix 3 of the TRF /3/) expressed previously by the Task Force (TOK) having reviewed the previous cost estimates;
- take into account an updated status of KCD (using the most recent physical and radiological data inventories);
- take into account new boundary conditions.

Two different assumptions / tasks are evaluated:

Task 1.1:

"Best estimate assumptions" mean the best estimates for the boundary conditions, for the data for physical and radiological inventory, and for the technical and commercial assumptions as they are normally used by NIS in its cost estimates and agreed with GKN.

Task 1.2:

"Conservative uncertainties" are the ones defined in the Appendix 9 of the Technical Requisition File (TRF) /6/ and agreed during working group meeting.

The new cost estimate is performed in a frame of a Preliminary Decommissioning Plan (PDP). The sections of the present study represent a table of content for this PDP as given in Appendix 1 of the Technical Requisition File (TRF) /6/. The level of detail is enabling GKN/VROM/COVRA/TE to fully understand how the decommissioning cost is obtained and that it is in compliance with Dutch Laws and context specifications taking into account all KCD conditions.

The scope of the present study includes the following sub-tasks:

- Task 1.1.1: Using best estimate assumptions, including clearance levels as defined in the Dutch "Kernenergiewet" /3/;
- Task 1.1.2: Using best estimate assumptions, but with IAEA RS-G-1.7 /4/ clearance levels;
- Task 1.2.1: Using conservative uncertainties, including clearance levels as defined in the Dutch "Kernenergiewet" /3/;
- Task 1.2.2: Using conservative uncertainties, but with IAEA RS-G-1.7 /4/ clearance levels.

The assumptions, boundary conditions and results of the new Decommissioning Cost Estimate KCD are described in the following sections and, in addition, all results are provided on a CD.

2 Description of the Plant

2.1 Site

De inrichting ligt in de Over-Betuwe (provincie Gelderland), aan de rechteroever van de Waal. De vestigingsplaats, circa 20 km ten westen van Nijmegen en Arnhem, ligt in het gebied van de gemeente Neder Betuwe, dorp Dodewaard, circa 2 km ten zuidoosten van het centrum, in de Hiensche uiterwaarden (see Figure 2-1).

In het bestemmingsplan buitengebied van de gemeente Dodewaard is aan het terrein waarop de inrichting staat de bestemming "elektriciteitscentrale" toegekend. Dit terrein is 26 ha groot; het gedeelte waarop de gebouwen staan, is opgehoogd tot 13 m boven NAP. De vloerhoogte van de gebouwen is 13,20 m boven NAP.

The KCD is out of operation since March 26th 1997 and since July 1st 2005 the plant is in a Safe Enclosure status, i.e. the controlled area is reduced to a minimum and all buildings which are not necessary anymore are removed. All presently redundant systems have been retired. Briefly this means that these systems have been drained, oil removed and isolated mechanically and electrically. Other systems are still in operation to maintain the required safety level for personnel and environment.

2.2 Buildings on Site

Tot de Veilige Insluiting behoren de volgende gebouwen:

- Reactorgebouw;
- Turbinegebouw;
- Nevengebouw;
- Ventilatiegebouw;
- Afvalgebouw.

The plant layout during SE is shown in Figure 2-2.

Hieronder volgt per gebouw een globaal overzicht van de componenten, systemen en ruimten die zich in de Veilige Insluiting bevinden:

- in het reactorgebouw bevinden zich onder andere het reactorvat, de reactorkamer, het biologisch schild, het splijtstofopslagbassin, de drukvereffeningsvaten en een aantal systemen die tijdens vermogensbedrijf sterk radioactief besmet zijn geraakt, zoals bijvoorbeeld het reactorwaterzuiveringssysteem (see Figure 2-3 and Figure 2-4);
- in het turbinegebouw bevinden zich onder andere de turbine, de generator, de condensors, voedingwaterpompen en voorwarmers. Tevens bevinden zich in dit gebouw enkele ruimten waarin potentieel met radioactieve stoffen besmette systemen zijn ondergebracht;

- in het afvalgebouw bevinden zich onder andere systemen die zijn gebruikt voor de verwerking en opslag van radioactief afval, zoals een aantal tanks voor de opslag van radioactief afvalwater, de afvalwaterindamper, de afvalverwerkingstraat en de balenpers;
- in het nevengebouw bevindt zich onder andere de ruimte voor toevoer, filtering en ontvochtiging van de ventilatielucht. In dit gebouw bevindt zich ook de bewaking-/bedieningsconsole voor de Veilige Insluiting. In dit gebouw is de hoofdtoegang tot de Veilige Insluiting gelegen met bijbehorende HTC faciliteiten, laboratorium faciliteit en kantoren. Tot het nevengebouw behoren verder nog diverse ruimten die tijdens vermogensbedrijf een functie hadden zoals de regelzaal, waterbehandelingsruimte, elektrische ruimten, schakelruimten, transformatorruimten en kabelruimten;
- in het ventilatiegebouw bevinden zich onder andere de afvoerventilator en het afvoerfilter. Verder bevinden zich in dit gebouw componenten van het voormalige hoofdventilatiesysteem.

Naast bovengenoemde gebouwen staan op het terrein van de inrichting nog enkele andere gebouwen en opstallen, zoals het afgesloten koelwatergebouw, waarvan de opbouw en de componenten zijn verwijderd, de steiger en de HTP (HoofdToegangsPoort). De HTP heeft de functie van loge en bevat een deel van het elektriciteitsvoorzieningsysteem.

Het koelwatergebouw, waarvan de opbouw en de componenten zijn verwijderd en de toegangen zijn afgesloten, maakt evenals de lossteiger geen deel uit van de Veilige Insluiting, doch dient evenals het koelwater uitlaatwerk en de constructies rond de koelwater inlaathaven te worden verwijderd tijdens de eindontmanteling.

2.3 Physical Inventory

The physical or mass inventory of the KCD plant is based on a detailed data collection and the results are stored in the Dodewaard Information System (DIS). DIS allows a detailed evaluation of the inventory data regarding several criteria like component type, material, locations, activity classes and dose rates. These data are transferred to the database CORA to use all information for the new decommissioning cost estimate in the present study.

Some examples of different mass reports (based on DIS/CORA) are given in Table 2-1 to Table 2-3 (names and description are taken from DIS). The masses for the building structures are taken from previous studies /1/, /2/ and are listed in Table 2-4. All these masses are so called primary masses.

During dismantling and treatment of the dismantled components and equipment so called secondary masses (clothes, plastic foils, tools, etc.) are produced. For more information see section 8.

For dismantling, treatment, packaging or release of the plant inventory new equipment has to be installed. New temporary buildings for the release measurement facility and buffer storages for incoming empty containers and outgoing filled containers are erected on site. These new equipments and buildings are called tertiary/additional masses. An evaluation of these masses is given in Table 2-5. More details are given in section 9.

The plant layout during the dismantling phase is shown in Figure 2-5.

2.4 Overview of known incidents with building contamination at KCD

During the PSE phase a report was conducted by POVI group (group of engineers responsible for the design of the SE) in close cooperation with the Chemistry group, the Health Physics group, and the building and site maintenance group. The report was released on September 17, 1998. Report number is 98-009/POV/R, rev 0. The information from the report is incorporated in DIS. The report itself is stored in the 1999 Technical information Package 1999 (TIP 99) archive under code number 3-4.

During the operational period of the plant, an overview of water transports in the plant was produced on a monthly basis. From these overviews, it was never possible to deduct a leakage or uncontrolled release of water to the environment.

Table 2-7 gives an overview of incidents resulting in contamination of building structures. The amount of concrete involved has been taken into account in a conservative way in the evaluation of the concrete masses which have to be removed during building decontamination (see also section 8.3.2). The cement in the floor drain systems is removed completely.

2.5 Tables

Building / Building level	Description	Mass [Mg] original
AG-NG-VG	Afval gebouw-Neven gebouw-Ventilatie gebouw	10,84
AG-A	Afval gebouw 10 meter vloer	47,39
AG-B	Afval gebouw 13 meter vloer	292,82
AG-C	Afval gebouw 19 meter vloer	101,52
AG-D	Afval gebouw 22 meter vloer	11,43
NG-A	Neven gebouw 10 meter vloer	32,96
NG-B	Neven gebouw 13 meter vloer	162,95
NG-C	Neven gebouw 17 meter vloer	107,07
NG-D	Neven gebouw 22 meter vloer	3,92
NG-E	Neven gebouw dak	3,00
RG-A	Reactor gebouw	193,21
RG-B	Reactor gebouw 13 meter vloer	489,01
RG-C	Reactor gebouw 17 - 22 meter vloer	2410,74
RG-D	Reactor gebouw 28 meter vloer	31,76
RG-E	Reactor gebouw 31 meter vloer	46,41
RG-F	Reactor gebouw 36 meter vloer	32,61
RG-G	Reactor gebouw lift vloer	74,72
TG	Turbine gebouw	17,99
TG-A	Turbine gebouw 10 meter vloer	337,65
TG-B	Turbine gebouw 13 meter vloer	244,26
TG-C	Turbine gebouw 17 meter vloer	90,17
TG-D	Turbine gebouw 22 meter vloer	615,40
VG-A	Ventilatie gebouw 10 meter vloer	0,59
VG-B	Ventilatie gebouw 13 meter vloer	73,90
VG-C	Ventilatie gebouw 19 meter vloer	3,00
	Total	**5435,32**

Table 2-1: KCD plant inventory – Masses per building / building level

System	Description	Mass [Mg] original
ACB/WWB	AFVALCHEMICALIENBEHANDELING/WASWATERBEHANDELING	8,81
ACS	AIRCONDITIONINGSYSTEEM	0,40
ADS	AUTOMATISCH DRUKAFLAATSYSTEEM	2,15
AIS	AFVALWATERINDAMPSYSTEEM	9,28
AVT	AFTAP EN VLOERWATERTANKS	1,29
AWO	AFSCHERMWATER OPSLAGTANKS	40,54
BBS	BRANDBLUSSYSTEEM	1,12
BLW	BRON EN LEIDINGWATER SYSTEEM	3,02
BMI	BRANDMELDINSTALLATIE VI	0,02
CBW	CONDENSOR EN BEDRIJFSKOELWATER	2,80
CRS	CONDENSAATREINIGINGSSYSTEEM	6,63
CVS	CENTRALE VERWARMINGSSYSTEEM	15,21
DACO	NOODDIESELAGGREGAAT	9,64
DHS	DEMINWATER HYDROFOORSYSTEEM	4,27
GIS	GAS INERTISERINGSSYSTEEM	1,27
GKS	GESLOTEN KOELWATERSYSTEEM	11,24
HKS	HOOFDKONDENSAATSYSTEEM	71,35
HRS	HARSREGENERATIESYSTEEM	7,22
HSS	HOOFDSTOOMSYSTEEM	189,90
IRD	ISOLATIE REACTORKAMER EN DRUKVEREFFENINGSVATEN	0,13
KIS/DAS	KERNINUNDATIE/DRUKVEREFFENINGSVATENSYSTEEM	136,23
KKS	KONDENSORKOELWATERSYSTEEM	182,32
KSL	KOELSYSTEEMLEIDBUIZEN	1,22
KSR	KOEL SYSTEEM REAKTORKAMER	2,55
LAS	LUCHTAFZUIGSYSTEEM	1,64
LOS	LAGEROLIESYSTEEM	1,92
LVA	LICHT VERONTREINIGD AFVALWATERBEHANDELING	4,57
LVS	LUCHTVOORZIENINGSSYSTEEM	9,45
LWS	LENSWATERSYSTEEM	0,73
NAI	NUCLEAIRE AFVALWATER INSTALLATIE VI	0,53
NCS	NOODCONDENSATIESYSTEEM	17,49
NGS	NEUTRONENGIFSYSTEEM	1,69
NIJS	NEUTRONENFLUX IJKSYSTEEM	9,12
NKS/TOS	NEVENKONDENSAATSYSTEEM/TURBINE ONTWATERINGSSYSTEEM	4,28
OMS	ONGEVALLEN MONSTERSYSTEEM	0,36
PLS	PAKKINGBUSLEKSYSTEEM	2,28
RAS	REACTORAFKOELSYSTEEM	5,78
RAV/AOT	RADIOACTIEF AFVALBEHANDELINGSSYSTEEM EN AFVAL OPSLAG TANKEN	71,31
RBS	REACTORBEVEILIGINGSSYSTEEM	0,12
ROS	REGELOLIESYSTEEM	0,20
RSA	AANDRIJFSYSTEEM	20,21
RV	REACTORVAT	181,06
	Included are:	
	- Drywell 82,07	
	- RPV Internals 6,82	
	- RPV Head 16,11	
	- RPV Cylindrical part and bottom 70,88	
	- RPV Insulation 6,20	
RZS	REACTORWATERZUIVERINGSSYSTEEM	15,44

Table 2-2: KCD plant inventory – Masses per system

System	Description		Mass [Mg] original
SBK/SRS	SPLIJTSTOFBASSIN KOELSYSTEEM/SLIJTSTDFDPSLAGBASSIN REINIGING		7,63
SHS/AG	SPERWATER HYDROFDDRSYSTEEM IN AFVALGEBOUW		0,46
SSW	SPOEL EN SUPPLETIEWATERSYSTEEM		13,51
SWD	SUPPLETIEWATER DEMINERALISATIE INSTALLATIE		6,79
TKS	TRANSFORMATORKOELSYSTEEM		0,59
TSS	TURBINE SPERWATERSYSTEEM		0,03
VAS	VACUUMAFGASSYSTEEM		35,13
VEN	VENTILATIESYSTEEM		103,41
VWB	VLDERWATERBEHANDELING		1,93
VWS	VOEDINGSWATERSYSTEEM		16,15
WRS	WATERSTOFRECDMBINATIESYSTEEM		1,74
YDS	IJZERSULFAAT DDSEER SYSTEEM		0,80
NOT DEF	ND SYSTEM DEFINED in DIS, here are included:		4190,16
	- ELEKTRICITEITSKAST	45,74	
	- KABELGOOT	303,93	
	- APPENDAGES	5,25	
	- LEIDINGEN	171,08	
	- OVERIGEN OPSLAG	67,19	
	- POMP	2,40	
	- KOPEREN RAILS (AARDLEIDING)	4,30	
	- MOTOR	116,54	
	- TANK	50,18	
	- BORDES, TRAP, ONDERSSTEUNINGEN, HIJSBALK	667,72	
	- OVERIGEN EI	27,90	
	- LIFT, VERWARMING, AFSCHERMING,VLOER	46,80	
	- BIOLOGICAL SHIELD (activated and not activated part)	2336,48	
	- NOT DEFINED	34,22	
	- AFSCHERMING	247,74	
	- WARMTEWISSELAAR	0,02	
	- PE LEIDINGEN	2,65	
	- INSULATION	40,02	
	Total		5435,32

Table 2-2: KCD plant inventory – Masses per system (continued)

Material	Description	Mass [Mg] original
NOT DEF	NOT DEFINED	41,61
STAAL	KOOLSTOFSTAAL	2030,32
RVS	ROESTVRIJSTAAL	230,20
KOPER	KOPER	36,22
PE	POLYETHYLEEN (KUNSTSTOF	4,42
LOOD	LOOD	29,54
DIV	DIVERSEN DOOR ELKAAR HEEN	2,49
BETON	BETON incl. Mass of Biological Shield [Mg]: 2336,48	2633,80
ALU	ALUMINIUM	11,08
HOUT	HOUT	3,11
PVC	POLYVENYLCHLORIDE	0,54
ZNST	ZINKSTAAL	2,99
KGM	KABELGOOT MATERIAAL (KOPER, STAAL, PVC, ZNST)	302,15
EKM	ELEKTRICITEITS KAST MATERIAAL (KOPER, STAAL, PVC)	48,83
CEMENT	CEMENT	18,00
WOOL	INSULATION MATERIAL	40,02
	Total	**5435,32**

Table 2-3: KCD plant inventory – Masses per material

Description	Mass [Mg]
Controlled Area:	
RG - structures (without Biological Shield)	11160,0
TG - structures	15020,0
AG -, VG -, NG - structures	22800,0
Conventional Part:	
HTP Entrance building	140,0
KWG Cooling water building / channel	7860,0
Piles	7270,0

RG = Reactorgebouw
TG = Turbinegebouw
AG = Avfalgebouw
VG = Ventilatiegebouw
NG = Nevengebouw

Table 2-4: KCD plant inventory – Masses of building structures

Description	Mass [Mg]
Masses from Preparation for Safe Enclosure	30,0
Remote controlled equipment	265,0
Treatment facilities and installations	294,0
New installations (e.g. transport equipment, ventilation system)	73,5
New installations (e.g. waste water treatment, conv. installations)	135,0
New buildings	840,0
Total	**1637,5**

Table 2-5: Evaluated tertiary masses (new buildings and installations)

Description	Mass [Mg]	
Plant inventory:		**6.232,8**
- Primary mass (see Table 2-1 to 2-3)	5.435,3	
- Tertiary/additional mass (see Table 2-5)	797,5	
Building structures:		**65.090,0**
- KCD buildings (see Table 2-4)	64.250,0	
- New buildings (see Table 2-5)	840,0	
Total mass:		**71.322,8**

Table 2-6: Summary of KCD masses to be dismantled or demolished

Location	Description	Activity (Bq)	Status
TG-E01	Roof ventilator system	3 times the background level	Removed before start SE
Emergency exit RG	Outside building ground contamination	Up to 10 times the background level	Removed at start construction Aux building 2
All basements	Incoming water from river due to extreme high water level	None	Not confirmed. This was just a rumour.
Several walls	Minor cracks. Possibly contaminated	Unknown	All cracks checked and injected. No true cracks.
All buildings	Floor drain systems	Unknown	Filled with cement during PSE *)
NG-A02	Basement former laboratory. Leakage of LWS-T15	5 E +8 (1980) Co-60	In top floor and long crack *)
Site	Particles found during routine checks	Above background	Removed when detected
RG-A04	AVT-T2. By drawing this floor should be covered by special bricks. In practice this is concrete.	High, as this was the RG sump.	Still in place. Change of airborne contamination. *)
RG-A02A	Overfill of AVT-T1 leads to floor contamination. Small cracks in floor paint and cover	High, as the water originated from RWCU resin transport	Partly cleaned. Due to high radiation from AVT-T1 no access to room. *)
VG-A01	Water leakage from drain system of HRS	High	Removed, including crack.
NG-A02 and NG-B01	Wall tumbled over. Open connection between LWS P5 and P6 to soil. Possible leak path.	Unknown	Can only be solved at final demolition. Non accessible. *)
Grounds surrounding NPP	Minor ground contamination	Below clearance levels	Reported to government. No action required.

*) Cement filled in floor drain systems is removed completely during decommissioning and the amount of contaminated concrete is considered together with the removed amount of concrete during building decontamination.

Table 2-7: Overview of incidents resulting in contamination of building structures

2.6 Figures

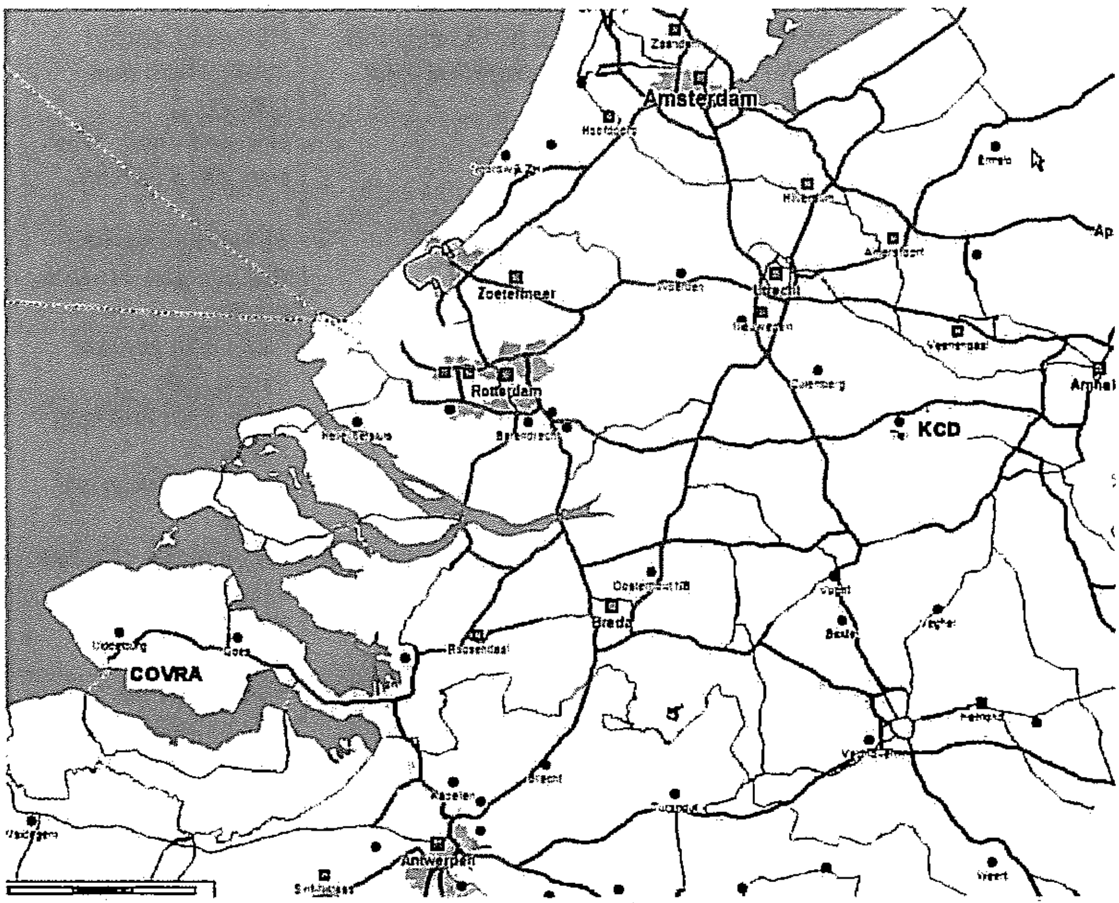


Figure 2-1: Location of the sites (KCD and COVRA)

10 1 b

[redacted]

Figure 2-2: Plant layout during Safe Enclosure Phase

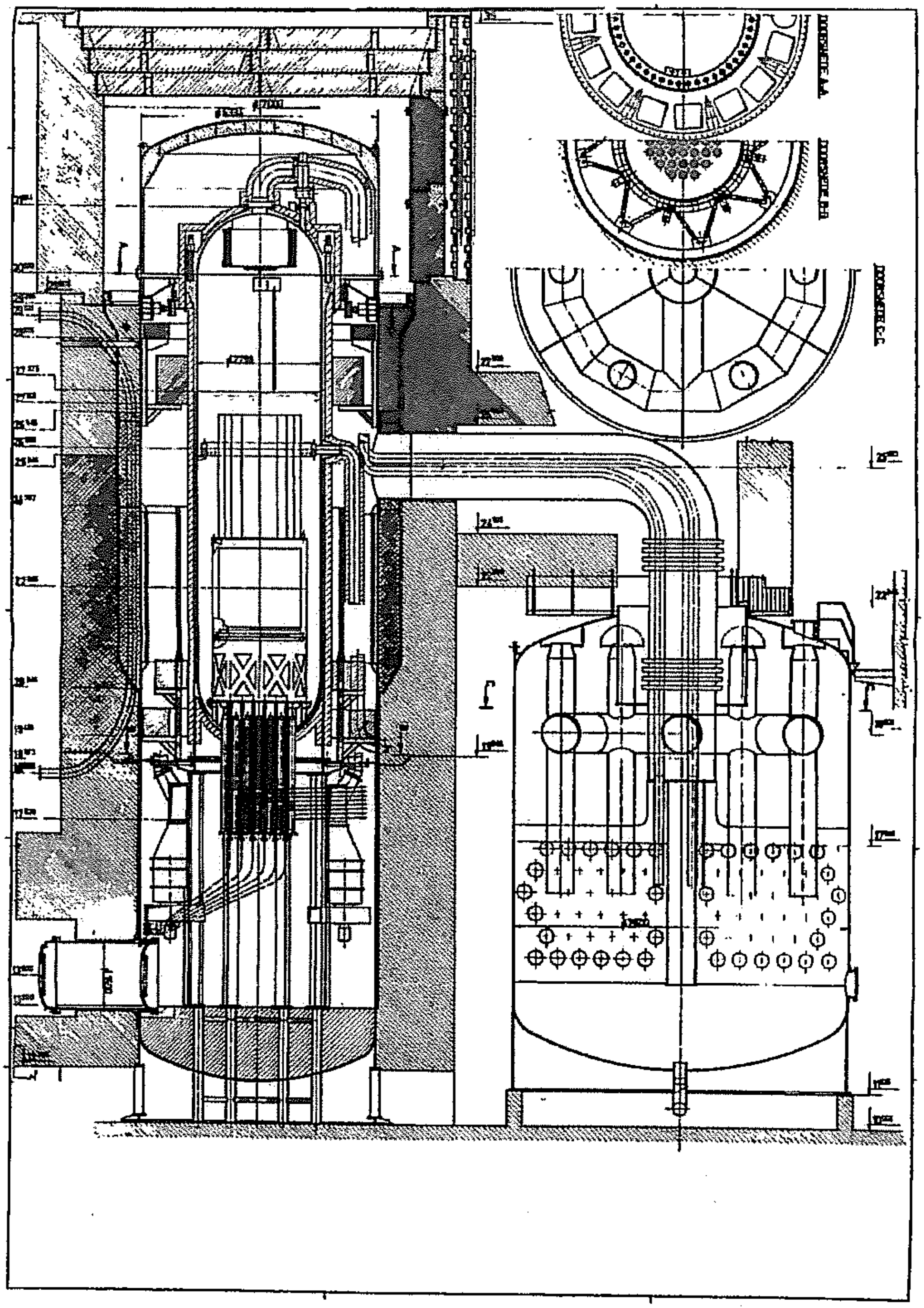


Figure 2-3: Section through Drywell and Internals (incl. Pressure Compensation Vessel)

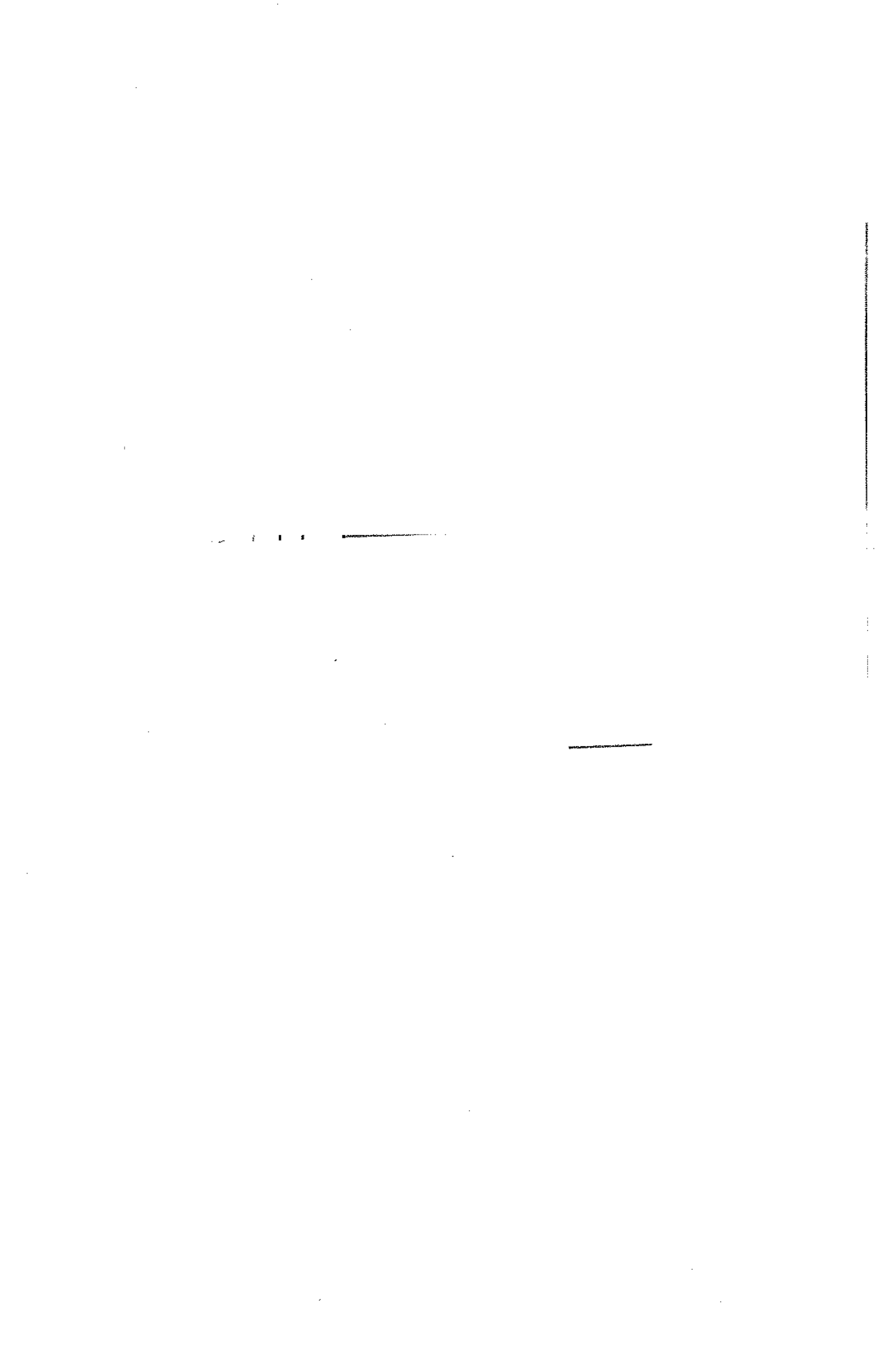


Figure 2-5: Plant layout during Dismantling Phase

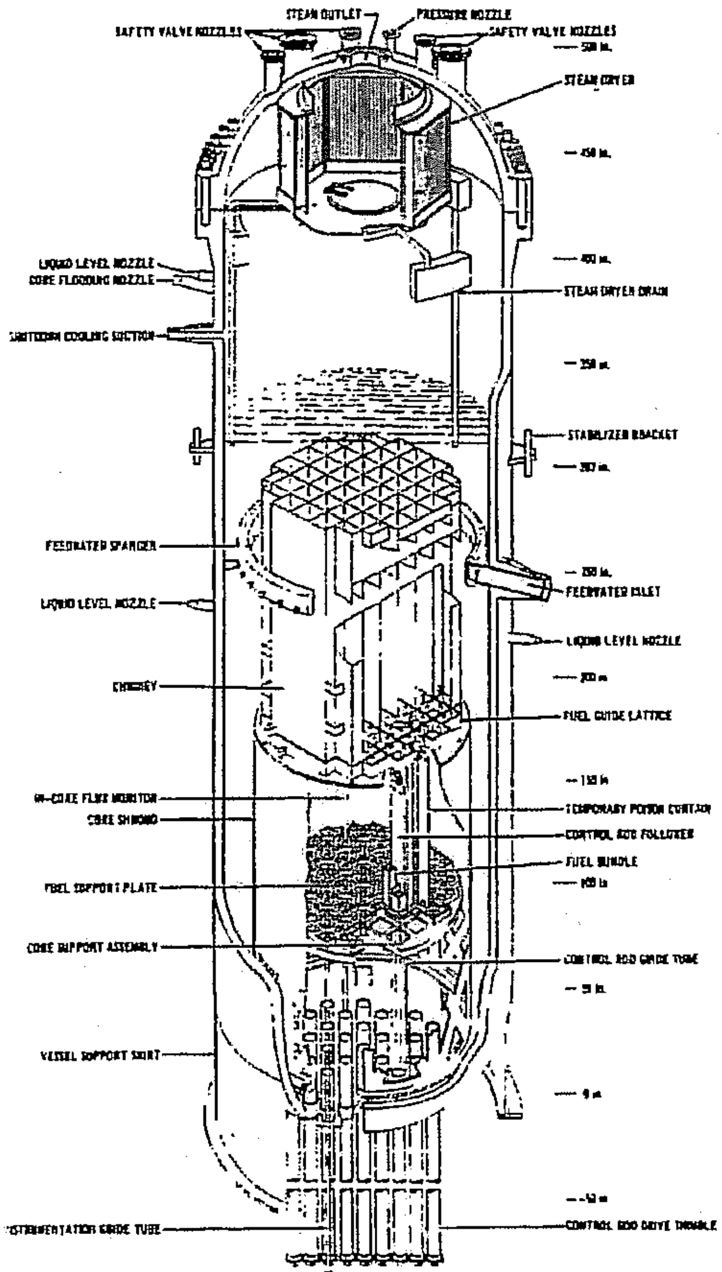


Figure 2-4: Section through Reactor Pressure Vessel and Internals

3 Radiological Inventory of the Plant

The data of the radiological inventory of the KCD plant is also stored in DIS. DIS allows an evaluation of these data considering different decay times. So the radiological inventory is estimated at the planned date of dismantling. These data are transferred to the database CORA to use the information for the new decommissioning cost estimate.

Under the "Reference Scenario", it is assumed that the actual KCD decommissioning starts in 2015. For the purpose of the study it is necessary to define a reference date where all evaluations (dismantling, waste management, radiation exposure, etc.) are based on. For the "Reference scenario" this date is assumed to be the 30.06.2017. This date has been chosen as a conservative date for the start of actual dismantling work. Until this date more or less only new installations and modification works will be carried out.

3.1 Radiological Inventory

The radioactivity and the nuclear decay is characterized by the nuclide vectors (= percentage of the different nuclides in a material). According to the earlier operation characteristics the nuclide vectors will be different in different buildings and/or systems.

The nuclide vectors were checked during the project and it was approved that the ones used for the previous study are still valid. No alpha-activity was found in samples taken, but trace amounts of alpha-emitting nuclides were found in the suction lines of the RPV. These trace amounts were below clearance levels. Sampling was done by GKN, while COVRA analyzed the samples /8/.

The nuclide vectors have then been changed corresponding to the nuclear decay of the different nuclides to show the situation at the reference date. Table 3-1 shows the nuclide vectors for the date of shutdown of the plant (26.03.1997) and the reference date (30.06.2017).

All material in the controlled area is supposed as being radioactive, unless measurements indicate that the contamination is below the clearance levels.

Two kinds of radioactivity have to be taken into account:

- Activation;
- Contamination.

The activation of the material was generated by neutron irradiation during reactor operation. Because of that the activated area is limited to the reactor area, i.e.:

- Reactor vessel and internals;
- Reactor chamber (drywell);
- Biological shield:

The range of radioactivity is largely spread within the group of the activated material. Therefore the total mass is divided in six Activation classes (A0 to A5).

The contamination of the material is spread over the whole controlled area. Two sources of contamination have to be considered:

- Air borne contamination at the outside of the systems and equipment;
- Deposits coming from the medium inside the systems.

The contamination is divided in five Contamination classes.

There is no radioactivity data available for different components, but it is known that the radioactivity is low or even not present. The masses of these components are marked with the radioactivity class "Not defined" (total value: 112,09 Mg).

The radioactivity classes (activation and contamination), the range of radioactivity and the masses per radioactivity class are shown in Table 3-2 for the activated materials and in Table 3-3 for contaminated materials for both the date of plant shutdown and the reference date for the present study.

The layers of the Biological Shield above activity class A0 with the corresponding masses are listed in Table 3-4 for the reference date 2017. Figure 3-1 shows the location of these layers schematically. Taking into account the two different clearance levels – Dutch law (KEW) and IAEA regulations (RS-G-1.7) – the amount of concrete considered as radioactive waste is given in Table 3-5. Taking into account the Dutch clearance levels (i.e. 1,0 Bq/g for Co-60) all activation classes above A1 are considered as radioactive waste and taking into account the IAEA regulations (i.e. 0,1 Bq/g Co-60) all activation classes above A0 are considered as radioactive waste.

3.2 Tables

Name of Nuclide Vector	Building or Component	Used for			Reference Date	Nuclide Composition [%]									
		1)	2)	3)		Mn-54	Fe-55	Co-60	Ni-63	Zn-65	Sb-125	Eu-154	Cs-134	Cs-137	Eu-152
WG	Waste Building	x		x	26.03.1997	17.8		78.5						3.1	
					30.06.2017			73.9						26.1	
BS-LB	Light concrete of biolog. shield		x		26.03.1997			27.9					5.2		63.0
					30.06.2017			8.0					<0.1		91.9
BS-ZB	Heavy concrete of biolog. shield		x		26.03.1997	3.6		8.0		38.0		51.0	1.9		8.0
					30.06.2017			5.1				78.9	<0.1		16.0
C-Steel	Steel	x	x		26.03.1997	3.7	87.6	4.3	<0.1						
					30.06.2017		60.7	31.6	9.2						
NG	Service Building	x		x	26.03.1997	14.5		83.9						2.6	
					30.06.2017			78.6						21.4	
RG	Reactor Building	x		x	26.03.1997	41.8		[illegible]							
					30.06.2017			100.0							
KWS	Stainless Steel	x	x		26.03.1997	4.2	60.3	34.5	2.0						
					30.06.2017		10.8	44.7	45.0						
SB	Core Parts		x		26.03.1997			26.4			73.6				
					30.06.2017			80.2			19.8				
TG	Turbine Building	x		x	26.03.1997	51.6		45.7		1.3	0.7			0.6	
					30.06.2017			92.8			0.1			7.3	
VG	Ventilation Building	x		x	26.03.1997	28.7		66.7						4.9	
					30.06.2017			52.6						47.7	

1) Used for the contamination of components
2) Used for the activation of components
3) Used for the contamination of room surfaces

26.03.1997 Values at the date of shutdown
30.06.2017 Values at reference date

Table 3-1: Nuclide vectors at the date of plant shutdown and the assumed date for decommissioning ("Reference Scenario")

No.	Activation class	Activity range	Mass in [Mg] *)	
			1997	2017
1	A0	Activated <= 0,1 Bq/g	1.704,74	1.785,79
2	A1	Activated > 0,1 Bq/g <= 1 Bq/g	166,79	215,06
3	A2	Activated > 1 Bq/g <= 100 Bq/g	409,16	463,28
4	A3	Activated > 100 Bq/g <= 10000 Bq/g	284,92	224,57
5	A4	Activated > 10000 Bq/g <= 1000000 Bq/g	100,72	16,70
6	A5	Activated > 1000000 Bq/g	45,00	5,93
		Total	**2.711,33**	**2.711,33**

*) 26.03.1997: Values at date of shutdown
30.06.2017: Values at reference date

Table 3-2: Activation classes, activity range and mass per activation class for all the activated materials

No.	Contamination class	Activity range	Mass in [Mg] *)	
			1997	2017
1	C1	Contaminated <= 0,4 Bq/cm²	770,84	1.656,07
2	C2	Contaminated > 0,4 Bq/cm² <= 4 Bq/cm²	704,63	349,41
3	C3	Contaminated > 4 Bq/cm² <= 40 Bq/cm²	434,56	445,87
4	C4	Contaminated > 40 Bq/cm² <= 400 Bq/cm²	290,96	87,48
5	C5	Contaminated > 400 Bq/cm²	410,91	73,07
		Total	**2.611,90**	**2.611,90**
6	Not Defined		112,09	112,09

*) 26.03.1997: Values at date of shutdown
30.06.2017: Values at reference date

Table 3-3: Contamination classes, activity range and mass per contamination class for all the contaminated materials

Parts of Biological Shield with Activation above A0, i.e. > 0,1 Bq/g (location of different parts see Figure 3-1)	Layer thickness [cm]	Rad. Cat.	Mass [kg]
PART A (Normal Concrete 3/4 of Pit) 29.50 - 35.80 m	0-5	A1	9.357
	5-10	A1	9.445
PART F (Normal Concrete 1/4 of Pit) 29.50 - 35.80 m	0-5	A1	5.006
	5-10	A1	5.049
PART B (Normal Concrete above Reactor) 25.85 - 29.50 m	0-5	A3	5.151
	5-10	A3	5.247
	10-15	A2	5.343
	15-20	A2	5.439
	20-25	A2	5.534
	25-30	A2	5.630
	30-35	A2	5.726
	35-40	A2	5.822
	40-45	A1	5.918
	45-50	A1	6.013
	50-55	A1	5.737
	55-60	A1	5.786
PART C (Normal Concrete 3/4 around Reactor) 20.55 - 25.65 m	50-55	A2	16.687
	55-60	A2	16.829
	60-65	A2	16.971
	65-70	A1	17.113
	70-75	A1	17.256
	75-80	A1	17.398
	80-85	A1	17.540
PART I (Normal Concrete 1/4 around Reactor) 20.55 - 25.85 m	50-55	A2	3.789
	55-60	A2	3.821
	60-65	A2	3.853
	65-70	A1	3.886
	70-75	A1	3.918
	75-80	A1	3.950
	80-85	A1	3.983
PART D (Heavy Concrete around Reactor) 20.55 - 26.85 m	0-5	A3	18.327
	5-10	A3	16.674
	10-15	A3	19.020
	15-20	A3	19.367
	20-25	A3	19.713
	25-30	A3	20.059
	30-35	A2	20.406
	35-40	A2	20.752
	40-45	A2	21.099
	45-50	A2	21.445
PART E (Normal Concrete ONDERAAN Reactor) 12.80 - 20.55 m.	0-5	A2	15.170
	5-10	A2	15.311
	10-15	A2	15.453
	15-20	A2	15.594
	20-25	A2	15.736
	25-30	A1	15.877
	30-35	A1	18.018
	35-40	A1	16.180

Table 3-4: Layers of Biological Shield with activation classes and masses (see also Figure 3-1)

Biological Shield		
Concrete type	KEW [Mg]	IAEA [Mg]
Normal concrete	183,11	368,52
Heavy concrete	198,86	198,86
Total	**381,97**	**567,38**

Table 3-5: Mass of Biological Shield considered as radioactive waste (clearance levels: KEW and IAEA)

3.3 Figures

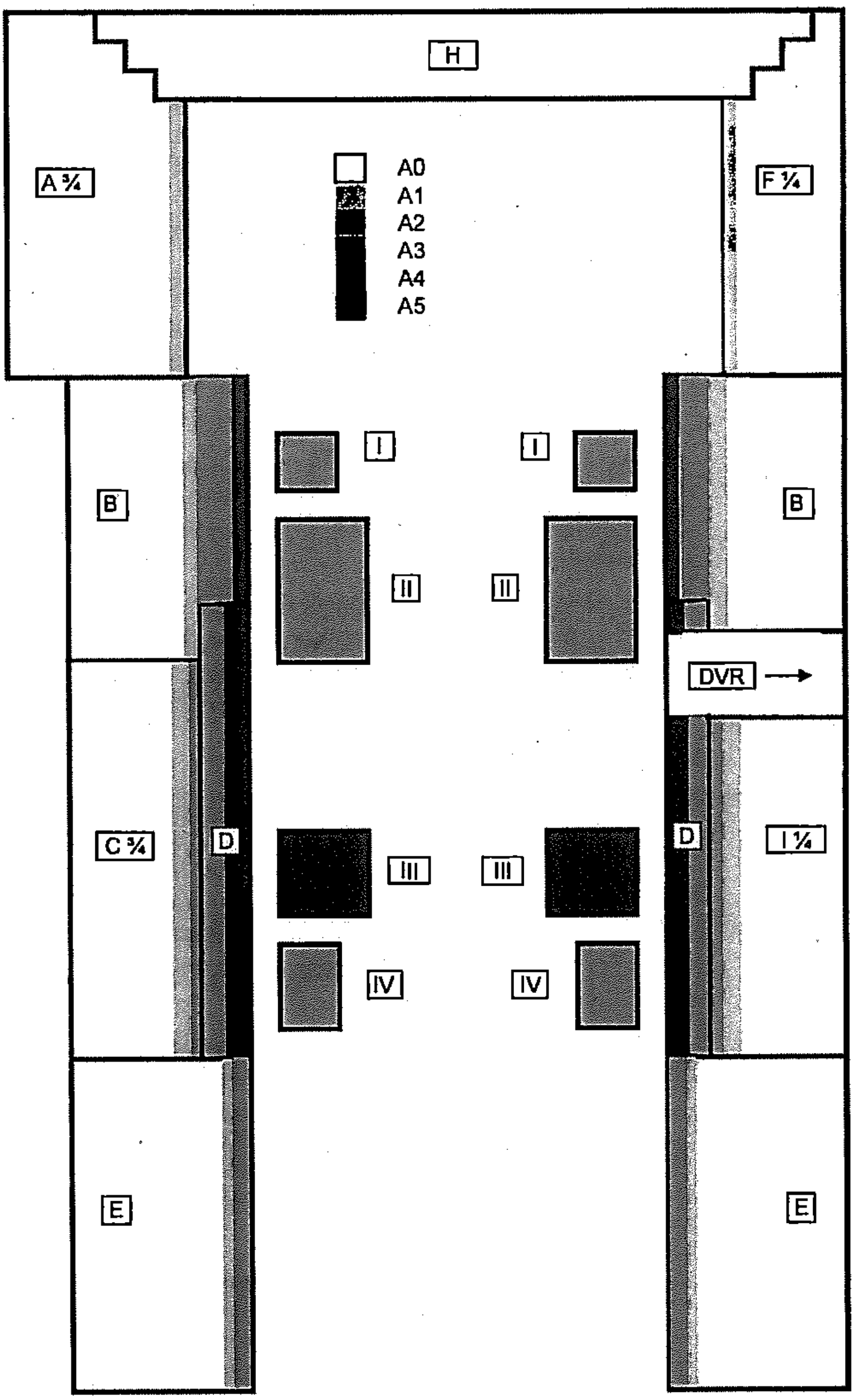


Figure 3-1: Activated layers of the Biological Shield (schematically)

4 Project Organization

4.1 Staff Qualifications

For the decommissioning cost of the NPP Dodewaard staff qualifications shown in the first column of the following table are considered, in relationship with the staff wages given in section 4.2 and Table 4-1. The second column comprises the description of the tasks and the work of the staff completed by examples explaining which qualification is required for special tasks during the decommissioning work.

Staff qualification	Description of tasks and work; examples
Project manager	He is an engineer with work experience of many years in project leading and management. In the assignment as a plant manager, he or his assistants have to co-ordinate all decommissioning activities and are responsible for safety and cost-efficiency of the whole decommissioning project. As an on-site manager he is responsible for all technical and economical aspects of individual fields during the decommissioning of a NPP. Following other on-site managers are assumed, e.g.: – 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	For instance engineers are used for the execution of the planning works and the licensing procedure, for the preparing of routine and special reports, for performing the radiation protection activities, for supervising the decommissioning and as shift engineers; e.g. the following positions are filled with 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 is working in the commercial department and is responsible for economical aspects (e.g. purchasing, contracts).
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), has to measure and record the on-the-job radiation dose information and operate the plant laboratory facilities including sampling and analysis; furthermore this personnel directs the work crews in the performance of the different decommissioning tasks (Crew leader); e.g. foremen are used as 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	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	Site security staff

Specific staff qualifications are requested for the conventional building demolition, as listed under section 4.2 and Table 4-1.

4.2 Wages

The wages (GKN and Contractor staff) used for the present decommissioning cost estimate are based on relevant wages of German companies active in D&D activities (see Appendix 6, item 6 and 7 of the Technical Requisition File /6/). The wages used for the conventional demolition are based on information from a Dutch company experienced in this area /11/. The Table 4-1 shows the wages for the above mentioned staff qualifications (price basis: 2009).

4.3 Staff Organization

It is very important to have a staff organization which fits to the needs of the decommissioning project. A general overview of the planned organization is shown in Figure 4-1.

The organization is divided up into four main parts:

- GKN;
- Main Contractor (nuclear);
- Sub-Contractors (nuclear);
- Main Contractor (conventional).

4.3.1 GKN

GKN will take care of overall plant management, finance and administration, license issues, health physics (partly), guarding (only management), operation of ventilation, electrical and waste water systems, electrical and mechanical maintenance. To fulfil these tasks a staff organization as shown in Figure 4-2 will be necessary. The total number will be 13 people.

The real decommissioning activities will be implemented by two Main Contractors, one for the nuclear decommissioning part and the other one for the conventional demolition and site restoration part.

4.3.2 Main Contractor (nuclear)

The Main Contractor is the only contact person for GKN and is managing the nuclear decommissioning of KCD, i.e. the dismantling as well as the on-site waste management activities. In this regard he is responsible for all Sub-Contractors involved in the decommissioning project. Additionally he will complement GKN in the operation of the site (maintenance, recurring checks of new installations/equipment, entrance to the controlled area, health physics, etc.). Figure 4-3 shows the tasks, the qualifications and number of staff needed for KCD decommissioning. A total number of 23,5 people will be permanent on site and additionally up to 50 people are necessary to implement the dismantling activities.

4.3.3 Sub-Contractors (nuclear)

Sub-Contractors are foreseen for following tasks:

- Preparatory work (installation of new equipment and buildings);
- Dismantling of contaminated components;

- Dismantling of activated components;
- Dismantling of activated part of biological shield;
- On-site waste management activities (e.g. free release, waste treatment and packaging)
- Asbestos removal;
- Building decontamination and building release.

The number of people on site will vary depending on the activities which have to be performed.

4.3.4 Main Contractor (conventional)

At the end of the nuclear dismantling the buildings are free of radioactivity above the clearance levels and the site is released from nuclear law.

The building demolition (including asbestos removal) and the site restoration is a conventional activity. Therefore the work will be done by an experienced demolition company.

This company replaces the Main Contractor (nuclear) as contact person for GKN.

4.4 Tables

Qualification	Wages [€/h]
Decommissioning	
Project manager	
Engineer	
Accountant	
Foreman / master craftsman	
Craftsman	
Worker	
Guard (site security) 1)	
Conventional Building Demolition	
Planner / Work organizer	
Foreman	
Craftsman / Crane operator	
Worker	

1) Possible increases:

Public holidays, weekdays:	60,5
Public holidays, weekend:	67,8
Overtime:	plus 10%
Call after stand by:	plus 30%

Table 4-1: Wages for different staff qualifications (price basis: 2009)

4.5 Figures

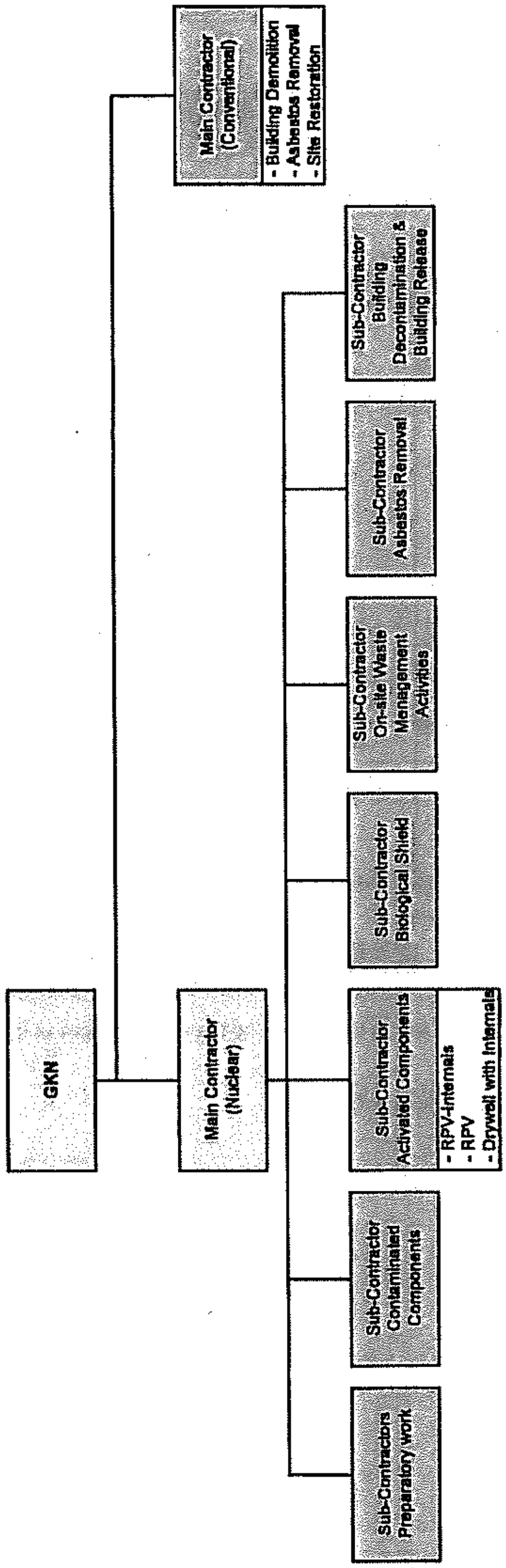
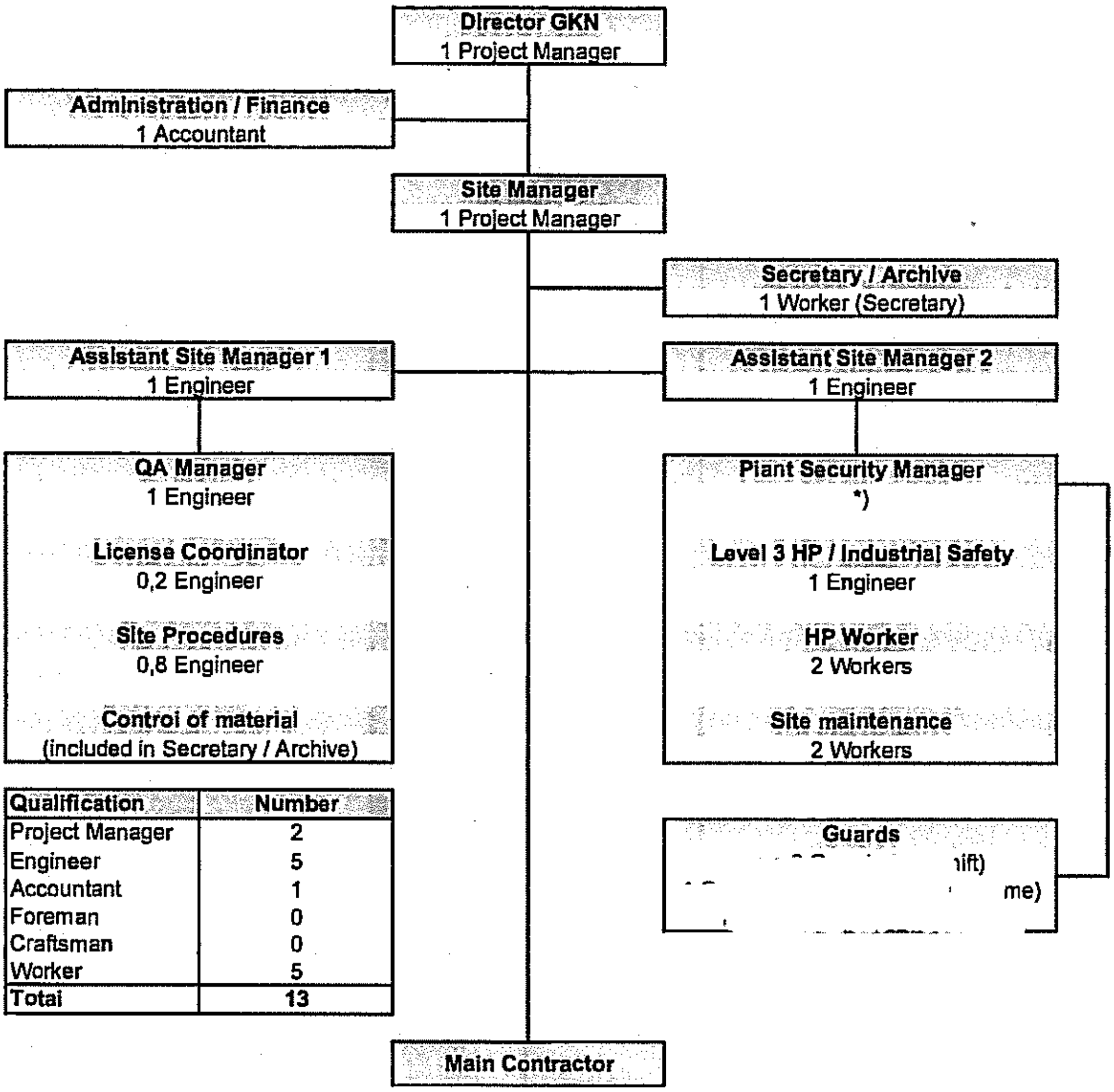


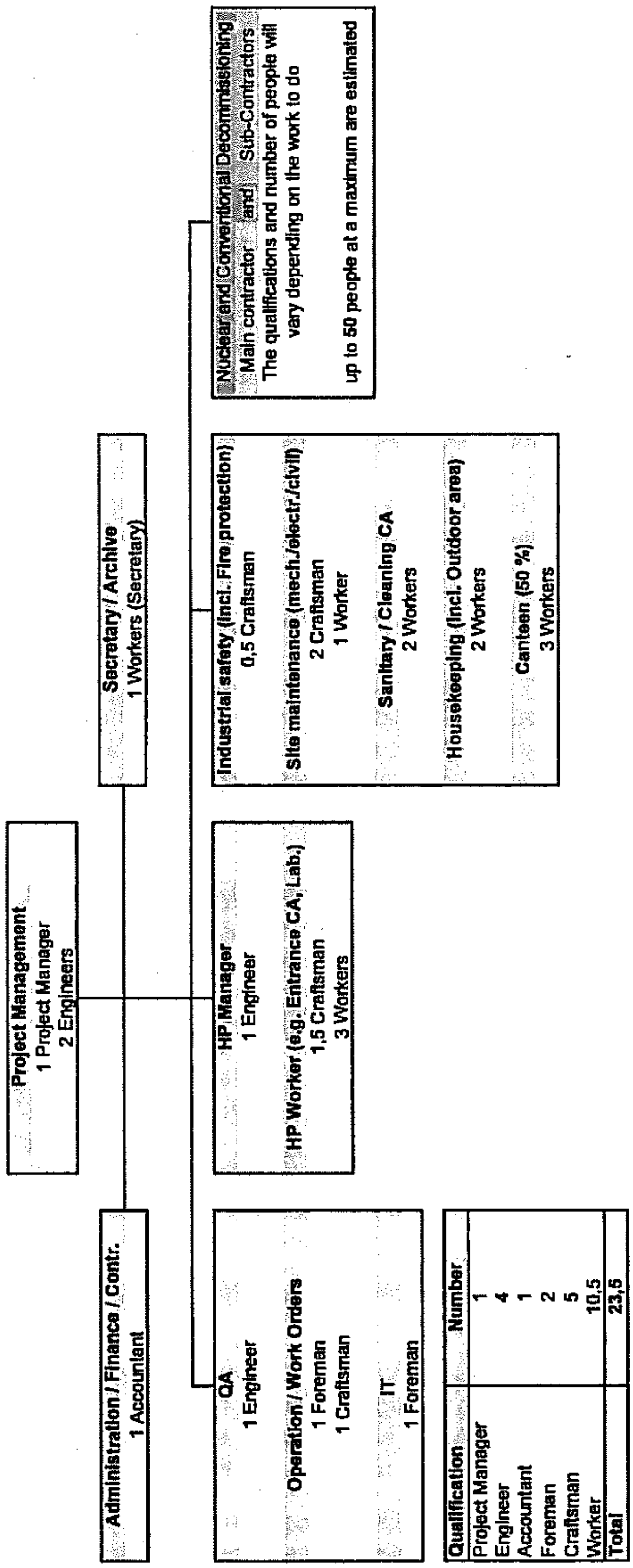
Figure 4-1: Project organization – Overview



Qualification	Number
Project Manager	2
Engineer	5
Accountant	1
Foreman	0
Craftsman	0
Worker	5
Total	**13**

*) Tasks of a Plant Security Manager will be carried out by the Site Manager or the Assistant Site Manager 2

Figure 4-2: Project organization – GKN



Qualification	Number
Project Manager	1
Engineer	4
Accountant	1
Foreman	2
Craftsman	5
Worker	10,5
Total	23,5

Figure 4-3: Project organization – Main contractor

5 Decommissioning Strategy

5.1 Site and surrounding characteristics

5.1.1 Nature of site

5.1.1.1 Situering van de inrichting (Site of plant)

Het terrein van de inrichting ligt op de noordoever van de Waal, op een kunstmatige verhoging in de Hiensche uiterwaarden, buiten de noordelijke Waalbandijk. De afstand tussen de beide bandijken ter plaatse van de inrichting is 1,3 km; de afstand van de inrichting tot het midden van de rivier bedraagt circa 400 m. De inrichting ligt hemelsbreed 2,2 km zuidoostelijk van het gemeentehuis van Dodewaard en 3,9 km ten westen van de plaats waar de snelweg A50 de Waal overbrugt. De snelweg A15 (Rotterdam-Nijmegen) ligt circa 2 km noordelijk van de inrichting, de dubbelbaans-spoorlijn Geldermalsen-Elst ongeveer 2,4 km. Enkele kilometers noordelijk van de inrichting bevindt zich de Betuwegoederenspoorlijn, parallel aan de A15.

5.1.1.2 De bevolking rondom de vestigingsplaats (Population in the vicinity of the plant)

De inrichting bevindt zich in de gemeente Dodewaard met ruim 4000 inwoners. De omliggende gemeenten Beuningen, Druten, Echteld, Kesteren en Valburg hebben samen ca. 75.000 inwoners (begin 1999, figure to be updated at time of preparing DP). De aanwezigheid van de inrichting levert geen beperking op voor de autonome ontwikkeling van de bevolking.

5.1.1.3 Grondgebruik en industrie (Land utilisation and industry)

Risicovolle ondernemingen, zoals chemische fabrieken, raffinaderijen en grootschalige faciliteiten voor de opslag van gevaarlijke stoffen, zijn in de omgeving van de inrichting niet aanwezig. Dit blijkt onder meer uit de gegevens van de Kamers van Koophandel, bestemmingsplannen en afgegeven Hinderwetvergunningen.

Militaire activiteit vindt plaats op ruime afstand van de inrichting. De meest nabijgelegen grote militaire faciliteiten zijn het vliegveld Deelen, een vaste luchtmachtbasis voor helikopters, op 20 km afstand en de schietterreinen op de Rozendaalse heide op 18 km. De grens van het militaire laag-vlieggebied Gilze-Rijen ligt op circa 8 km afstand van de inrichting. De dichtstbijzijnde munitiedepots bevinden zich op meer dan 5 km van de inrichting.

De landerijen rond de installatie worden voornamelijk gebruikt voor veeteelt en gewassen.

In de nabije omgeving van de inrichting bevinden zich de spoorlijn Geldermalsen-Elst, de Betuwe goederenspoorlijn, de snelweg A15 en de rivier de Waal. Alle vier hebben ter plaatse van de inrichting een oost-west oriëntatie en alle vier vormen een belangrijke verbindingsschakel tussen Rotterdam en het Duitse Ruhrgebied.

De rivier de Waal vormt een belangrijke transportroute voor schepen tussen Rotterdam en het Duitse Ruhrgebied. De schepen die een potentieel gevaarlijke lading vervoeren zijn (duw)tankschepen. Totaal passeren jaarlijks gemiddeld 23.100 tankers de inrichting.

5.1.1.4 Klimaat en weersomstandigheden (Climate and average weather conditions)

De inrichting ligt in een gebied met gematigd zeeklimaat. Een gematigd zeeklimaat wordt gekenmerkt door gematigde temperaturen, een neutrale tot stabiele atmosfeer en beperkt zicht. De regio van de vestigingsplaats is een landelijk en waterrijk gebied, met een hoge gewas- en bodemuitdamping.

De atmosfeer van de regio is, vooral in herfst en winter, regelmatig neutraal tot stabiel.

Pasquill klasse D (neutraal) overheerst en klasse F (stabiel) komt veelvuldig voor.

Gedurende de stabiele omstandigheden is de lucht overwegend koel en relatief vochtig, optisch gekenmerkt door beperkt zicht, met een laaghangend wolkendek. Onder andere weersomstandigheden is vaak sprake van een hoge luchtvochtigheid (heiig, sluierwolken) en stabiel weer. Gedurende 17% van de tijd is de atmosfeer onstabiel.

De inrichting ligt tussen de grote rivieren Waal en Neder-Rijn in een waterrijk, grotendeels agrarisch, vlak polderlandschap zonder uitgestrekte bossen. De relatieve vochtigheid is hoog, evenals de gemiddelde windsnelheid.

5.1.1.5 Kenmerken van de Waal (Characteristics of the River Waal)

De inrichting ligt op een kunstmatige verhoging met het maaiveld op 13 m boven Normaal Amsterdams Peil (NAP) in de uiterwaarden van de Waal. De Waal is een zijtak van de Rijn, die bij Lobith Nederland binnenkomt. De waterhuishouding van de Waal is gedeeltelijk gecontroleerd.

Van grote invloed op de waterhuishouding zijn de stuwen in de zijtakken van de Waal en de stuw in de Neder-Rijn bij Driel. Weigering van de stuw zou kunnen leiden tot dijkbreuk of overstroming. De bedrijfszekerheid is echter zeer hoog. Verder wordt de stuw geflankeerd door sluizen; elke stuw heeft bovendien een overloopdrempel, gebaseerd op het maatgevend hoog water.

Behalve de regulering van waterstanden zijn ook de waterverdedigingswerken van invloed op de waterhuishouding. Voor de Waal bestaan deze uit een systeem van uiterwaarden, zomerdijken en Waalbandijken. De Waalbandijken voorkomen overstroming van de binnendijkse gebieden. Deze dijken zijn alle in de periode na 1986 verbeterd, gebaseerd op het maatgevend hoog water zoals dat in 1986 is gedefinieerd. Recentelijk zijn meerdere dijktracés opgehoogd en verbeterd, tot een niveau dat voortvloeit uit het in 1993 opnieuw gedefinieerde maatgevend hoog water.

Tijdens de extreem hoge waterstanden in 1993 werd op 25 december, bij weinig wind, een hoogste stand van 11,8 m boven NAP gemeten. Bij de laatste hoge waterstand in januari 1995 is het waterpeil gestegen tot 11,95 m +NAP. Het terrein ligt op 13 m +NAP. Zelfs wanneer het water boven dit niveau zou stijgen zullen hoge golven, als gevolg van de geringe diepte van het water op het terrein, niet tot dynamische belastingen op de bouwconstructies leiden. De dijk nabij de inrichting is verbeterd in het kader van het dijkverzwaringsprogramma.

De hoogte van de Waalbandijk ten noorden van de inrichting is 14,15 m boven NAP. Statistisch zal de Waal de verbeterde dijk dan eens in de 1250 jaar doen breken of overspoelen. Ter plaatse van de inrichting moet men rekening houden met een hoogst mogelijke waterstand van 13,6 m +NAP, gebaseerd op een waterstand welke eens per 1250 jaar voorkomt (12,99 m +NAP) en een golfoploophoogte van 0,6 m.

Behalve de Waal zijn er nog enkele andere oppervlaktewateren in de omgeving van de inrichting. Een kleine rivier is de Linge, 6 km ten noorden van de inrichting.

De inrichting maakt alleen gebruik van grondwater als extra brandblusmiddel door gebruik te maken van een puls.

De bovenste bodemlagen van de Hiensche uiterwaarden zijn permeabel; dat wil zeggen dat regenwater in dit gebied vrij gemakkelijk naar de Waal afstroomt. Het dieper liggende, watervoerende pakket wordt afgeschermd door een kleilaag van 5 m dikte. Deze laag vormt de afsluiting van het onderliggende grondwater. De kleilaag komt in het binnendijkse gebied aan het oppervlak. De watervoerende laag, bij de inrichting meer dan 20 m diep, ligt in Andelst op 5 m diepte. Het diepere grondwater stroomt gemiddeld in westelijke richting, parallel aan de rivier.

5.1.1.6 Geologische kenmerken (Geological characteristics)

De inrichting is gelegen op een zandige ondergrond, met daarop een kleipakket dat doorsneden wordt door meer zandige (en soms grindrijke) rivierafzettingen.

Ook in geologisch rustige perioden beweegt de aardkorst. Dat gebeurt onder invloed van diepgelegen convectiestromen, waardoor grote schollen van de aardkorst ten opzichte van elkaar bewegen. De Boven-Rijndalslenk is een systeem dat samenhangt met de druk die de beweging van de Afrikaanse aardschol ten opzichte van de Europese teweegbrengt. Een uitloper is het systeem van de slenken en horsten in de Peel, dat zich - met afnemende intensiteit - voortzet in de richting van Amsterdam. Dodewaard ligt ongeveer op de rand van dit systeem.

Aardbevingen kunnen op verschillende wijzen worden ingedeeld. Meestal gebeurt dat volgens een van de volgende "schalen":

- de magnitudeschaal van Richter, die een maat is voor de hoeveelheid energie die in het hypocentrum vrijkomt en daarmee voor de sterkte van de aardbeving;
- de intensiteitschaal van Mercalli (eventueel die van Medvedev, Sponheuer & Karnik: de MSK-schaal), die aangeeft wat de uitwerking van de aardbeving is, daarbij rekening houdend met de opbouw van de ondergrond en de afstand tot het hypocentrum.

Een betrekkelijk grote aardbeving in Nederland, met een epicentrum nabij Roermond, vond plaats op 13 april 1992. Deze beving had een voor Nederlandse begrippen hoge magnitude, namelijk 5,8 op de schaal van Richter. De intensiteit ter plaatse bedroeg VII en volgens opgave van het KNMI bedroeg de versnelling in horizontale richting 0,5 m/s2. Deze voor Nederland zeer sterke aardbeving heeft geen enkele invloed gehad op de bedrijfsvoering van de centrale. In de afgelopen jaren hebben zich ook in het noorden en noordoosten van Nederland en in de provincie Noord-Holland enkele lichte aardbevingen voorgedaan. De grootste was die in Roswinkel op 19 februari 1997, met een magnitude van 3,4 op de schaal van Richter.

In Nederland worden door het KNMI sinds 1904 aardbevingen geregistreerd. Jaarlijks worden door de vier grote seismische stations (De Bilt, Witteveen, Winterswijk en Heerlen) ongeveer 1200 bevingen waargenomen, waarvan de epicentra verspreid liggen over de hele wereld. Daarnaast beschikt men over tal van historische gegevens over aardbevingen vanaf het jaar 330.

Uit deze gegevens zijn door het KNMI voor Nederland seismische intensiteitskaarten opgesteld; hierop is de maximale intensiteit van een aardbeving in een bepaald gebied aangegeven, afhankelijk van zijn waarschijnlijkheid van optreden. De inrichting ligt op de grens van zones met overgangen in de maximale intensiteiten. Om die reden is voor de locatie Dodewaard in 1993 een studie uitgevoerd naar mogelijke aardbevingsbelastingen, waarbij rekening is gehouden met:

- de aardbeving bij Roermond;
- een verfijning van de tektonische zones in het gebied rondom de inrichting;
- het optreden van regionale variatie binnen een tektonische zone;
- het locaal optreden van eventuele (minder sterke) aardbevingen.

De uitgevoerde studie heeft de bovenbeschreven kenmerken beschouwd en de volgende parameters bepaald:

- de intensiteit en de horizontale piekversnelling aan het aardoppervlak, afhankelijk van de waarschijnlijkheid van optreden;
- de vrije veld spectra voor eerdere waarschijnlijkheden van optreden van een aardbeving en de variatie in de grondsoort (de bovenste zachte lagen of de diepere, meer geconsolideerde zanden).

De inrichting ligt in een gebied (de Hiensche uiterwaard) dat sterk beïnvloed is door de veranderingen die in de laatste tienduizend jaar zijn opgetreden in de loop van de Waal. De hierdoor ontstane afwisseling van kleien en grovere pakketten kan als volgt worden gekarakteriseerd:

- de bodemgesteldheid van de hogere grondlagen wordt gekenmerkt door klei- en zandlagen met matige vastheden;
- op grotere diepten komen vastere zandlagen voor, doorsneden door lagen klei, leem, veen of grind;
- de diverse gebouwen van de inrichting rusten op een onderheide fundatie die via de heipalen steunt op de relatief vaste, zandige ondergrond.

De mogelijkheid van instabiel gedrag van de bodem en de fundatie moet vanwege de bodemkarakteristieken als verwaarloosbaar klein worden beschouwd.

5.1.2 Future use of the site

The current spatial planning plan ("Bestemmingsplan Buitengebied Dodewaard") for the area surrounding the plant is "Uiterwaard". The land is used for farming and recreation. The town council of Dodewaard decided in 1997 that after final dismantling of the plant the land must be turned into uiterwaard. In practice this means the land has to be lowered to the same level as the surroundings and the cooling water inlet and outlet have to be filled with the land that currently is the elevated ground on which the plant is situated. The parking lot must be removed. (Note: for practical reasons this might change as the parking lot is frequented by people walking in the uiterwaarden.)

5.2 Description of the Selected Strategy

The Dodewaard NPP (KCD) has been shut down on March 26th 1997. The dismantling strategy is a complete dismantling of the plant to Greenfield Conditions after a waiting period of several years as a so called Safe Enclosure (SE).

On April 23rd 2003 the phase Preparation for Safe Enclosure (PSE) started. This phase lasted till June 30th 2005. On July 1st 2005, the phase Safe Enclosure (SE) started. For the purpose of the present study this phase is planned to last until June 30th 2015.

After the SE phase the NPP will be completely dismantled to so-called Greenfield Conditions.

The decommissioning of KCD is implemented in three main steps:

- Preparation of the site for dismantling
- Dismantling and removing of all contaminated and/or activated installations and release of the building structures from nuclear regulations
- Conventional demolition of building structures and site restoration.

More details are given in section 9.

5.3 Reference Scenario

The KCD new Decommissioning Cost Estimate is evaluated in the frame of an "Early decommissioning scenario" called also **"Reference Scenario"**. Under this scenario, it is assumed that the actual KCD dismantling works start in 2015.

WBS	Working Packages with sub-levels	Total [k€]	2011 [k€]	2012 [k€]	2013 [k€]	2014 [k€]	2015 [k€]	2016 [k€]	2017 [k€]	2018 [k€]	2019 [k€]	2020 [k€]	2021 [k€]	2022 [k€]	2023 [k€]	2024 [k€]	2025 [k€]
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1																
04.01	Reactor Building																
04.01.01	Planning and Engineering																
04.01.02	Attendant Measures																
04.01.03	Execution Project																
04.02	Waste Building																
04.02.01	Planning and Engineering																[redacted]
04.02.02	Attendant Measures																
04.02.03	Execution Project																
04.03	Auxiliary Building																
04.03.01	Planning and Engineering																
04.03.02	Attendant Measures																
04.03.03	Execution Project																
04.04	Ventilation Building																
04.04.01	Planning and Engineering																
04.04.02	Attendant Measures																
04.04.03	Execution Project																
04.05	Turbine Building																
04.05.01	Planning and Engineering																
04.05.02	Attendant Measures																
04.05.03	Execution Project																
05	DISMANTLING RPV INTERNALS																
05.01	Planning and Engineering																
05.01.01	Implementation planning																
05.01.03	Detailed Planning																
05.02	Attendant Measures																
05.02.01	Project management																
05.02.02	Supervision																
05.02.03	On Site Radiological Protection																
05.02.04	Internal Transport																
05.02.05	Accompanying Decontamination																
05.03	Preparational Work																
05.03.01	Preparation Reactor Floor and Pool																
05.03.02	Remote Controlled Dismantling Equipment																
05.03.03	Training of Staff																
05.04	Execution Project																
05.04.01	Removing Drywell Head																
05.04.02	Cutting Drywell Head																
05.04.03	Removing RPV Head (incl. Steam dryer)																
05.04.04	Cutting RPV Head (incl. Steam Dryer)																
05.04.05	Dismantling and Cutting Uper internals																
05.04.06	Dismantling and Cutting Chimney (incl. FWS)																
05.04.07	Dismantling and Cutting Core grid & Fuel support plate																
05.04.08	Dismantling and Cutting Lower RPV internals																
05.04.09	Dismantling and Cutting Shroud																
05.04.10	Close Working Place																

Table 10-11: Detailed KCD Decommissioning costs per year (continued)

WBS	Working Packages with sub-levels	Total [k€]	2011 [k€]	2012 [k€]	2013 [k€]	2014 [k€]	2015 [k€]	2016 [k€]	2017 [k€]	2018	2019	2020	2021	2022	2023 [k€]	2024 [k€]	2025 [k€]
06	DISMANTLING RPV																
06.01	Planning and Engineering																
06.01.01	Implementation planning																
06.02	Attendant Measures																
06.02.01	Project management																
06.02.02	Supervision																
06.02.03	On Site Radiological Protection																
06.02.04	Internal Transport																
06.02.05	Accompanying Decontamination																
06.04	Execution Project																
06.04.01	Dismantling RPV-Insulation																
06.04.02	Cutting RPV-Flange																
06.04.03	Add Cut RPV-Flange																
06.04.04	Dismantling RPV-Insulation (26 to 29 m)																
06.04.05	Cutting RPV-Cylindrical part (26 to 29 m)																
06.04.06	Add Cut RPV-Cylindrical part (26 to 29 m)																
06.04.07	Dismantling RPV-Insulation (24,5 to 26 m)																
06.04.08	Cutting RPV-Cylindrical part (24,5 to 26 m)																
06.04.09	Add Cut RPV-Cylindrical part (24,5 to 26 m)																
06.04.10	Dismantling RPV-Insulation (21,5 to 24,5 m)																
06.04.11	Cutting RPV-Cylindrical part (21,5 to 24,5 m)																
06.04.12	Add Cut RPV-Cylindrical part (21,5 to 24,5 m)																
06.04.13	Dismantling RPV-Insulation (Bottom and Support ring)																
06.04.14	Cutting RPV-Bottom and Support ring																
06.04.15	Add Cutting RPV-Bottom and Support ring																
06.04.16	Close Working Place																
07	DISMANTLING DRYWELL																
07.01	Planning and Engineering																
07.01.01	Implementation planning																
07.02	Attendant Measures																
07.02.01	Project management																
07.02.02	Supervision																
07.02.03	On Site Radiological Protection																
07.02.04	Internal Transport																
07.02.05	Accompanying Decontamination																
07.04	Execution Project																
07.04.01	Dismantling Drywell internals above 29 m																
07.04.02	Dismantling Drywell internals between 26 and 29 m																
07.04.03	Dismantling Drywell internals between 24,5 and 26 m																
07.04.04	Dismantling Drywell internals between 21,5 and 24,5 m																
07.04.05	Dismantling Drywell internals between 17,5 and 21,5 m																
07.04.06	Dismantling Drywell internals below 17,5 m																
07.04.07	Dismantling Insulation inside Drywell																
07.04.08	Dismantling Drywell Wall																
07.04.09	Close Working Place / Dismantling new equipment																

Table 10-11: Detailed KCD Decommissioning costs per year (continued)

WBS	Working Packages with sub-levels	Total [k€]	2011 [k€]	2012 [k€]	2013 [k€]	2014 [k€]	2015 [k€]	2016 [k€]	2017 [k€]	2018 [k€]	2019 [k€]	2020 [k€]	2021 [k€]	2022 [k€]	2023 [k€]	2024 [k€]	2025 [k€]
08	DISMANTLING BIOLOGICAL SHIELD								[illegible]								
08.01	Planning and Engineering																
08.01.01	Implementation planning																
08.01.03	Detailed Planning																
08.02	Attendant Measures																
08.02.01	Project management																
08.02.02	Supervision																
08.02.03	On Site Radiological Protection																
08.02.04	Internal Transport																
08.02.05	Accompanying Decontamination																
08.03	Preparational Work																
08.03.01	Preparation Reactor Pool																
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	Dismantling Biological shield (Part B up to 50 cm and Part D)																
08.04.02	Segmentation and Packaging BS parts (Part B up to 50 cm and Part D)																
08.04.03	Dismantling Biological Shield (other activated parts & Drywell bottom)																
08.04.04	Segmentation and Packaging BS parts (other activated parts & Drywell bottom)																
08.04.05	Close Working Place																
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]
09.01	Planning and Engineering																
09.01.01	Implementation planning																
09.01.02	Detailed Planning																
09.02	Attendant Measures																
09.02.01	Project management																
09.02.02	Supervision																
09.02.03	On Site Radiological Protection																
09.02.04	Internal Transport																
09.02.05	Accompanying Decontamination																
09.03	Execution Project																
09.03.01	Reactor Building																
09.03.02	Waste Building																
09.03.03	Auxiliary Building																
09.03.04	Ventilation Building																
09.03.05	Turbine Building																
09.03.06	Other Buildings																
10	CLEARANCE OF BUILDING STRUCTURES						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]
10.01	Planning and Engineering																
10.01.01	Implementation planning																
10.01.03	Detailed Planning																
10.02	Attendant Measures																
10.02.01	Project management																
10.02.02	Supervision																
10.02.03	On Site Radiological Protection																
10.02.04	Internal Transport																
10.02.05	Accompanying Decontamination																
10.03	Execution Project																
10.03.01	Reactor Building																
10.03.02	Waste Building																
10.03.03	Auxiliary Building																
10.03.04	Ventilation Building																
10.03.05	Turbine Building																
10.03.06	New Buildings																
10.03.07	Other Buildings and Site																

Table 10-11: Detailed KCD Decommissioning costs per year (continued)

WBS	Working Packages with sub-levels	Total [k€]	2011 [k€]	2012 [k€]	2013 [k€]	2014 [k€]	2015 [k€]	2016 [k€]	2017 [k€]	2018 [k€]	2019 [k€]	2020 [k€]	2021 [k€]	2022 [k€]	2023 [k€]	2024 [k€]	2025 [k€]
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL																
11.01	On-site Treatment																
11.01.01	Cutting																
11.01.02	Decontamination																
11.01.03	Shredding																
11.01.04	Super-compaction																
11.01.05	Packaging and immobilization																
11.01.06	Release measurements																
11.02	Attendant Measures																
11.02.02	Supervision																
11.02.03	On Site Radiological Protection																
11.02.04	Internal Transport																
11.02.05	Accompanying Decontamination																
11.03	External Treatment																
11.03.01	Incineration																
11.03.03	External Treatment of Radioactive Liquids																
11.04	Container Cost Primary Waste																
11.04.09	Press drums																
11.04.10	200-l drums																
11.04.11	1000-l containers																
11.04.12	MOSAIK Type II																
11.04.13	KONRAD Type II																
11.05	Container Cost Secondary Waste																
11.05.09	Press drums																
11.05.10	200-l Drums																
11.06	Transport, Interim Storage at COVRA, and Disposal																
11.06.01	200-l container, (PW) with surface dose rate <= 0,2 mSv/h																
11.06.02	200-l container, (SW) with surface dose rate <= 0,2 mSv/h																
11.06.03	200-l container, with surface dose rate > 0,2 mSv/h <= 2 mSv/h																
11.06.05	200-l container, with surface dose rate > 2,5 mSv/h <= 4 mSv/h																
11.06.06	1000-l container, with surface dose rate > 0,2 mSv/h <= 2 mSv/h																
11.06.11	MOSAIK Type II																
11.06.12	KONRAD Type II																
12	CONVENTIONAL DEMOLISHING																
12.01	Planning and Engineering																
12.01.01	Project management																
12.01.03	Detailed Planning																
12.03	Attendant Measures																
12.03.01	Supervision																
12.04	Execution Project																
12.04.01	Preparation Working Place																
12.04.02	Demolition Buildings incl. Piles																
12.05	Conventional Waste																
12.05.03	Removal and treatment cost building rubble (incl. transport)																
12.05.04	Removal and treatment cost steel (incl. transport)																
13	SITE RESTORATION, CLEANUP AND LANDSCAPING																
13.01	Planning and Engineering																
13.01.01	Project management																
13.01.02	Detailed Planning																
13.02	Attendant Measures																
13.03	Execution Project																
14	ASBESTOS REMOVAL																

Table 10-11: Detailed KCD Decommissioning costs per year (continued)

WBS	Working Packages with sub-levels	Total [k€]	2011 [k€]	2012 [k€]	2013 [k€]	2014 [k€]	2015 [k€]	2016 [k€]	2017 [k€]	2018 [k€]	2019 [k€]	2020 [k€]	2021 [k€]	2022 [k€]	2023 [k€]	2024 [k€]	2025 [k€]
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT																
15.01	GKN																
15.01.01	Plant Management																
15.01.02	Finance, accountancy and personnel																
15.01.04	Secretary / Archive																
15.01.06	Quality Assurance																
15.01.07	License coordinator																
15.01.08	Site procedures																
15.01.09	EDV / IT																
15.01.10	Revenues																
15.02	Main Contractor																
15.02.01	Project Management																
15.02.02	Finance, accountancy and personnel																
15.02.04	Secretary / Documentation																
15.02.06	Quality Assurance																
15.02.09	EDV / IT																
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE																
16.01	GKN																
16.01.01	Operation, Maintenance																
16.01.02	Radiological Protection/Health Physics																
16.01.03	Industrial Safety																
16.01.05	Other Operational Expenditures																
16.02	Main Contractor																
16.02.01	Operation, Maintenance																
16.02.02	Radiological Protection/Health Physics																
16.02.03	Industrial Safety																
16.02.04	Security / Guards																
16.02.05	Other Operational Expenditures																
17	AUTHORITIES																
Sum																	

Table 10-11: Detailed KCD Decommissioning costs per year (continued)

Container Type	Packed Mass [Mg]	Number of Containers [-]	Container Costs [k€]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal [k€]
90-l Press drums	349,8	7.009		-	
200-l Container, with a surface dose rate <= 0,2 mSv/h	469,0	2.487		604,4	
200-l Container, with a surface dose rate > 0,2 <= 2,0 mSv/h	2,4	10		2,5	
200-l Container, with a surface dose rate > 2,5 <= 4,0 mSv/h	1,4	6		1,5	
1000-l Container, with a surface dose rate > 0,2 <= 2,0 mSv/h	0,7	3		2,5	
KONRAD Type II-Container	904,7	201		926,5	
MOSAIK-Container	5,6	17		23,1	
Total without 90-l Press drums	**1.383,8**	**2.724**		**1.560,5**	
Total with 90-l Press drums		**9.733**		**1.560,5**	

Table 10-12: Container data (Best estimate using clearance levels from Kernenergiewet)

Description	No. of locations stored in DIS or additional	Hours per location	Percentage surcharge	Total hours	Number of staff	Wages in €/h	Costs per hour in €/h	Total number of additional samples	Costs per sample analysis in €	Total costs in €
Verification of Asbestos locations	[redacted]									
Additional investigations										
Analyses of additional samples										
Technical specification and tender										
Asbestos removal work										
Asbestos removal work (additional: 60% of 20)										
Scaffolding, tents, etc.										
Follow-up of work										
Total										

Waste management costs are included in decommissioning costs.

Table 10-13: Estimate of asbestos removal costs

Qualification	Number per Year															Total Man-Years per Qualification
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
GKN-Project Manager	[redacted]															
GKN-Engineer																
GKN-Accountant																
GKN-Worker																
Sub-Total - GKN																
Project Manager																
Engineer																
Accountant																
Foreman																
Craftsman																
Worker																
Guard																
Guard (overtime)																
Sub-Total - Contractors (nuclear)																
C-Planner / Work organizer																
C-Foreman																
C-Craftsman / Crane Operator																
C-Worker																
Sub-Total - Contractors (conventional)																
Total per Year																

Table 10-14: KCD Decommissioning – Number of staff per qualification and year

WP No.	Working Package	Radiation exposure [man-mSv]
01	PRE-DECOMMISSIONING ACTIONS	0,7
02	LICENSING PROCEDURE	0,0
03	PREPARATORY WORK	39,0
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1	308,6
05	DISMANTLING RPV INTERNALS	141,4
06	DISMANTLING RPV	69,6
07	DISMANTLING DRYWELL	180,3
08	DISMANTLING BIOLOGICAL SHIELD	72,4
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2	51,3
10	CLEARANCE OF BUILDING STRUCTURES	117,3
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL	1.370,7
12	CONVENTIONAL DEMOLISHING	0,0
13	SITE RESTORATION, CLEANUP AND LANDSCAPING	0,0
14	ASBESTOS REMOVAL	0,0
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT	0,0
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE	124,2
17	AUTHORITIES	0,0
SUM		2.475,6

Table 10-15: Radiation exposure per working package

No.	Uncertainty	Margins to be included in the PDP	
1.	Physical Inventory	Activated parts	Mass + 10 %
		Main components	Mass + 5 %
		Biological shield (above clearance level)	Mass + 10 %
		Contaminated systems	Mass + 5 %
		Contaminated equipment	Mass + 5 %
		Building masses	Mass + 5 %
		Stairs, platforms, other structures	Mass + 5 %
2.	Radiological inventory and decontamination efficiency	For the activated and/or contaminated waste: assume +10 % increase of the radioactive waste	
3.	Decontamination of concrete	A 10 % increase of the calculated efforts for the decontamination of the concrete surfaces	
4.	Dismantling efficiency	Increase the needed man-hours per kg in the calculation by 5 %	
5.	Boundary conditions	No uncertainty on waste management costs to be considered	
6.	Costs of external services and deliveries	1 % / year on top of average long term inflation rate as provided by the Dutch Central Statistics Agency CBS ("Centraal Bureau voor de Statistiek")	
7.	Personnel costs	Increase of 2 % / year on top of average long term inflation rate	
8.	Investments	Increase of 2 % / year on top of average long term inflation rate	
9.	Taxes and insurance	No uncertainty is to be considered	
10.	Overall time schedule	The total project duration is increased by three additional month	

Table 10-16: Considered uncertainties

Description		Total Costs	Increase			
			Step by step	Step by step	Compared to Best estimate	Compared to Best estimate
		[M€]	[M€]	[%]	[M€]	[%]
Best estimate		[redacted]				
No.	Uncertainty					
1.	Physical Inventory					
2.	Radiological inventory and decontamination efficiency					
3.	Decontamination of concrete					
4.	Dismantling efficiency					
5.	Boundary conditions					
6.	Costs of external services and deliveries					
7.	Personnel costs					
8.	Investments					
9.	Taxes and insurances					
10.	Overall time schedule					

Table 10-17: Results of conservative estimate with clearance levels as defined in the "Kernenergiewet"

WP No.	Working Package	Total costs [M€]	Staff costs [M€]	Investment costs / Revenues [M€]	Consumable costs *) [M€]	Other costs [M€]
01	PRE-DECOMMISSIONING ACTIONS					
02	LICENSING PROCEDURE					
03	PREPARATORY WORK					
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1					
05	DISMANTLING RPV INTERNALS					
06	DISMANTLING RPV					
07	DISMANTLING DRYWELL					
08	DISMANTLING BIOLOGICAL SHIELD					
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2					
10	CLEARANCE OF BUILDING STRUCTURES					
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL					
12	CONVENTIONAL DEMOLISHING					
13	SITE RESTORATION, CLEANUP AND LANDSCAPING					
14	ASBESTOS REMOVAL					
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT					
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE					
17	AUTHORITIES					
SUM						

*) "0,0" M€ means that the estimated costs are below 0,05 M€

Table 10-18: KCD Decommissioning costs per working package and cost type (Best estimate using clearance levels from IAEA RS-G-1.7)

WP No.	Working Package	Total [k€]	2011 [k€]	2012 [k€]	2013 [k€]	2014 [k€]	2015 [k€]	2016 [k€]	2017 [k€]	2018 [k€]	2019 [k€]	2020 [k€]	2021 [k€]	2022 [k€]	2023 [k€]	2024 [k€]	2025 [k€]
01	PRE-DECOMMISSIONING ACTIONS																
02	LICENSING PROCEDURE																
03	PREPARATORY WORK																
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1																
05	DISMANTLING RPV INTERNALS																
06	DISMANTLING RPV																
07	DISMANTLING DRYWELL																
08	DISMANTLING BIOLOGICAL SHIELD																
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2																
10	CLEARANCE OF BUILDING STRUCTURES																
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL																
12	CONVENTIONAL DEMOLISHING																
13	SITE RESTORATION, CLEANUP AND LANDSCAPING																
14	ASBESTOS REMOVAL																
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT																
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE																
17	AUTHORITIES																
Sum																	

Table 10-19: KCD Decommissioning costs per working package and per year (Best estimate using clearance levels from IAEA RS-G-1.7)

Container Type	Packed Mass [Mg]	Number of Containers [-]	Container Costs [k€]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal [k€]
90-l Press drums	349,8	7.009		-	
200-l Container, with a surface dose rate <= 0,2 mSv/h	469,0	2.487		604,4	
200-l Container, with a surface dose rate > 0,2 <= 2,0 mSv/h	2,4	10		2,5	
200-l Container, with a surface dose rate > 2,5 <= 4,0 mSv/h	1,4	6		1,5	
1000-l Container, with a surface dose rate > 0,2 <= 2,0 mSv/h	0,7	3		2,5	
KONRAD Type II-Container	1090,1	249		1152,1	
MOSAIK-Container	5,6	17		23,1	
Total without 90-l Press drums	**1.569,2**	**2.772**		**1.786,1**	
Total with 90-l Press drums		**9.781**		**1.786,1**	

Table 10-20: Container data (Best estimate using clearance levels from IAEA RS-G-1.7)

Description	Total Costs [M€]	Increase: Step by step [M€]	Increase: Step by step [%]	Increase: Compared to Best estimate [M€]	Increase: Compared to Best estimate [%]
Best estimate	[redacted]				
No. Uncertainty					
1. Physical Inventory					
2. Radiological inventory and decontamination efficiency					
3. Decontamination of concrete					
4. Dismantling efficiency					
5. Boundary conditions					
6. Costs of external services and deliveries					
7. Personnel costs					
8. Investments					
9. Taxes and insurances					
10. Overall time schedule					

Table 10-21: Results of conservative estimate with clearance levels as defined in IAEA RS-G-1.7

10.13 Figures

[redacted]

Figure 10-1: Percentage distribution of the total decommissioning cost to cost types

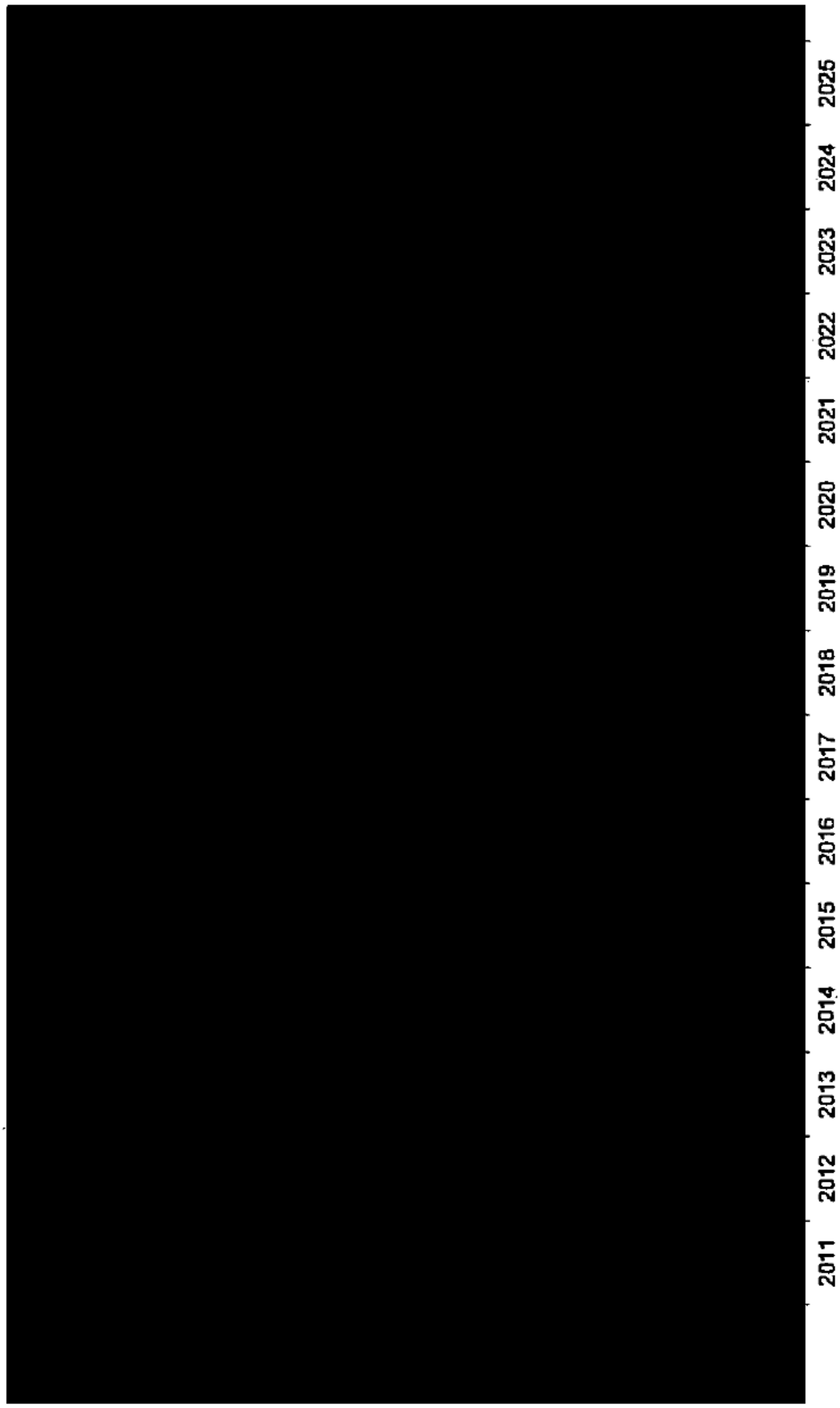


Figure 10-2: KCD Decommissioning cost per year in [k€]

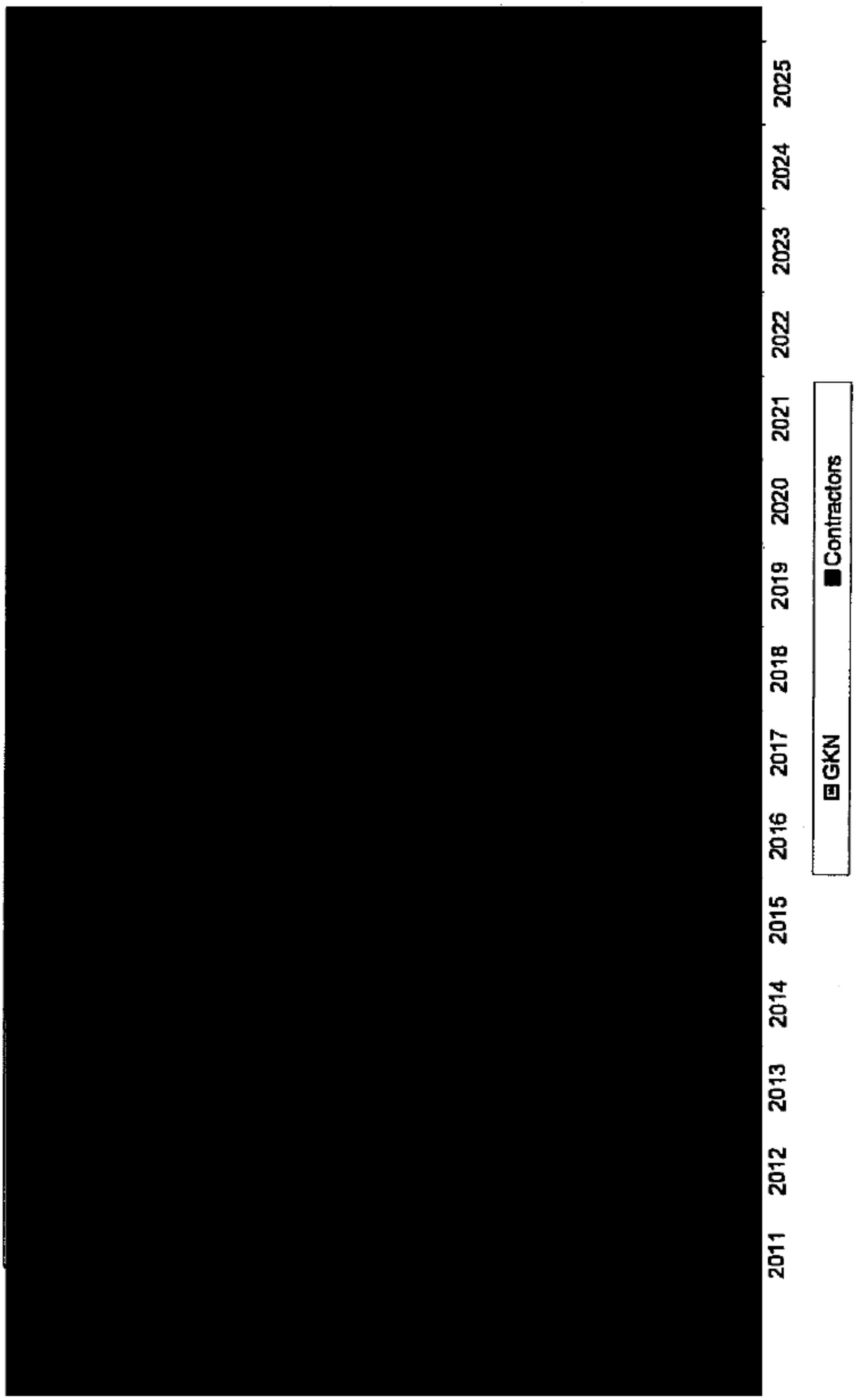


Figure 10-3: KCD Decommissioning - Total number of staff per year (GKN vs. Contractors)

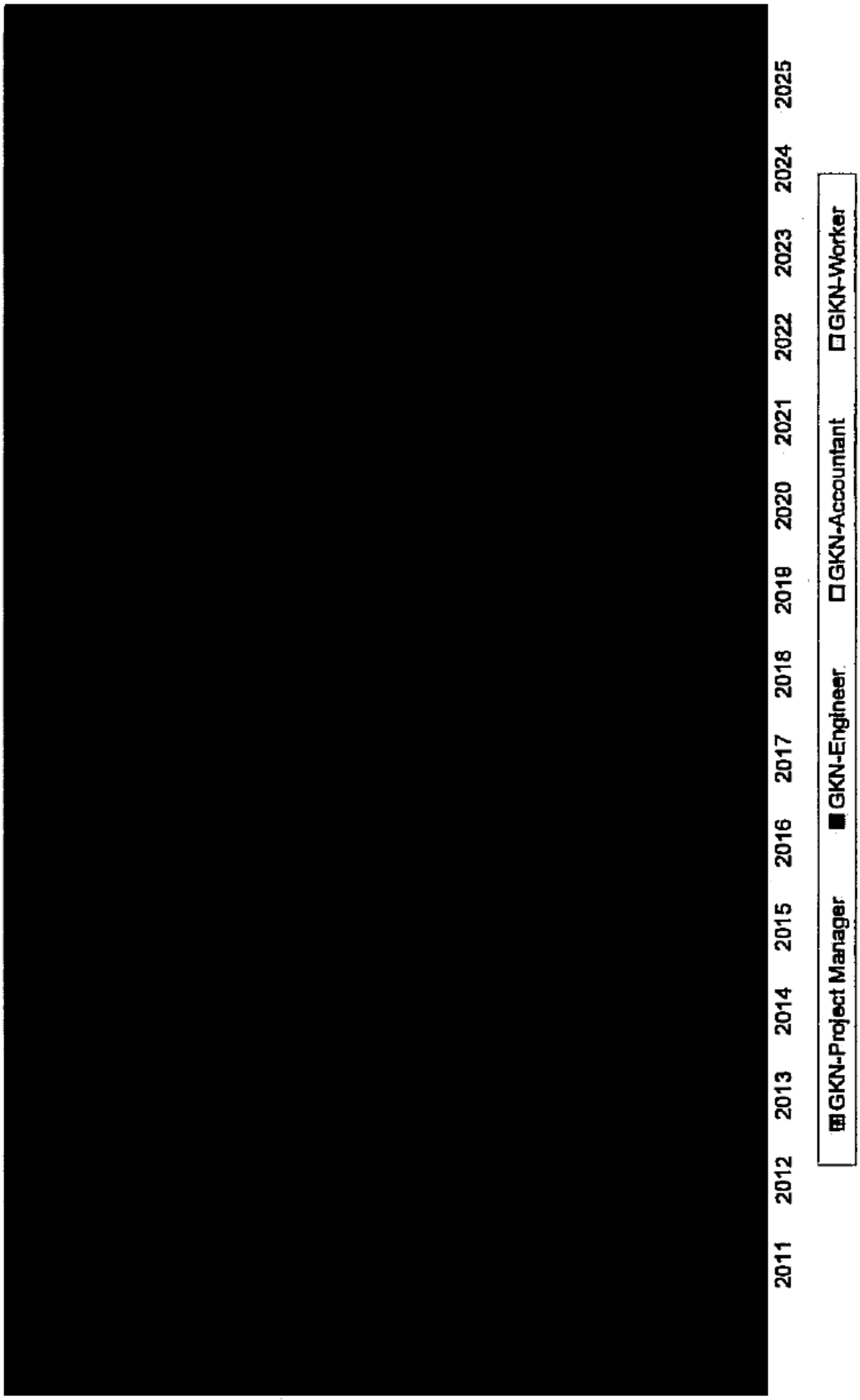


Figure 10-4: KCD Decommissioning - GKN staff per qualification and year

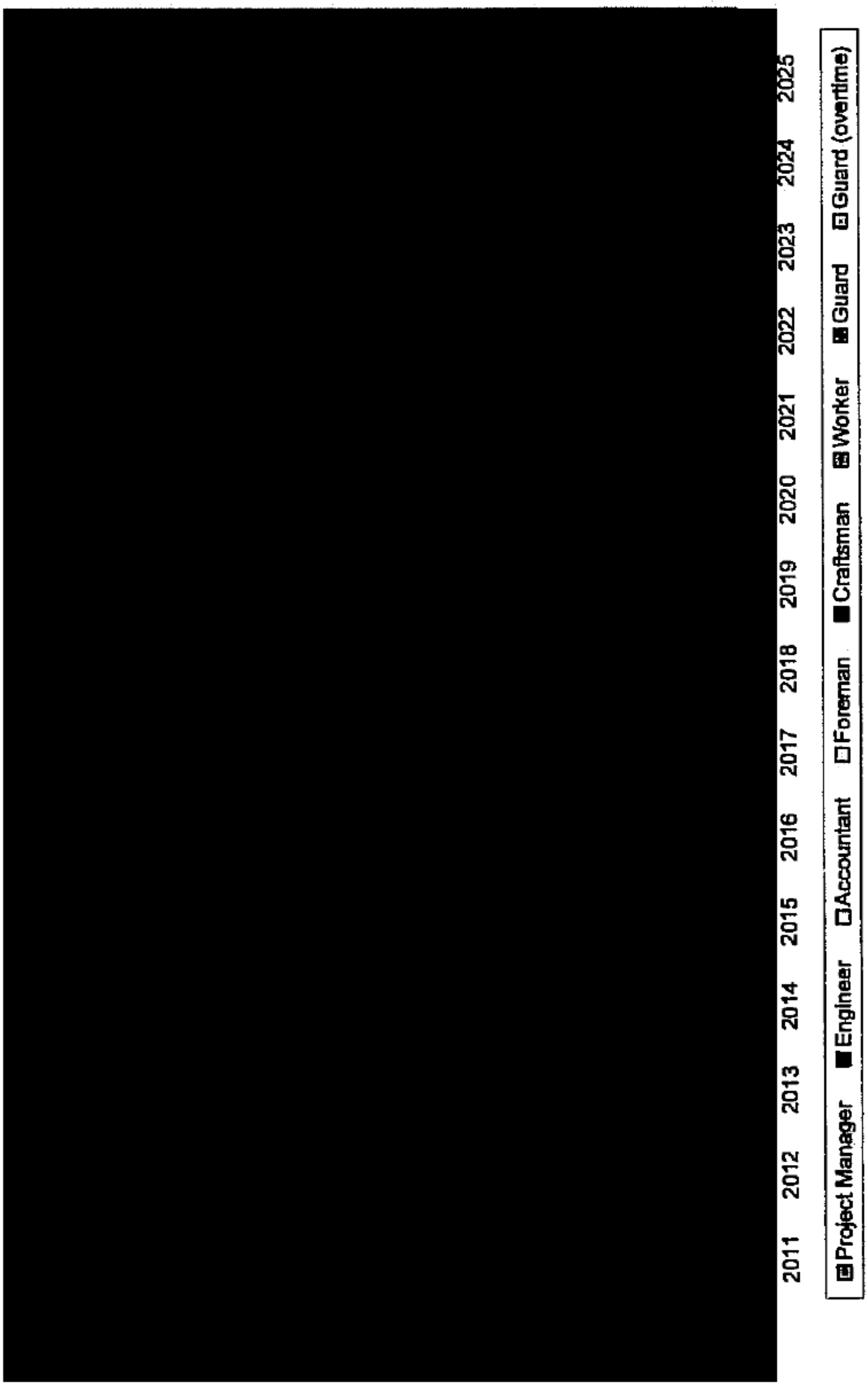


Figure 10-5: Nuclear dismantling - Contractors staff per qualification and year

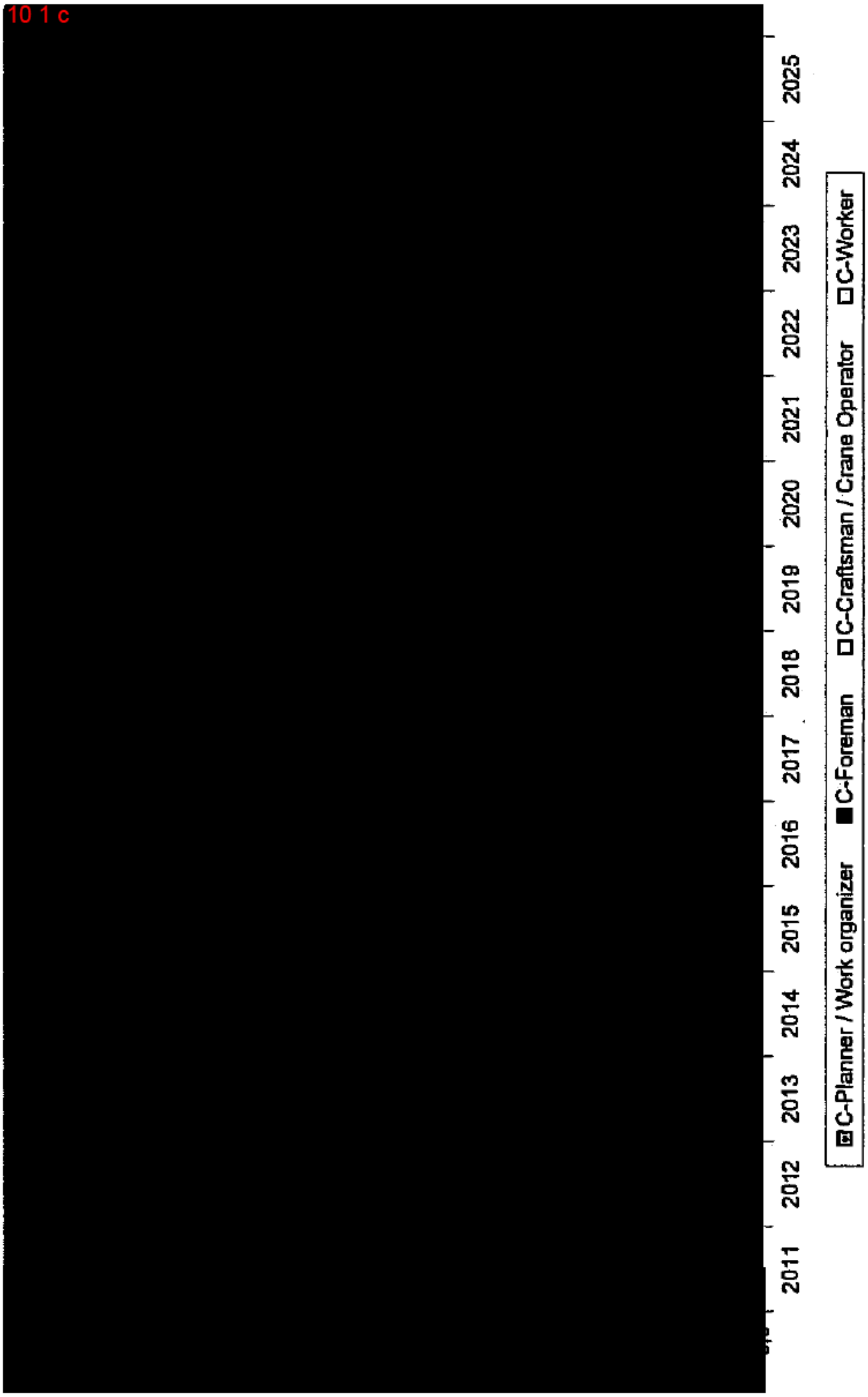


Figure 10-6: Conventional demolishing - Number of staff per qualification and year

References

/1/ Costs of decommissioning the nuclear power plant at Dodewaard
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Appendix 1: List with Distribution Factor Sets (Output from CORA)

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate - Kernenergiewet

No.	Distribution Factor Set / Portion [%] Disposal Way		Portion [%]	Cask Type	Waste Category	Capacity [kg]	
1	RPV-Internals - A5, A4 — 100,00 Radioactive Waste + Direct packaging	*Packaging:*	100,00	MOSAIK Type II / 100mm Fe	Steel parts	320,0	☑
2	RPV-Internals - A3, A2 — 100,00 Radioactive Waste + Direct packaging	*Packaging:*	100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
3	RPV - A5, A4, A3 — 100,00 Radioactive Waste + Direct packaging	*Packaging:*	100,00	KONRAD Type II / 180mm NC/30mm Fe	Steel parts	2.800,0	☑
4	RPV - A4, A3 — 100,00 Radioactive Waste + Direct packaging	*Packaging:*	100,00	KONRAD Type II / 180mm NC	Steel parts	3.200,0	☑
5	RPV - A3, A2 — 100,00 Radioactive Waste + Direct packaging	*Packaging:*	100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
6	RK - Internals/vessel (mix material, e.g. concrete/steel) — 100,00 Radioactive Waste + Direct packaging	*Packaging:*	100,00	KONRAD Type II	Steel & concrete mixture (40 %)	4.800,0	☑
7	RK - Internals (steel) — 100,00 Radioactive Waste + Direct packaging	*Packaging:*	100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
8	RK - Internals A3 (steel) — 100,00 Radioactive Waste + Direct packaging	*Packaging:*	100,00	KONRAD Type II / 180mm NC	Steel parts	3.200,0	☑

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate - Kernenergiewet

No.	Distribution Factor Set	Portion [%]	Disposal Way / Packaging				
9	RK - vessel	100,00	Radioactive Waste + Direct packaging				
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
10	RK - vessel A3	100,00	Radioactive Waste + Direct packaging				
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II / 180mm NC	Steel parts	3.200,0	☑
11	RPV-Insulation	100,00	Radioactive Waste + Super-compaction				
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			16,00	200-l drum (> 0,2 <= 2 mSv/h)	5 Pellets 90-l (Insulation)	212,5	☑
			20,00	200-l drum (> 2,5 <= 4 mSv/h)	5 Pellets 90-l (Insulation)	212,5	☑
			64,00	200-l drum (<= 0,2 mSv/h)	5 Pellets 90-l (Insulation)	212,5	☑
			100,00	90-l press drum	Insulation for super-compaction	42,5	☐
20	BS - NC	100,00	Radioactive Waste + Direct packaging				
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II	Concrete (NC - 40%)	3.800,0	☑
21	BS - HC	100,00	Radioactive Waste + Direct packaging				
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II	Concrete (HC - 40 %))	5.600,0	☑
22	BS - HC A3	100,00	Radioactive Waste + Direct packaging				
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II / 180mm NC	Concrete (HC)	2.800,0	☑
30	Unrestricted Release C1	100,00	Unrestricted Release + Direct release				
31	Landfill Release C1	100,00	Landfill + Direct release				
32	Release after Decontamination	100,00	Unrestricted Release + Dry blasting				

*) 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.

No.	Distribution Factor Set	Portion [%]	Disposal Way
33	Concrete Release	50,00	Landfill + Direct release
		50,00	Unrestricted Release + Direct release
34	Electrical equipment Release C1	70,00	Unrestricted Release + Direct release
		30,00	Landfill + Direct release
35	Cable trays with cables C1	35,00	Unrestricted Release + Direct release
		35,00	Reuse of Material + Shredding
		30,00	Landfill + Shredding
36	Steel contsruction >C1	60,00	Unrestricted Release + Direct release
		35,00	Unrestricted Release + Dry blasting
		5,00	Radioactive Waste + Cutting

Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
	100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate - Kernenergiewet

No. Distribution Factor Set
Portion [%] Disposal Way

37 Small Pipes (<50 mm)

50,00 Unrestricted Release + Dry blasting

30,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

10,00 Unrestricted Release + Direct release

10,00 Radioactive Waste + Direct packaging

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

38 Medium Pipes (>50 <100 mm)

70,00 Unrestricted Release + Dry blasting

10,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

10,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

10,00 Unrestricted Release + Direct release

39 Large Pipes (>100 mm)

80,00 Unrestricted Release + Dry blasting

10,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

10,00 Unrestricted Release + Direct release

*) 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.

No.	Distribution Factor Set	Portion [%]	Disposal Way
40	Small Vessels (<=100 kg)	70,00	Unrestricted Release + Dry blasting
		10,00	Unrestricted Release + Direct release
		10,00	Radioactive Waste + Cutting
		10,00	Radioactive Waste + Super-compaction
41	Medium Vessels (>100 <1000 kg)	75,00	Unrestricted Release + Dry blasting
		10,00	Radioactiva Waste + Cutting
		10,00	Unrestricted Release + Direct release
		5,00	Radioactive Waste + Super-compaction
42	Large Vessels (>1000 kg)	80,00	Unrestricted Release + Dry blasting
		10,00	Radioactive Waste + Cutting
		10,00	Unrestricted Release + Direct release

No. 40 – 10,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

No. 40 – 10,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

No. 41 – 10,00 Radioactiva Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

No. 41 – 5,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

No. 42 – 10,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

*) 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.

No. **Distribution Factor Set**
Portion [%] Disposal Way

43 Small Heat Exchangers (<200 kg)

55,00 Unrestricted Release + Dry blasting

30,00 Radioactive Waste + Super-compaction

<u>*Packaging:*</u>

Portion [%]	*Cask Type*	*Waste Category*	*Capacity [kg]*	
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

10,00 Radioactive Waste + Cutting

<u>*Packaging:*</u>

Portion [%]	*Cask Type*	*Waste Category*	*Capacity [kg]*	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

5,00 Unrestricted Release + Direct release

44 Medium Heat Exchangers (>=200 <1000 kg)

65,00 Unrestricted Release + Dry blasting

20,00 Radioactive Waste + Super-compaction

<u>*Packaging:*</u>

Portion [%]	*Cask Type*	*Waste Category*	*Capacity [kg]*	
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

10,00 Unrestricted Release + Direct release

5,00 Radioactive Waste + Cutting

<u>*Packaging:*</u>

Portion [%]	*Cask Type*	*Waste Category*	*Capacity [kg]*	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

*) 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.

No.	Distribution Factor Set / Portion [%] Disposal Way
62	Devices (e.g. Manipulator)
	50,00 Unrestricted Release + Dry blasting
	30,00 Unrestricted Release + Direct release
	15,00 Landfill + Direct release
	5,00 Radioactive Waste + Cutting

<u>Packaging:</u>

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

No.	Distribution Factor Set / Portion [%] Disposal Way
63	Ventilation ducts
	60,00 Unrestricted Release + Dry blasting
	25,00 Radioactive Waste + Super-compaction

<u>Packaging:</u>

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

	10,00 Unrestricted Release + Direct release
	5,00 Radioactive Waste + Cutting

<u>Packaging:</u>

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

*) 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.

No.	Distribution Factor Set	Portion [%]	Disposal Way
45	Large Heat Exchangers (>1000 kg)	70,00	Unrestricted Release + Dry blasting
		15,00	Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

No.	Distribution Factor Set	Portion [%]	Disposal Way
		10,00	Unrestricted Release + Direct release
		5,00	Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

No.	Distribution Factor Set	Portion [%]	Disposal Way
46	Small Pumps (<=25 kg)	100,00	Radioactive Waste + Direct packaging

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

No.	Distribution Factor Set	Portion [%]	Disposal Way
47	Medium Pumps (>25 <200 kg)	60,00	Unrestricted Release + Dry blasting
		30,00	Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

No.	Distribution Factor Set	Portion [%]	Disposal Way
		10,00	Unrestricted Release + Direct release
48	Large Pumps (>=200 kg)	70,00	Unrestricted Release + Dry blasting
		15,00	Unrestricted Release + Direct release
		15,00	Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

*) 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.

No.	Distribution Factor Set					
	Portion [%] Disposal Way					
49	Small Valves (<=25 kg)	100,00 Radioactive Waste + Direct packaging				
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
50	Medium Valves (>25 <200 kg)	60,00 Unrestricted Release + Dry blasting				
		30,00 Radioactive Waste + Cutting				
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
		10,00 Unrestricted Release + Direct release				
51	Large Valves (>=200 kg)	70,00 Unrestricted Release + Dry blasting				
		15,00 Radioactive Waste + Cutting				
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
		15,00 Unrestricted Release + Direct release				
52	FR - Mixed material with super-compaction (e.g. PE, PVC)	100,00 Radioactive Waste + Super-compaction				
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	200-l drum (<= 0,2 mSv/h)	5 Pellets 90-l (Mix material)	175,0	☑
		100,00	90-l press drum	Mixed material for super-compaction (e.g. PE, PVC)	35,0	☐
53	FR - Metal Components with super compaction	100,00 Radioactive Waste + Super-compaction				
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
		100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

*) 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.

No.	Distribution Factor Set	Portion [%]	Disposal Way
54	Cable trays with cables C2, C3	35,00	Reuse of Material + Shredding
		30,00	Radioactive Waste + Shredding

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	5 Pellets 90-l (Insulation)	212,5	☑
100,00	90-l press drum	Insulation for super-compaction	42,5	☐

Portion [%]	Disposal Way
20,00	Unrestricted Release + Direct release
10,00	Unrestricted Release + Dry blasting
5,00	Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

No.	Distribution Factor Set	Portion [%]	Disposal Way
55	Concrete blocks contaminated	97,00	Landfill + Dry blasting
		3,00	Radioactive Waste + Dry blasting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	Concrete rubble	200,0	☑

No.	Distribution Factor Set	Portion [%]	Disposal Way
56	Electrical Equipment > C1	60,00	Unrestricted Release + Direct release
		20,00	Landfill + Direct release
		10,00	Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	5 Pellets 90-l (Mix material)	175,0	☑
100,00	90-l press drum	Mixed material for super-compaction (e.g. PE, PVC)	35,0	☐

Portion [%]	Disposal Way
10,00	Unrestricted Release + Dry blasting

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate - Kernenergiewet

No.	Distribution Factor Set / Portion [%] Disposal Way		Portion [%]	Cask Type	Waste Category	Capacity [kg]	
57	FR - Mixed material (e.g. PE, PVC, wood)	100,00 Radioactive Waste + Cutting					
		Packaging:	100,00	KONRAD Type II	Mixed material (e.g. PE, PVC, wood - 40 %)	2.400,0	☑
58	FR - Contaminated conrete rubble	100,00 Radioactive Waste + Direct packaging					
		Packaging:	100,00	200-l drum (<= 0,2 mSv/h)	Concrete rubble	200,0	☑
59	FR - Metal Components directly	50,00 Radioactive Waste + Direct packaging					
		Packaging:	100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
		50,00 Radioactive Waste + Cutting					
		Packaging:	100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
60	Turbine	80,00 Unrestricted Release + Dry blasting					
		10,00 Unrestricted Release + Direct release					
		10,00 Radioactive Waste + Cutting					
		Packaging:	100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
61	FR - Special material (e.g. crud)	100,00 Radioactive Waste + Direct packaging					
		Packaging:	100,00	1000-l container (NC) / 60mm Fe	Steel parts	260,0	☑

*) 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.

No.	Distribution Factor Set	Portion [%]	Disposal Way
64	Ventilator	50,00	Unrestricted Release + Dry blasting
		25,00	Radioactive Waste + Super-compaction
		10,00	Unrestricted Release + Direct release
		10,00	Landfill + Direct release
		5,00	Radioactive Waste + Direct packaging
65	Insulation (Mineral wool)	80,00	Radioactive Waste + Super-compaction
		20,00	Unrestricted Release + Direct release
86	FR - Metal Components with super compaction (higher dose rate,	100,00	Radioactive Waste + Super-compaction

64 Ventilator – 25,00 Radioactive Waste + Super-compaction – Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

64 Ventilator – 5,00 Radioactive Waste + Direct packaging – Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

65 Insulation (Mineral wool) – 80,00 Radioactive Waste + Super-compaction – Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	200-l drum (<= 0,2 mSv/h)	5 Pellets 90-l (insulation - mineral wool)	100,0	☑
100,00	90-l press drum	Insulation for super-compaction (minearal wool)	20,0	☐

86 FR - Metal Components with super compaction (higher dose rate, – 100,00 Radioactive Waste + Super-compaction – Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
50,00	200-l drum (> 2,5 <= 4 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
50,00	200-l drum (> 0,2 <= 2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate - Kernenergiewet

No. **Distribution Factor Set**
Portion [%] Disposal Way

67 Medium Pipes (>50 <100 mm), higer dose rate (C5)

70,00 Unrestricted Release + Dry blasting

20,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
50,00	200-l drum (> 2,5 <= 4 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
50,00	200-l drum (> 0,2 <= 2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

10,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

68 Small&Medium Vessels (<=1000 kg), higer dose rate (C5)

70,00 Unrestricted Release + Dry blasting

20,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

10,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (> 0,2 <= 2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

69 Medium Heat Exchangers (>=200 <1000 kg), higer dose rate (C5)

65,00 Unrestricted Release + Dry blasting

20,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (> 0,2 <= 2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

10,00 Unrestricted Release + Direct release

5,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

*) 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.

No. Distribution Factor Set
Portion [%] Disposal Way

70 Large Heat Exchangers (>1000 kg), higer dose rate (C5)

70,00 Unrestricted Release + Dry blasting

15,00 Radioactive Waste + Super-compaction

Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
	100,00	200-l drum (> 0,2 <= 2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
	100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

10,00 Unrestricted Release + Direct release

5,00 Radioactive Waste + Cutting

Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
	100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

71 New Equipment

50,00 Unrestricted Release + Dry blasting

20,00 Unrestricted Release + Direct release

10,00 Radioactive Waste + Super-compaction

Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
	100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
	100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

10,00 Landfill + Direct release

10,00 Radioactive Waste + Cutting

Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
	100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

72 Concrete rubble (Building Decontamination)

45,00 Landfill + Direct release

35,00 Radioactive Waste + Direct packaging

Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
	100,00	200-l drum (<= 0,2 mSv/h)	Concrete rubble	200,0	☑

20,00 Unrestricted Release + Direct release

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate - Kernenergiewet

No.	Distribution Factor Set	Portion [%]	Disposal Way
73	Masses SE	50,00	Unrestricted Release + Direct release
		30,00	Radioactive Waste + Direct packaging
			Packaging: Portion [%]: 100,00; Cask Type: KONRAD Type II; Waste Category: Steel & concrete mixture (40 %); Capacity [kg]: 4.800,0 ☑
		20,00	Unrestricted Release + Dry blasting
80	Reuse C1 - Copper	100,00	Reuse of Material + Direct release
81	Reuse A0, C1 - Lead	100,00	Reuse of Material + Direct release
82	Reuse C1 - Aluminium	100,00	Reuse of Material + Direct release
83	Reuse C2 - Copper	100,00	Reuse of Material + Dry blasting
84	Reuse >C1 - Lead	90,00	Landfill + Direct release
		10,00	Landfill + Dry blasting
85	Reuse & FR >C1 - Lead	88,00	Landfill + Direct release
		10,00	Landfill + Dry blasting
		2,00	Radioactive Waste + Direct packaging
			Packaging: Portion [%]: 100,00; Cask Type: 200-l drum (<= 0,2 mSv/h); Waste Category: Lead; Capacity [kg]: 450,0 ☑

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate - Kernonorgiewet

No.	Distribution Factor Set / Portion [%] Disposal Way					
100	Incineration	100,00 Radioactive Waste + Super-compaction				
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		10,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Secondary Waste)	100,0	☑
		10,00	90-l press drum	Secondary waste for super-compaction	25,0	☐

*) 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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6 Maintenance Description

6.1 Inleiding Stralingsveiligheid (Introduction to Radiation Safety)

Hoofduitgangspunt van de stralingsveiligheid is dat zowel onder normale bedrijfsomstandigheden als bij storingen en ongevallen nooit een toestand mag ontstaan, waarbij het personeel, derden, de omwonende bevolking en de medewerkers van omliggende bedrijven ontoelaatbaar geachte schade zal kunnen worden toegebracht. In de afgelopen jaren is, in het kader van het milieubeleid van de overheid, de risicobenadering ontwikkeld. Dit is voor de bescherming tegen de aan ioniserende straling verbonden gevaren vastgelegd in het Besluit stralenbescherming Kernenergiewet (BsK). In overeenstemming met dit besluit wordt als uitgangspunt gehanteerd dat de dosis voor leden van de bevolking in de omgeving van de inrichting niet groter mag zijn dan 0,1 mSv per jaar bij normale bedrijfssituaties.

Conform het desbetreffende overheidsbeleid geldt daarnaast dat gestreefd wordt naar een individueel risico dat kleiner is dan 1 E-8 per jaar, het zogenoemde secundair niveau, overeenkomend met 4 E-4 mSv per jaar.

Voor ongevalsituaties tijdens de Eindontmanteling wordt gestreefd naar een veiligheidsniveau resulterend in een individueel risico dat kleiner is dan het secundair niveau van 1 E-8 per jaar.

Daarnaast is er een criterium voor het groepsrisico, dat bedoeld is om maatschappelijke ontwrichting te voorkomen. Aangezien er geen realistische ongevalscenario's denkbaar zijn waarbij acute slachtoffers in de omgeving kunnen vallen is dit criterium niet relevant voor de Eindontmanteling.

Voor mogelijke storingen en ongevallen in de installatie tijdens de Eindontmanteling zullen in het Veiligheidsrapport Eindontmanteling diverse veiligheidsanalyses worden gemaakt. Daarbij is voor ongevallen met mogelijke consequenties voor de omgeving nagegaan of het individueel risico voldoet aan bovengenoemd uitgangspunt.

Bij de uitwerking van bovenstaand uitgangspunt zal gebruik worden gemaakt van een aantal belangrijke erkende veiligheidsbeginselen (principes), waarvan de belangrijkste het ALARA-, het "defence-in-depth"- en het IBC-principe zijn.

6.2 Basis uitgangspunten voor de stralingsveiligheid (Assumptions for Radiation Safety)

6.2.1 Het ALARA-principe (ALARA principle)

Uitgangspunt van het beleid ten aanzien van de stralingsbescherming van het personeel en de omgeving is een vermijdbare blootstelling aan straling te voorkomen en onvermijdelijke blootstelling zo veel mogelijk te beperken.

Dit beleid is erop gericht dat de blootstelling zo laag als redelijkerwijs mogelijk is: "As Low As Reasonably Achievable" (ALARA). Daarnaast geldt als randvoorwaarde dat de wettelijke vastgelegde dosislimieten niet worden overschreden.

De praktische uitwerking van het ALARA-principe in het ontwerp en de bedrijfsvoering van de Veilige Insluiting betekent dat onderzocht wordt welke technieken en procedures kunnen leiden tot een beperking van de stralingsdoses voor medewerkers, derden en de omwonende bevolking. Hierbij vindt een afweging plaats tussen de te bereiken reductie van de stralingsdosis en de kosten van de maatregelen die deze reductie mogelijk maken.

6.2.2 Het "defence-in-depth"-principe (Defence in depth principle)

Het "defence-in-depth"-principe is het beginsel dat mogelijk menselijk falen of falen van (delen van de) installaties gecompenseerd dient te worden door meerdere beveiligingsniveaus, die aanwezig dienen te zijn ter voorkoming van het vrijkomen van radioactieve stoffen in de omgeving.

Deze beveiligingsniveaus zijn:

- Niveau 1
  Het voorkomen van storingen door de kwaliteit van het ontwerp, de bouw en de bedrijfsvoering van de installatie door middel van kwaliteitsborging en het handhaven van een adequate veiligheidscultuur.
- Niveau 2
  Het voorkomen dat storingen tot ongevallen kunnen leiden door middel van het detecteren van abnormale situaties en het adequaat reageren hierop.
- Niveau 3
  Het beperken van de gevolgen van ongevallen door middel van de toepassing van actieve en/of passieve veiligheidsvoorzieningen.
- Niveau 4
  Het nemen van maatregelen om de gevolgen van ongevallen voor het personeel, de bevolking en medewerkers van omliggende bedrijven en de omgeving verder te beperken.

6.2.3 Het IBC-principe (The IBC principle)

Het "defence-in-depth"- principe sluit nauw aan bij het IBC-principe, dat voor de insluiting van de radioactieve stoffen wordt toegepast en bestaat uit:

- isoleren;
- beheersen;
- controleren.

Isoleren

Dit principe leidt ertoe dat radioactieve stoffen worden ingesloten binnen een of meerdere barrières die kunnen bestaan uit het materiaal zelf, de verpakking, de ruimte waarin het materiaal zich bevindt en/of de filters in het ventilatiesysteem van de Veilige Insluiting. Het is verder uitgewerkt in de volgende voorzieningen:

- potentieel besmette gebieden worden op onderdruk gehouden;

- er wordt een gerichte luchtstroming in stand gehouden die loopt vanaf een gebied zonder radioactieve besmetting naar gebieden met een hogere potentiële besmetting.

Daartoe zijn binnen de installatie gescheiden zones ingesteld en wordt ventilatielucht uitsluitend via filters geloosd naar de omgeving.

Beheersen

Dit principe leidt ertoe dat de insluiting van radioactief materiaal zeker gesteld dient te worden. Dit wil zeggen dat de barrières, die het vrijkomen van radioactieve stoffen verhinderen, in stand worden gehouden gedurende de Eindontmanteling.

Dit heeft niet alleen betrekking op de bouwkundige en systeemtechnische voorzieningen die zijn aangebracht, maar ook op het onderhoud- en inspectieprogramma en het kwaliteitsborgingsysteem dat gedurende de Eindontmanteling zal worden onderhouden.

Controleren

Dit principe leidt ertoe dat geen radioactieve materialen onopgemerkt de installatie verlaten. Dit wordt gerealiseerd doordat:

- gasvormige producten en aërosolen uitsluitend gefilterd geloosd kunnen worden en de hoeveelheid radioactiviteit na een filter wordt gemeten en geregistreerd;
- essentiële procesparameters worden gemeten en geregistreerd;
- er geen radioactief afvalwaterlozingen kunnen plaatsvinden anders dan door aftappen van de verzameltank van besmet water;
- eventueel transport van aanwezig niet geconditioneerd radioactief materiaal door de materiaalmonitor bij de uitgang van het terrein wordt gedetecteerd.

6.3 Interne en externe invloeden op de veiligheid (Internal and external influences to Safety)

6.3.1 Interne invloeden op de veiligheid (Internal influences to Safety)

De veiligheidscriteria die gesteld worden aan het ontwerp van de installatie tijdens de Eindontmanteling worden gerelateerd aan de zogenaamde ontwerpgebeurtenissen, waarbij rekening wordt gehouden met de ernst van de gevolgen en de kans van optreden. De indeling in categorieën ontwerpgebeurtenissen is ontleend aan de voor dit doel goed bruikbare Amerikaanse standaard voor installaties voor de droge opslag van splijtstofelementen. Hierbij wordt onderscheid gemaakt tussen:

- Categorie 1: Normaal bedrijf
  Hieronder worden alle handelingen verstaan die continu of regelmatig optreden gedurende de Eindontmanteling, zoals het bedrijf van het ventilatiesysteem, onderhoud en inspectie, evenals het verkleinen en verpakken van radioactief afval. Het normale bedrijf van de installatie heeft geen schadelijke gevolgen voor de omgeving. Het individueel risico bij normaal bedrijf is kleiner dan het secundair niveau.

- Categorie 2: Storingen
  Hieronder worden alle gebeurtenissen verstaan die niet regelmatig optreden, maar waarvan verwacht kan worden dat deze ten minste eenmaal per jaar kunnen voorkomen, bijvoorbeeld het uitvallen van de exteme elektriciteitsvoorziening en het uitvallen van het ventilatiesysteem. Tot de storingen worden ook fouten tengevolge van foutief menselijk handelen gerekend. De kans van optreden van deze gebeurtenissen is van de orde van 1 maal per jaar. Het individueel risico tengevolge van storingen is kleiner dan het secundair niveau.

- Categorie 3: Ongevallen
  Hieronder worden alle gebeurtenissen verstaan waarvan verwacht kan worden dat deze een beperkt aantal malen gedurende de Eindontmanteling zouden kunnen optreden, bijvoorbeeld het uitvallen van de externe elektriciteitsvoorziening gedurende een lange periode, of een interne brand. De kans van optreden van deze gebeurtenissen is van de orde van 1 maal per 10 tot 100 jaar. In het ontwerp van de installatie is met ongevallen van deze categorie rekening gehouden. Het individueel risico tengevolge van ongevallen is kleiner dan het secundair niveau.

- Categorie 4: Extreme ongevallen
  Hieronder worden alle gepostuleerde gebeurtenissen verstaan die, gezien hun ernst, gevolgen zouden kunnen hebben voor de omgeving van de installatie. Tot deze gebeurtenissen dienen ook externe invloeden van natuurlijke of niet-natuurlijke oorsprong gerekend te worden. De kans van optreden van deze gebeurtenissen is kleiner dan 1 maal per 100 jaar.

Naast bovengenoemde categorieën kan onderscheid worden gemaakt tussen "ontwerpongevallen" (ter beheersing waarvan in het ontwerp voorzieningen zijn getroffen) en "buiten-ontwerpongevallen" (ongevallen die niet in het ontwerp zijn betrokken). Voor interne ongevallen met ernstiger gevolgen dan die onder categorie 3 genoemd, komen alleen die scenario's in aanmerking waarbij de radioactieve inventaris van het reactorvat en/of het biologisch schild vrij komt. Hiervoor is echter geen realistisch scenario denkbaar. Ongevallen van categorie 4 zijn derhalve uitsluitend die met een externe oorsprong.

Analyse van de gevolgen van interne ongevallen:
De mogelijke gevolgen van de storingen en ongevallen zullen in het Veiligheidsrapport "Eindontmanteling"verder worden uitgewerkt.

6.3.2 Externe invloeden op de veiligheid (External influences to Safety)

Externe gebeurtenissen, die invloed kunnen hebben op de veiligheid van de installatie tijdens de Eindontmanteling behoren voor wat betreft de kans van optreden tot de categorie 4. Deze externe invloeden zijn naar oorzaak te onderscheiden in:

- invloeden met een natuurlijke oorsprong:
  - overstroming;
  - aardbeving;
  - harde wind en windhoos;
- invloeden met een niet-natuurlijke oorsprong:

- transportongeval op de Waal (gaswolkexplosie);
- neerstortend vliegtuig.

Analyse van de gevolgen van externe gebeurtenissen:
De mogelijke gevolgen van externe gebeurtenissen zullen in het Veiligheidsrapport Eindontmanteling verder worden uitgewerkt.

6.4 Beveiliging (Security)

Beveiliging van de installatie is noodzakelijk om te voorkomen dat personen onbevoegd het gebied zouden kunnen betreden en zichzelf daarmee aan straling of besmetting met radioactieve stoffen bloot zouden kunnen stellen. Daarnaast is beveiliging van de insluiting noodzakelijk om te voorkomen dat al dan niet kwaadwillende derden een voor de omgeving gevaarlijke situatie kunnen creëren.

De volgende beveiligingsmaatregelen zullen worden getroffen.

- Organisatorische maatregelen
  Hieronder vallen de organisatie, het personeel en de middelen die ingezet worden om de beveiliging gestalte te geven. Onder middelen worden de noodzakelijke beleidsstukken, procedures, richtlijnen, voorschriften, instructies en dergelijke verstaan.

- Bouwkundige maatregelen
  Hieronder vallen alle materiële voorzieningen die tot doel hebben weerstand te bieden tegen het middelenarsenaal waarmee binnendringing van een beveiligd object redelijkerwijs kan plaatsvinden. Hiertoe behoren wanden, daken, deuren, ramen, plafonds en dergelijke.

- Elektronische maatregelen
  Hieronder vallen alle materiële elektronische, elektrotechnische en optische voorzieningen die een observerende, signalerende of alarmerende functie hebben.

Naast de actief getroffen beveiligingsmaatregelen wordt de vorm waarin het radioactieve materiaal aanwezig is gekenmerkt door een hoge mate van passieve veiligheid (voornamelijk chemisch gebonden en geactiveerd materiaal) die onafhankelijk is van de permanente werking van mechanische en elektrotechnische systemen die door moedwillige beschadiging buiten werking zouden kunnen worden gesteld. De aard en de vorm waarin de radioactieve producten zich bevinden, beperken het risico van het vrijkomen van radioactiviteit tengevolge van sabotage of terroristische acties.

6.5 Industriële veiligheid (Industrial Safety)

De zorg voor de industriële veiligheid is geïntegreerd in de zorg voor de arbeidsomstandigheden (veiligheid, gezondheid en welzijn) en heeft tot doel de veiligheid van de eigen werknemers en die van derden te waarborgen, in overeenstemming met de bepalingen van de Arbo-wet.

7 Decontamination and Dismantling Techniques

7.1 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 experience is available with a wide variety of dismantling and decontamination techniques. The needed techniques are available and known. Published descriptions of these techniques can be found in the literature, e.g. /13/.

Not all techniques that were developed in the past could achieve acceptance in practice. In the course of the last ten years there has been a process of consolidation.

The techniques mentioned hereafter should give a short overview and they are commonly used today, but not all are taken into account in the present study. The selected decontamination and dismantling techniques are presented in section 7.3 and section 7.7 respectively.

7.1.1 Non-contaminated and Non-activated Objects

Non-activated and non-contaminated objects from the controlled area will be regarded as potentially contaminated. They will be removed from the plant and transferred to free release measurements before being free released when found in compliance with the free release limits.

Further treatment is carried out if this is required for the release measurements, for example if the geometry of the components makes release measurements too difficult or impossible.

7.1.2 Contaminated Objects

Contaminated objects will be removed from the plant and treated for free release or disposal as radioactive waste.

The components are cut in situ to suitable dimensions for internal transfer to the treatment areas. There a further cutting is carried out so that the parts can be free released after decontamination or they are packed and conditioned as radioactive waste.

7.1.3 Activated Objects

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

The aim of the dismantling is:

- to cut the activated parts to suitable dimensions for packaging
- to put them in the repository package

as effectively as possible.

7.2 Decontamination Techniques

Decontamination is an important issue in the Decommissioning & Dismantling (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:

- 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 clearance level.

7.2.1 Mechanical Decontamination

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

The procedures range from simple washing off and brushing off, mostly in combination with decontamination cleansers, to abrasion and mechanical removal of the surfaces for example by steel or sand blasting. The procedures are applied on well accessible surfaces (outer surface or inner surface after cutting) of almost all materials. The contamination can be loose or firmly clinging at the surface or even slightly penetrated into the surface. The volume of secondary waste is relatively small, as the abrasive media, for instance, may be applied several times. A partial decontamination of surfaces is possible in order to remove so-called hot spots. Mechanical decontamination can be used as a stand alone technique or in sequence with chemical decontamination.

The personnel needs might be high and the required protection measures against spreading of the dust are significant (depending on the technique).

7.2.1.1 High Pressure Water Decontamination

This technique is well known from non-nuclear applications. It is used for superficial contaminations. Water at high pressure is used to spray the surface (see Figure 7-1). Complicated surfaces can be cleaned. The consumption of additives is low.

This technique meets its limits if the contamination is chemically bound to the surface, or if it has penetrated into the surface. In such a case, one of the techniques that remove the surface must be applied.

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

7.2.1.2 Dry Blasting Decontamination (Grit Blasting)

The grit blasting technique is commonly called steel/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 (see Figure 7-2 and Figure 7-3).

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).

7.2.1.3 Scarification Techniques

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.

7.2.2 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 the duration, and on the 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 (see Figure 7-4).

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.

7.2.3 Decontamination by Melting

The D&D melting process 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 Caesium-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;
- Duratek Melting Facility, USA;
- 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.

7.3 Selection of an appropriate Decontamination Technique

The decision for the use of the above mentioned decontamination techniques depend on different technical or economic factors. The possible decontamination treatments are not applicable to every component. The decision for the decontamination starts with the evaluation and analysis of the existing components and materials. The analysis will be figured out by the NIS software Cora and the Dodewaard specific component data base (DIS).

When selecting a specific technique for component decontamination, the following main requirements have been considered:

- Safety;
- Cost-effectiveness;
- Waste minimisation;
- Feasibility of industrialisation.

To achieve a good decontamination factor, a decontamination process must be designed for site-specific application taking into account a wide variety of parameters. Some of them are listed below:

- Type of plant and plant process: reactor type, reprocessing plant, etc.;
- Operating history of the plant;

- Type of material: steel, concrete, etc.;
- Type of surface: rough, porous, coated, etc.;
- Type of contaminant: oxide, crud, sludge, loose, etc.;
- Composition of the contaminant (i.e. activation products, fission products, actinides, etc.) and the specific radionuclides involved;
- Regulatory requirements and required decontamination factor;
- Destination of the decontaminated components: disposal, reuse, etc.;
- Time required for application;
- Proven efficiency of the process for the type of contamination in the facility;
- Type of component: pipe, tank, etc.

Other factors which are important in selecting the method, but do not affect the decontamination factor, are:

- Availability, cost and complexity of the decontamination equipment and consumables;
- Need and capability of treatment and conditioning of the generated secondary waste;
- Potential exposure to hazardous materials and/or chemicals used in the decontamination process;
- Occupational and public doses resulting from decontamination (justification of the practice);
- Other safety, environmental and social issues;
- Extent to which the plant needs to be decontaminated to achieve acceptable conditions for decommissioning;
- Salvage value of materials which would otherwise be disposed of;
- Extent to which the facility must be modified to do the decontamination: isolate systems, enclosed and ventilated spaces, etc.

In addition, the choice of a process will finally depend on several other factors such as:

- The specific nature of the application, the complexity of the system;
- The feasibility of industrialisation;
- The cost/benefit analysis taking into account all aspects of the decontamination operation, i.e. until disposal of remaining radioactive waste.

Due to the situation at KCD (dismantling after SE and no operable waste water system available) the intention is to avoid water. Therefore only dry decontamination techniques are selected.

Three decontamination areas are installed in the new treatment area in the Turbine building (investments see No. 14 of Table 10-8):

- Caisson for dry blasting;
- Grinding / Scarifying area;
- Decontamination place for hands on decontamination like scrubbing or wiping incl. the possibility of using decontamination cleansers.

The gathered experience in the field of decontamination shows that the necessary decontamination work can be done by dry decontamination techniques.

The selection of dry blasting technique is based on the following aspects:

- Very flexible technique;
- Recirculation and/or recycling of abrasives;
- Comparably low priced technique;
- Large and small pieces can be decontaminated;
- Treatment of large tanks in situ;
- Metal removal on demand;
- Technique gives result in a relative short time;
- Equipment is well developed and commercially available;
- High practical experience.

Nevertheless the entire treatment process (cutting, treatment, disposal etc.) leaves scope for future optimization, especially since there are no finalized findings about the radiological plant conditions (i.e. kind and level of contamination) at the actual time of dismantling and treatment yet.

Melting might be also an alternative, but all available facilities are outside of the Netherlands, what necessitate a lot of transports abroad. In addition there might be also a problem with the probably still contaminated ingots which has to be disposed of as radioactive waste.

7.4 Dismantling Techniques

7.4.1 General

Today a great experience on dismantling of components in nuclear installations is available. New developments are needed only in some specific cases where the local situation is very special. 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 decommissioning project, as described in the following.

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

- internal transfer;
- Decontamination;
- Measuring for release;
- 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. large components which will be radioactive waste and which can be put directly into a container.

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

So dismantling techniques are needed for the following:

- Dismantling in situ: The components and equipment have to be removed from the plant and in most cases they will be transported to the treatment area for further handling and conditioning. Components that are a part of a system must be cut out of the system. Components with a size that can be handled and transported without cutting will be removed in one piece. Pipes will be cut to pieces that are suitable for internal transportation. The in situ cutting techniques must be flexible.
- Remote dismantling: The RPV internals, the RPV itself, the RPV insulation, the drywell with its installations and the biological shield will be dismantled in situ, but under remote control. All these dismantling activities are processed under dry conditions. Cut pieces are directly put in storage packages.
- Dismantling in treatment areas: A lot of the dismantled equipment (except activated parts like RPV, RPV internals, etc.) are treated in special treatment areas, e.g. in the turbine building. Further cutting is needed either to facilitate decontamination, to achieve a better filling rate of the packages, or to facilitate clearance measurements.

The following chapters give some information on dismantling techniques which were preferred in real decommissioning projects of today.

7.4.2 Mechanical Cutting

Mechanical cutting is the name for techniques such as sawing, cutting, milling, planning, abrasive cutting etc. These separation processes are possible under dry conditions 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, kerfs, 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.

7.4.2.1 Band Saw Cutting

Band saw cutting (see Figure 7-5) 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).

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 substructure 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.

7.4.2.2 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.

7.4.2.3 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 and has a diameter of 2.5 m and can cut a 1 m 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 tonnes 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 30 cm, the weight and bulk of the machines then require special adaptations to the manipulation and guidance equipment.

7.4.2.4 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 kerfs (the width being a constant).

Wire saw cutting is suitable for reinforced concrete but also for simple thick steel structures.

The wires are provided with small blades (see Figure 7-6).

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.

The technique of cable cutting is well known 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.

7.4.2.5 Hydraulic Shear

A hydraulic shear (see Figure 7-7) 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.

In case of remote controlled operation the cutting forces and the resulting moments must be observed to prevent damages to the remote control handling tools.

7.4.2.6 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.

7.4.3 Thermal Cutting

Thermal cutting processes (see Figure 7-8) include, for example, oxyacetylene 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.

7.4.3.1 Acetylene Cutting Technique

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 combustion 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 1150°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 200 mm can be achieved for mild steel.

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

7.4.3.2 Plasma Arc Cutting technique

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 electric 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.

7.5 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 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).

7.6 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.

7.7 Application and Selection of Dismantling Techniques

The selection criteria for the dismantling techniques are comparable to the criteria for the selection of decontamination techniques, like:

- Safety;
- Cost-effectiveness;
- Component type, material, geometry;
- Flexibility;
- Remote controlled handling;

- Practical experience;
- Feasibility of industrialisation.

The above mentioned techniques fulfil these requirements. The wide variety of components and materials require also a variety in dismantling techniques and therefore, more or less all described techniques are chosen for the dismantling of KCD (see next sections). Only the WAS Technique is not selected, because this would demand costly new waste water systems, which are not considered in the present study.

7.7.1 Contaminated and Non-Contaminated Components

The dismantling process is carried out system by system and/or room by room and/or component by component. The sequence of work will be decided during the detailed planning work depending on the needs of keeping some systems in operation, on the needs of working space and the improvement of the infrastructural matters. Mechanical and thermal cutting processes will be applied.

Applied mechanical separation processes are such as sawing, milling, grinding, etc.; in the field of thermal separation processes the acetylene cutting and plasma cutting are used.

The thermal cutting process is associated with the generation of dust and aerosols. To avoid the contamination on the surrounding surfaces additional ventilation systems and/or caissons are necessary.

The investments for the selected tools are given in Table 10-8 under No. 20 to 22.

A lot of the dismantled components have to be cut further to allow their decontamination and/or to fit into the storage containers. These further cutting activities are carried out in a special treatment area in the Turbine building. The cutting is done by mechanical (e.g. band saw, hydraulic shear) and by thermal techniques (e.g. cutting torch). The planned investments for these cutting tools are listed in Table 10-8 under No. 15.

7.7.2 Dismantling RPV-internals, RPV and Drywell with internals

The most important dismantling activities are the dismantling of the RPV-internals and the RPV itself. The internals will be dismantled in an in situ action and packaged directly in storage container like MOSAIK cast iron containers.

The packaging concept affects the dismantling procedures and the sequence of work very strongly, but not the dismantling techniques useable for the RPV internals.

For the disassembling and the cutting action of all activated components (RPV internals, RPV, Internals of Drywell and Drywell itself) the following techniques are used:

- Acetylene burning;
- Plasma burning;
- Mechanical cutting such as sawing, milling, grinders, nibblers.

Taking into account the present situation at KCD, no active waste water system is available, so only dry dismantling techniques (e.g. Plasma burning) are used to dismantle the activated RPV internals. Such a dry dismantling was carried out in the German dismantling project Niederaichbach where NIS was involved and experiences are available.

The dismantling of the RPV itself will be performed in air without water and under remote control. The techniques used are sawing (blade saw) and Plasma burning. This is common practice in other decommissioning projects. In 2010, the RPV of the NPP Stade is for example dismantled under dry conditions by NIS.

The cutting of the RPV is carried out from the top to the bottom by segmenting it into pieces which fit in KONRAD Type II-Containers. Before cutting the RPV segments, the surrounding internals of the Drywell are cut and packaged also into KONRAD Type II-Containers. After dismantling the Drywell internals and the RPV, the Drywell itself is cut into pieces and packaged, starting from the top and ending with the bottom part.

At the beginning of the dismantling work substantial installations and preparatory works are necessary on the reactor building operating deck (level F) and in the reactor vessel pit itself; e.g.:

- Erection of a caisson (shielding and separate ventilation system);
- Installation of remote-controlled equipment and cutting tools comprising control panels;
- Installation of cameras;
- Improvement of the fuel loading bridge.

The investments for dismantling of the activated parts (RPV internals, RPV, Drywell internals and Drywell) are given in Table 10-8 under No. 17 and 18.

7.7.3 Biological Shield

The radioactive part of the biological shield is dismantled by means of the rope sawing method together with a blade saw. With this technique a rope is pulled through holes drilled in the concrete. On the surface of the rope there are very hard materials placed in defined distances. Diamonds, very hard metals or ceramics have been applied up to now. This rope is led through deflection pulleys to a drive unit. There is the possibility to detach square meter large pieces which may then be demolished in a work shop using appropriate cutting tools. See No.19 in Table 10-8 for all necessary investments to remove the biological shield.

7.7.4 Dismantling of Non-Nuclear Equipment and Buildings

The building structures will be dismantled with conventional techniques and procedures under consideration of the relevant technical rules and prescriptions. As far as possible the different waste categories will be separated (concrete, masonry, etc.).

The present section describes the procedures to be followed in the non-nuclear buildings and in the nuclear buildings after nuclear clearance.

The conventional dismantling includes:

- Preparation of a report on toxic substances;
- Preparation of the dismantling and demolishing;
- Removal of toxic substances such as asbestos and other mineral fibres;
- Removal of toxic substances from operation such as spilled oil;
- Dismantling and demolishing of the buildings;
- Separation of the material fractions;
- Site Recovery.

7.8 Summary of selected Decontamination and Dismantling Techniques

To give a short overview, a list summarizing the selected main decontamination and dismantling techniques is following:

Decontamination Techniques:

- Dry blasting in a special caisson;
- Grinding / Scarifying;
- Hands on decontamination like scrubbing or wiping incl. the possibility of using decontamination cleansers.

Dismantling Techniques:

- Blade saw;
- Band saw / circular diamond saw;
- Diamond rope saw
- Angle grinder
- Hydraulic shear
- Shredder (cables)
- Acetylene cutting technique
- Plasma arc cutting technique

7.9 Figures

Figure 7-1: Decontamination by high pressure water (Picture by courtesy of EWN)

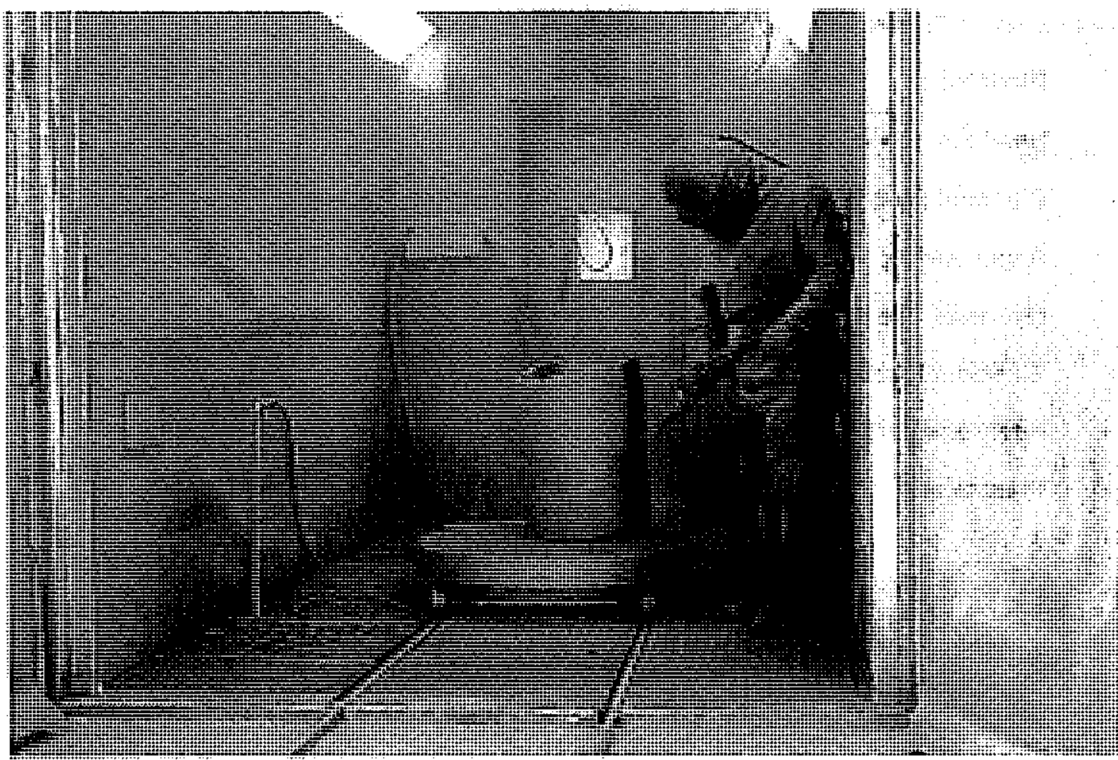

Figure 7-2: Dry blasting decontamination (Picture by courtesy of EWN)

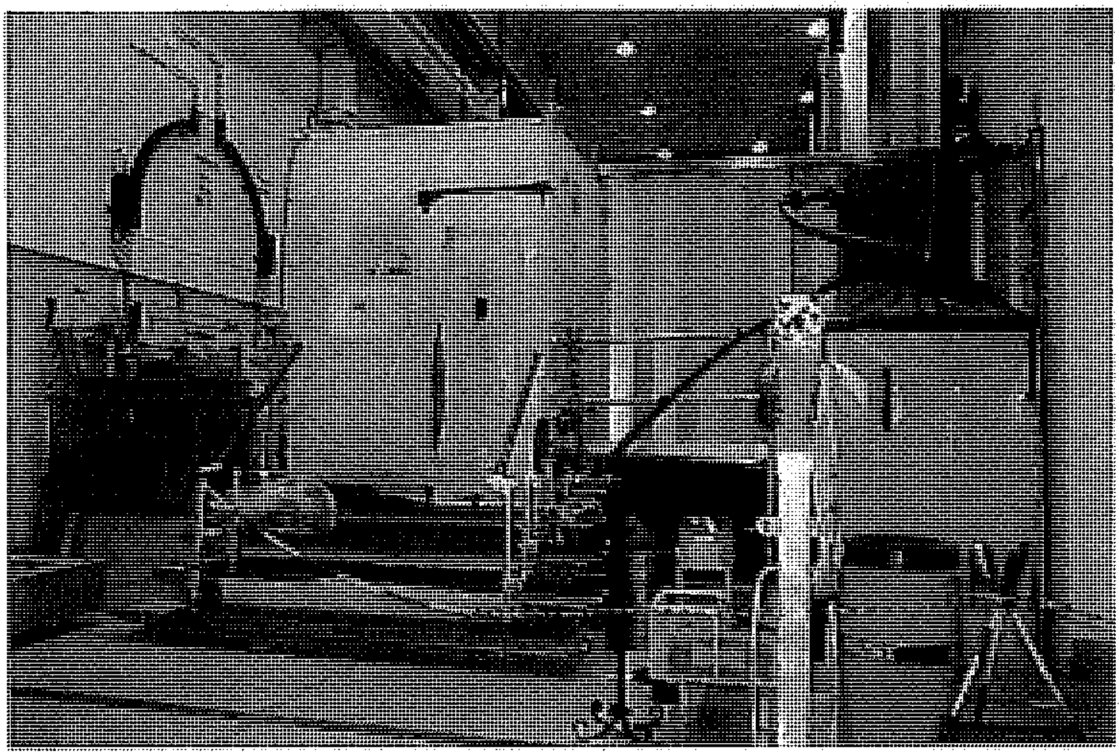

Figure 7-3: Blasting caisson at NPP Kahl

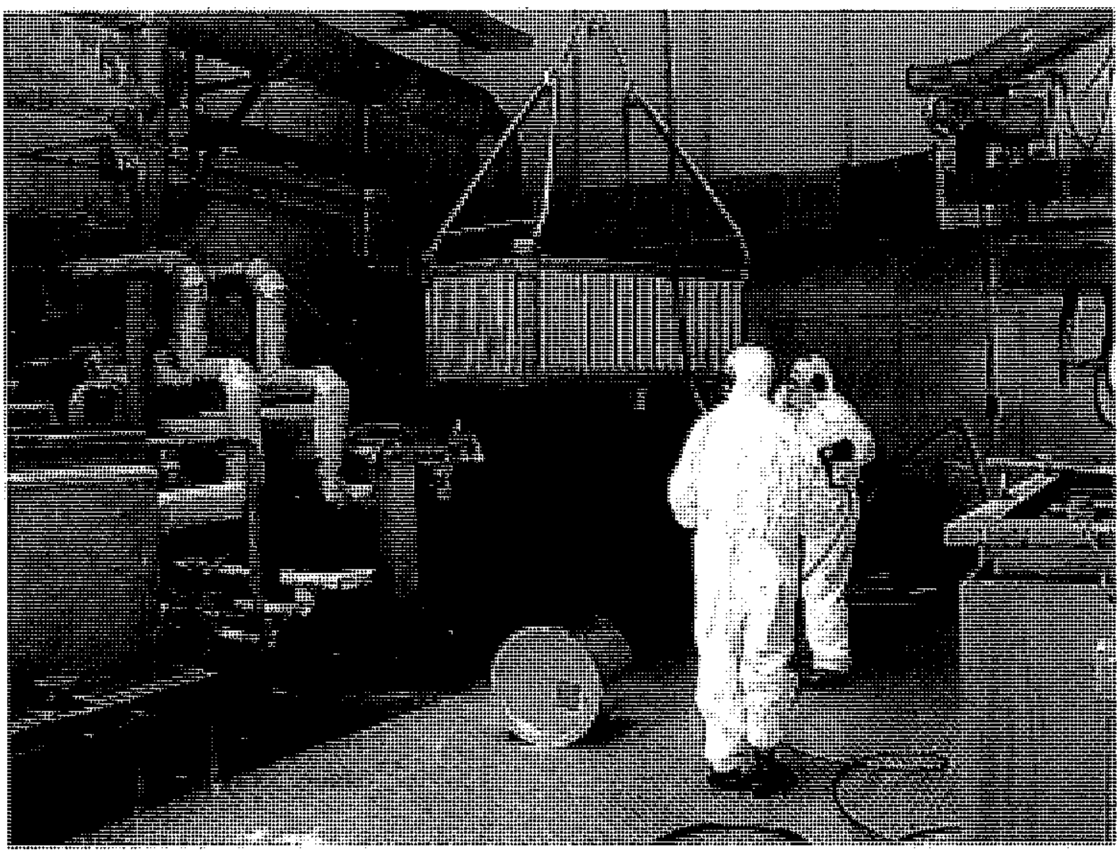

Figure 7-4: Chemical decontamination (Picture by courtesy of EWN)

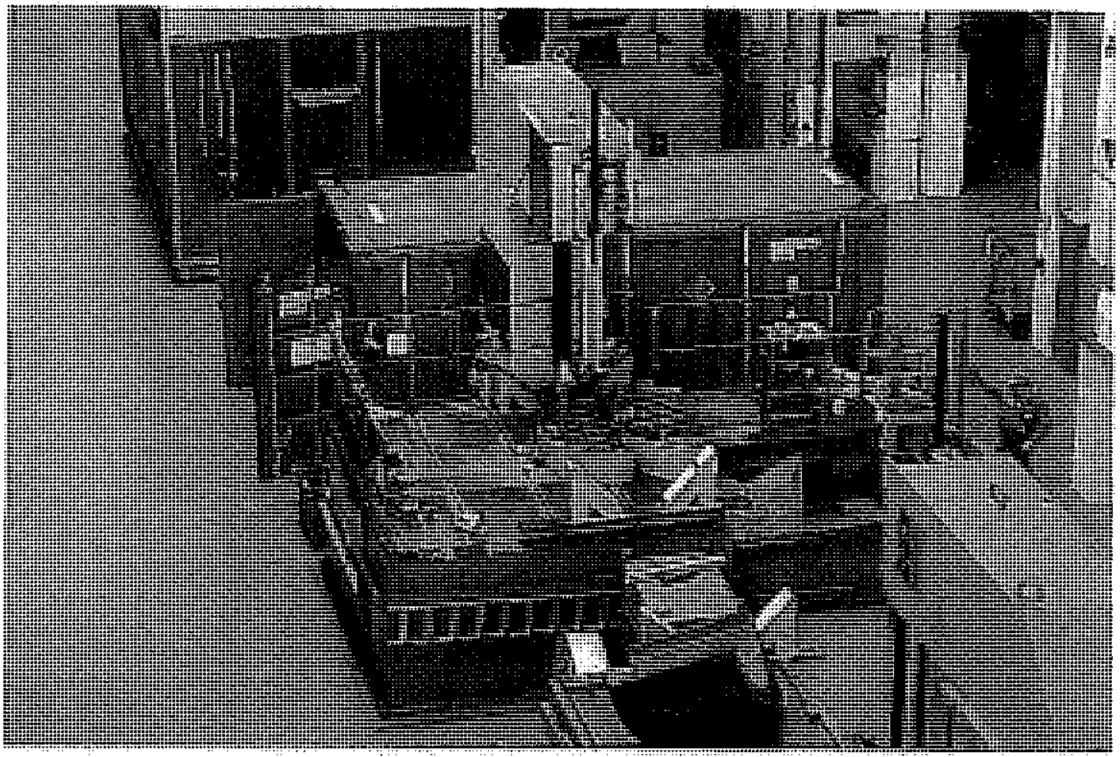

Figure 7-5: Band saw (Picture by courtesy of EWN)

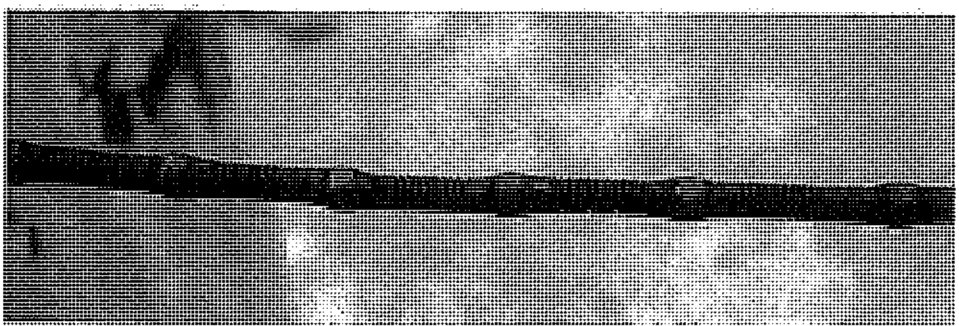

Figure 7-6: Cutting wire with diamond "Pearls" and distance springs

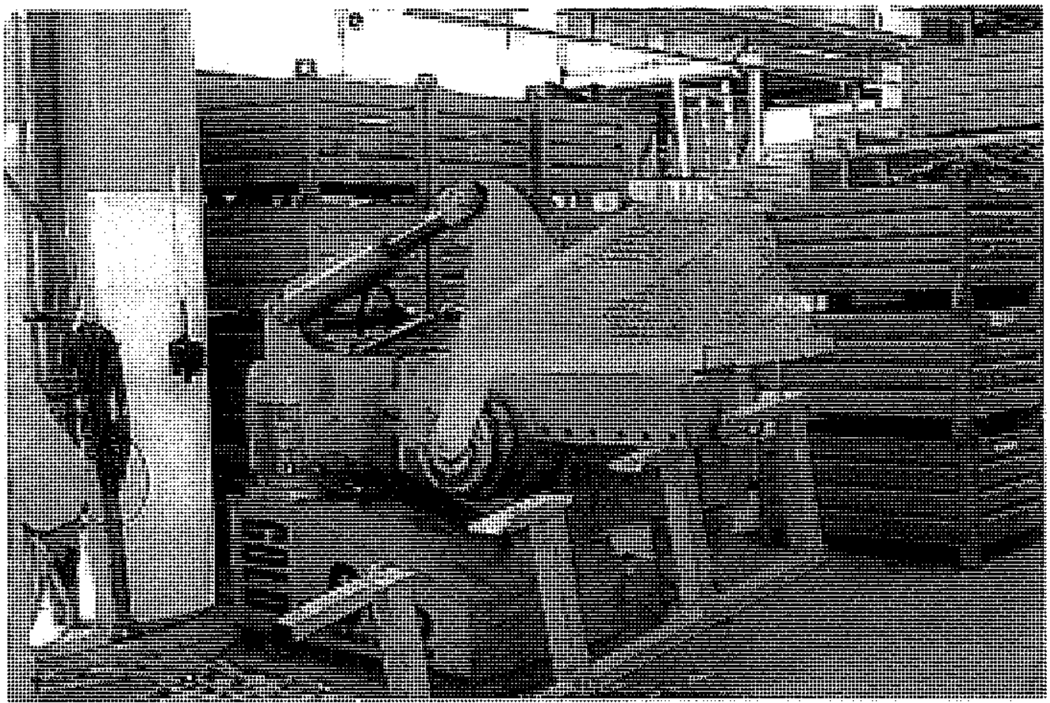

Figure 7-7: Hydraulic shear (Pictura by courtesy of EWN)

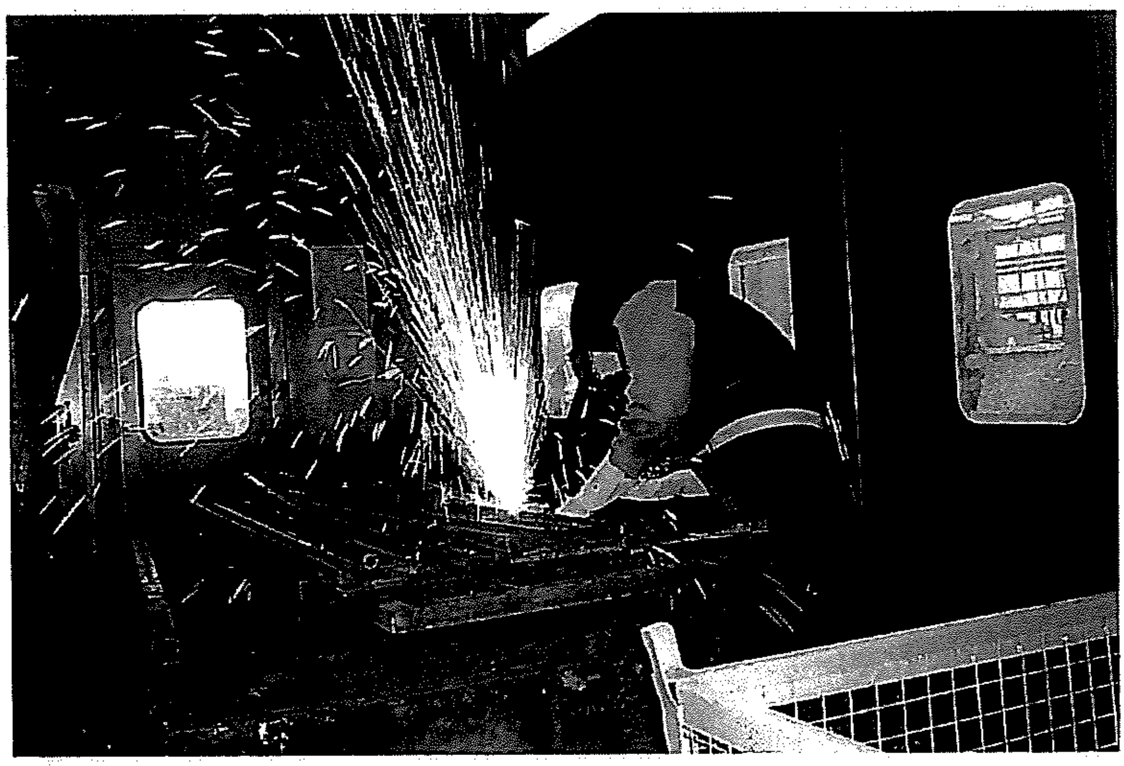

Figure 7-8: Thermal cutting (Picture by courtesy of EWN)

8 Waste Management

8.1 Basic Considerations

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

- Release of non-radioactive material for industrial recycling, if necessary a decontamination treatment can be applied before;
- Preparation for final repository of radioactive waste, so called conditioning and packaging;
- Preparation for conventional repository of non-radioactive waste.

Also several groups of material will be generated. The main groups, entitled by the origin, are:

- Primary masses:
  Components and structures contained in the NPP at the final shutdown (this group contains all masses stored in DIS and transferred to CORA).
- Secondary masses:
  All material which are generated during the D&D work, i.e. consumables, plastic foils, clothes, air filters, worn tools, solids from decontamination, etc.
- Tertiary/additional masses:
  New buildings, tools and equipment used for the D&D work, but possibly reusable for other D&D projects (e.g. super-compactor).

8.2 Qualitative and Quantitative Estimate of Dismantling Masses

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 can not be released from nuclear constraints.
- Conventional waste:
  Material that is free from nuclear constraints, but there are other (non-nuclear) reasons why this material must be treated as waste.

8.2.1 Mass distribution factor sets

Thousands of different components have to be considered for the D&D planning. For the calculation of the D&D costs one must decide what will be done with these components: 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. In CORA / CALCOM this is done via the so called mass distribution factor sets (DF sets). The concept of the DF sets is explained in the following.

A DF set indicates what will be done with the component and how the resulting waste will be packed. If needed, a separate DF set can be defined for each individual component, but in most cases a DF set serves for several components.

As an example the DF for "contaminated cable trays with cables" gives:

- 35% are reused after treatment (shredding), this is the copper part of the cables;
- 30% are packaged after shredding and super-compaction (e.g. insulation of cables);
- 20% are released after measuring without a special decontamination (steel from cable trays);
- 10% are released after mechanical decontamination (steel from cable trays);
- 5% are packaged after super-compaction (e.g. parts of cable trays).

For a first evaluation each component listed in CORA (about 5750 different items) has been allocated with a DF set. All DF sets which are used are given in Appendix 1 as a printout of CORA.

Three possible destinations of the dismantled materials have been considered:

- Unrestricted release / landfill (cleared material);
- Reuse, as non-radioactive (cleared) material;
- Final repository.

Taking into account the DF sets Table 8-1 (KEW) and Table 8-2 (IAEA) give an overview about the masses for the different destinations.

The tables show that about 17 % (KEW) or 20 % (IAEA) of the plant inventory (incl. the new installations) has to be stored as radioactive waste. Considering the total plant masses (incl. building structures, see Table 2-6) less than **2 %** will be radioactive waste.

8.2.2 Size specific classification of physical input data

An effort is made to consider the influence of the component size on the dismantling work and on the decision on what will be done with the dismantling components.

Therefore the system components are classified in three groups:

- Small;
- Medium;

- Large.

The assumed criteria used for the classification of pipes, valves, pumps, vessels and heat exchangers are listed in Table 8-3.

8.3 Waste Management Strategy

8.3.1 Dismantled components

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, Drywell and Biological Shield) all other dismantled parts are pre-sorted (e.g. materials) and transported to the treatment area in the Turbine building. The selected transport routes are shown in Figure 8-1 to Figure 8-7. 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.

The treatment area is prepared in the Turbine building. The considered area is shown in Figure 8-8. Before the installation of the treatment equipment and facilities the present equipment is dismantled and the area is prepared for the new installations. By thoroughly checking building drawings and scrutinising the situation on site it has been verified that there is enough available room to buffer store the materials which had to be removed for the preparation of the treatment area (e.g. 22,2 m floor of the Turbine building). Treatment methods and techniques are combined to the actual needs. It includes:

- 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 can not be removed. Then one will try to separate the contaminated portion from the rest, to minimise the amount of radioactive waste.

- Super-Compaction:
  Super-compaction is done to reduce the size (in m^3) 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 on-site. Therefore a mobile super-compactor is installed in the Turbine building (see section 8.7). An alternative to the treatment on-site is to carry out the super-compaction at COVRA, but this is depending on the amount of material for super-compaction and the available duration for the performance of the work. The buffer storage capacities at COVRA are limited. Due to the extended decommissioning period (compared to the previous studies /1/, /2/) there might be a cost benefit in transporting the waste to COVRA for treatment (potential savings up to 10 [redacted] might be possible). This issue has to be revisited very carefully at the time of the execution of the decommissioning project as soon as the real amount and duration for treatment are better known.

- 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.

- 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:
  Combustible waste will be sent to an incineration facility. Incineration leads to a reduction in mass and in volume of the waste. After incineration the radioactive particles will be concentrated in the ashes and in the air filters. About 35,6 Mg of combustible waste have been taken into account in the present study.

- Liquid waste treatment:
  The liquid waste is collected in a storage tank. Batch wise the contaminated liquids are transported to COVRA (using 60-l drums) for further treatment. In the present study is assumed that in average about 6.500 litres of radioactive liquids per year have to be transported and treated. No liquid treatment on site is foreseen. Non-contaminated liquids are measured and discharged to the river.

Depending on the origin of the dismantled parts and what is known about their physical, chemical and radiological properties, the operators of the treatment area will decide how to treat and condition the parts. For example:

- A specific component may be cut to smaller pieces, some of its parts may be decontaminated, another portion may be packed as radioactive waste and a third part may be super-compacted and then packed;
- Some other equipment may be cleared after clearance measurements;

– Some other structures may never have been in the controlled area, and they require no treatment at all. If they are not to be treated as conventional waste, they can be cleared for reuse.

The above said is reality in D&D projects, and – with few exceptions – it appears to be impossible to decide in advance what's to be done exactly with a specific component. But there are experiences which can be used to predict what will be needed for specific types of components. The NIS software uses the concept of so-called "Distribution Factor Sets" (DF-Sets) which describe what, as an average, will happen to the components they are assigned to (see section 8.2.1 and Appendix 1).

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 (see section 8.5). Otherwise it has been packed into the containers for transport, interim storage at COVRA and later disposal.

8.3.2 Decontamination of Building Structures

Decontamination of building structures is completely different from decontamination of components and equipment that was treated in the previous section.

The surfaces of the building structures inside the controlled area are decontaminated by removing the surface layer where contamination is suspected.

Regarding the removal of surface layers following assumptions have been taken into account (derived from NIS experience with real D&D projects):

– Floors – contamination > 0,4 Bq/cm²: 100 % of the surface are removed (20 mm);

– Floors – contamination <= 0,4 Bq/cm²: 25 % of the surface are removed (20 mm),

– Walls – contamination > 0,4 Bq/cm²: 20 % of the surface are removed (2 mm),

– Walls – contamination <= 0,4 Bq/cm²: 10 % of the surface are removed (2 mm);

– Ceilings: no surface removal assumed.

The building structures are then measured for clearance as a whole, in situ (see section 8.6.2).

After clearance from nuclear regulations, the building structures are dismantled under conventional conditions.

8.4 Packaging Concept / Containers

Radioactive waste is packaged regarding the acceptance requirements of COVRA. Main boundary conditions are:

– The maximum total weight of a filled storage container is below 15 Mg.

– The contents of the storage containers and 200-l drums are immobilized with cement. Only the MOSAIK containers are not filled with cement.

- The dose rate for transportation are below the limits of the International transport regulations, i.e.:
  - 2 mSv/h at surface of the transport package
  - 0,1 mSv/h a 2 m distance from the transport package
- The 200-l drums and the 1000-l containers themselves can have higher surface dose rates, but the transport, interim storage and disposal fees are depending on the surface dose rates. In the present study following dose rates have been considered:
  - 200-l drum with a surface dose rate <= 0,2 mSv/h
  - 200-l drum with a surface dose rate > 0,2 <= 2,0 mSv/h
  - 200-l drum with a surface dose rate > 2,5 <= 4,0 mSv/h
  - 1000-l container with a surface dose rate > 0,2 <= 2,0 mSv/h
- 90-l drums for super-compaction are used to ensure the stackability of the immobilized 200-l drums (eightfold stacking must be possible).
- Standard 60-l drums are used for the transportation of radioactive liquid waste.
- Lead as an additional internal shielding should not be used (in the present study only concrete or steel have been used as additional shielding).

Except the activated parts (e.g. RPV-internals, RPV), which are packaged directly at the dismantling place, all other radioactive waste is packaged and immobilized with concrete in the treatment area of the Turbine building. Mainly 200-l drums and KONRAD containers are used. The filling rate of the drums and containers is considered with 20 % for metallic and mixed materials and with 40 % for concrete rubble. The loaded masses, that means which mass of the dismantled materials are loaded into the different packages, can be taken from Appendix 1.

Containers used for the packaging of the radioactive waste are:

- 90-l drum (press drum for super-compaction);
- 60-l drum (for transport of liquid waste to COVRA);
- 200-l drum;
- 1000-l container;
- MOSAIK Type II container;
- KONRAD Type II container.

Examples of the different drums and container types are shown in Figure 8-9 to Figure 8-15. The main dimensions are given in Table 8-4.

KONRAD Type II containers are currently not licensed in the Netherlands. It was agreed by VROM these packages can be brought forward for licensing as long as these packages are licensed in Germany. COVRA agreed to accept these packages.

Table 8-5 to Table 8-7 show the results of an estimation of the maximum specific activity [Bq/g] of Co-60 which can be packaged in a MOSAIK Type II-, in a KONRAD Type II-Container or in a 1000-l Container to comply with the transport regulations. The results are given for different shielding thicknesses and materials. The highlighted types in the different tables are used for the present study.

Table 8-8 gives the maximum specific activity [Bq/g] of Co-60 for a 200-l drum to comply with the different COVRA limits for transportation, interim storage and disposal.

As mentioned above also the type and number of packages have been evaluated by using these DF. The results of the evaluation for the primary masses are shown in Table 8-9 for Task 1.1.1 (Best estimate using clearance levels from the Dutch Kernenergiewet) and in Table 8-10 for Task1.1.2 (Best estimate using clearance levels from IAEA RS-G-1.7).

8.5 Clearance Measurements

8.5.1 Measurement Equipment

8.5.1.1 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 smooth, then samples can be taken from representative surfaces.

8.5.1.2 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 radiating nuclides (alpha, or pure beta radiators).

8.5.1.3 Total Gamma Measurement

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

8.5.1.4 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.

8.5.1.5 In-Situ Gamma Measurements

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.

8.5.1.6 Nuclide Specific Gamma Measurements (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.

8.5.1.7 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 radio nuclides, 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.

8.5.1.8 Germanium Detectors for Clearance of Material

Germanium detectors are semiconductor diodes having a P-I-N structure in which the Intrinsic (I) region is sensitive to ionizing radiation, particularly X-rays and gamma rays. Under reverse bias, an electrical field extends across the intrinsic or depleted region.

When photons interact with the material within the depleted volume of a detector, charge carriers (holes and electrons) are produced and are swept by the electrical field to the P and N electrodes. This charge, which is in proportion to the energy deposited in the detector by the incoming photon, is converted into a voltage pulse by an integral charge sensitive preamplifier. Because germanium has a relatively low band gap, these detectors must be cooled in order to reduce the thermal generation of charge carriers (thus reverse leakage current) to an acceptable level. Otherwise, leakage current induced noise destroys the energy resolution of the detector. Liquid nitrogen, which has a temperature of 77 K is the common cooling medium for such detectors.

The detector is mounted in a vacuum chamber which is attached to or inserted into a liquid nitrogen Dewar or an electrically powered cooler. The sensitive detector surfaces are thus protected from moisture and condensable contaminants.

8.5.1.9 Preamplifiers for Germanium Detectors

There are only two basic types of preamplifiers in use on Ge detectors. These are charge sensitive preamplifiers that employ either dynamic charge restoration (RC feedback) or pulsed charge restoration (Pulsed optical or Transistor reset) methods to discharge the integrator.

Pulsed Optical Reset preamplifiers are widely used on low energy detectors where resolution is of utmost consideration. Eliminating the feedback resistor decreases noise without a serious impact on dead-time, as long as the average energy per event is low to moderate.

At 5.9 keV per event, a preamplifier may process almost 1000 pulses between resets. Since the reset recovery time is 2-3 amplifier pulse widths, little data is lost in this situation. Optical feedback systems can, however, exhibit long recovery times due to light activated surface states in the FET.

Proper selection and treatment of components can minimize the problem, but it is generally present to some degree in pulsed optical systems. With high energies, where resets necessarily occur very often, perhaps after as few as 10 events, this spurious response can be a serious problem. As a consequence, pulsed optical feedback systems are not in general used with coaxial detectors.

The Transistor Reset Preamplifier was developed in an attempt to overcome the problems associated with pulsed optical reset preamplifiers in high energy, high rate systems. The feedback capacitor is discharged by means of a transistor switch connected to the FET gate. This transistor adds some capacitance and noise to the input circuit but this is tolerable in most applications involving high count or energy rates. Compared to an RC preamplifier with selected feedback resistor for high rate performance, the transistor reset preamplifier will exhibit less noise but will sacrifice dead time because the amplifier will require 2-3 pulse widths to recover from the periodic reset of the preamplifier.

8.5.2 Clearance Concept

A site specific clearance concept will be prepared as a basis for the clearance of material from the controlled area. The clearance concept will cover the specification of the clearance measurement equipment, the agreements with the authorities, the description of the measurement and clearance procedures and the documentation of the results and decisions.

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.

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.

8.5.3 Clearance for Transportation

A special type of clearance is the clearance for the transportation of radioactive material. Measurements will be made to demonstrate that the individual packages are below the limits for transportation, and also the complete batch (for example a truck with several waste packages) will be measured. The procedures to be followed and the limits to be complied with will be described in a working directive.

8.6 Clearance of Components, Equipment, Buildings and Site from Nuclear Regulations

8.6.1 Clearance of Components and Equipment

Components and equipment to be cleared are cut and decontaminated, if needed, and then sent to the decision measurement station. The decision measurements will be performed per batch. The clearance directives will be complied with, and all measurements will be documented. Portions that can not be cleared will be removed from the batch and sent back to the waste conditioning station.

The documentation for the batch will be presented to the authority or its representation. They can check the documentation and can perform independent measurements. After clearance by the authority the batch is free from nuclear regulations and is handed over to a qualified recycling company.

8.6.2 Clearance of Nuclear Buildings (Removal of Controlled Area)

Building structures will be decontaminated, if needed, and cleared in situ. The dismantling can then be done under conventional conditions.

When all components and equipment are removed from a specific area, and the modified ventilation and media supply systems are in operation (pressurised air, electrical energy, and illumination), this area is separated from the rest of the controlled area. Pre-measurements are performed to decide about the decontamination techniques for the building. The relevant directives will be complied with.

After the decontamination of the area (bottoms, walls, ceilings as decided on the basis of the pre-measurements) the plant operator will measure the complete area and prepare a detailed report with the measuring results. The authority can check the documentation and can perform independent measurements. When all rooms of a separated area are measured and the authorities have confirmed their agreement, the area can be released from controlled area constraints. The controlled area specific measures such as access control and ventilation with under-pressure are not required anymore in this area.

Measurements will also be performed on the removed material (concrete rubble). The authority can check the documentation and can perform independent measurements. Cleared material is handed over to a qualified recycling company.

8.6.3 Clearance of Non Nuclear Buildings and Site

Spot tests will be performed to prove that the non nuclear buildings and the surroundings (streets, free areas) are free from nuclear contamination. The techniques to be used and the samples to be taken (location, specification and number) will be described in a technical report that will be agreed upon with the authority.

Individual rooms in non nuclear buildings which are suspected of possible contamination will be checked carefully and samples will be taken as if they belonged to the controlled area. If necessary they will be decontaminated.

The present study is based on the assumption that outside the controlled area no contamination will be found that could have a significant impact on the D&D plan, on the time schedule or on the costs.

8.6.4 Clearance of Site from Nuclear Regulations

When all the aforementioned steps are performed for the site, it can be cleared from nuclear regulations. A report will be prepared describing the actual status of the site. The authorities will check the report and confirm the clearance from nuclear regulations.

The area and the activities on it are then ruled by the conventional regulations for industrial sites under dismantling.

8.7 Needed Installation and Equipment

New offices are installed in the existing control room and the former visitor room. Also a small canteen/cafeteria is planned in this area. Therefore the closed windows have to be reopened again (see No. 11 of Table 10-8).

The personnel access (e.g. sanitary area) and the radiation protection surveillance must be modified and adapted to the changing needs because of the higher number of working people on site. The area of the former switch yard is used for it. The area is modified and connected with the current main entrance point (see No. 4, 6, 7 and 12 of Table 10-8).

Ventilation, heating, energy supply and safety equipment must be adapted to the changing conditions during decommissioning and dismantling (see No.5 and 9 of Table 10-8).

A mechanical and electrical work shop is installed in the former Waste building. Also the buffer store for conditioned drums and containers is placed in the Waste building. The foreseen area was used as buffer store also during operation of the plant. A new door and handling devices have to be installed. A large forklift which can handle containers up to a weight of 20 Mg is used for transportation of the containers (see No. 3 and 10 of Table 10-8).

The treatment area is located in the Turbine building (see Figure 8-8). After removal of the present installation and after modification of the area new equipment is installed. The main equipments foreseen to treat the dismantled parts are as follows:

- Caisson for dry blasting (see section 7.3 and No. 14 of Table 10-8);
- Grinding / Scarifying area (see section 7.3 and No. 14 of Table 10-8);
- Decontamination place for hands on decontamination like scrubbing or wiping incl. the possibility of using decontamination cleansers (see section 7.3 and No. 14 of Table 10-8);
- Band saw / Frame saw (see No.15 of Table 10-8);
- Hydraulic shear (see No.15 of Table 10-8);
- Cutting torch (see No.15 of Table 10-8);

- Disassembling place (see No.15 of Table 10-8);
- Cable granulating plant (see No.15 of Table 10-8);
- Super-compactor (see No.16 of Table 10-8);
- Cementation plant (see No. 13 of Table 10-8);
- New building for free release measurements with measurement facility (see No. 1 and 2 of Table 10-8 and Figure 2-5);
- Entrance buffer storage (see No. 1 of Table 10-8 and Figure 2-5).

8.8 Tables

Destination	Mass [Mg] *)	Percentage
Cleared Material (e.g. Unrestricted release / Reuse / Landfill)	5.151	83%
thereof after decontamination	961	
Final repository	1.082	17%
Total	**6.233**	**100%**

*) Without building structures (see Table 2-6)

Table 8-1: Mass distribution according to the planned destination (Best estimate with Dutch (KEW) clearance levels)

Destination	Mass [Mg] *)	Percentage
Cleared Material (e.g. Unrestricted release / Reuse / Landfill)	4.965	80%
thereof after decontamination	961	
Final repository	1.268	20%
Total	**6.233**	**100%**

*) Without building structures (see Table 2-6)

Table 8-2: Mass distribution according to the planned destination (Best estimate with IAEA clearance levels)

Component type	Classification		
	Small	Medium	Large
Pipes	Dia <= 50 mm	Dia > 50 mm < 100 mm	Dia >= 100 mm
Valves	Mass <= 25 kg	Mass > 25 kg < 200 kg	Mass >= 200 kg
Pumps	Mass <= 25 kg	Mass > 25 kg < 200 kg	Mass >= 200 kg
Vessels	Mass <= 100 kg	Mass > 100 kg < 1000 kg	Mass >= 1000 kg
Heat exchangers	Mass <= 200 kg	Mass > 200 kg < 1000 kg	Mass >= 1000 kg

Table 8-3: Size classification of system components

Container type	Height [m]	Width [m]	Length [m]	Diameter [m]	Outer volume [m³]	Wall tickness [mm]	Material	Mass of empty drum or container [kg]
90-l drum	0,64			0,45	0,1	1,5	steel	10
200-l drum	0,93			0,58	0,2	1,0	steel	75
1000-l container (NC) / 60mm Fe	1,25			1,00	1,0	180 / 60	concrete / steel	2.120
KONRAD Type II	1,70	1,70	1,60		4,6	10	steel	1.500
KONRAD Type II / 180mm NC	1,70	1,70	1,60		4,6	10 / 180 / 10	steel / concrete /steel	6.300
KONRAD Type II / 180mm NC / 30 mm Fe	1,70	1,70	1,60		4,6	10 / 180 / 10 / 30	steel / concrete /steel	9.100
MOSAIK Type II / 100mm Fe	1,50			1,06	1,3	160 / 100	cast iron /steel	7.790

Table 8-4: Main dimensions of the drums and containers used

No.	Shielding Cast Iron	Steel	Lead	Inner Volume	Mass Waste	Specific Actvity (Co-60) 0,1 mSv/h 1 m distance	2,0 mSv/h Surface
	[cm]			[m³]	[kg]	[Bq/g]	
1	16			0,490	770	3,47E+05	2,09E+06
2	16	3		0,372	580	1,26E+06	7,52E+06
3	16	6		0,291	450	4,47E+06	2,69E+07
4	16	10		0,203	320	2,45E+07	1,45E+08
5	16	14		0,134	210	1,43E+08	8,25E+08
6	16		3	0,372	580	2,41E+06	1,48E+07
7	16		6	0,291	450	1,64E+07	1,03E+08
8	16		10	0,203	320	2,16E+08	1,36E+09
9	16		12	0,166	260	7,95E+08	4,97E+09
10	16		14	0,134	210	2,95E+09	1,82E+10

(shaded) = Used for the present study

Table 8-5: Specific activity for Co-60 in Bq/g for MOSAIK Type II-Container to comply with the transport regulations

No.	Shielding Steel 7,86 g/cm³	Concrete 2,35 g/cm³	Concrete 3,5 g/cm³	Concrete 4,2 g/cm³	Steel *) 7,86 g/cm³	Inner Volume	Mass Waste Concrete	Mass Waste Steel	Specific Actvity (Co-60) 0,1 mSv/h 1 m distance	2,0 mSv/h Surface
	[cm]					[m³]	[kg]	[kg]	[Bq/g]	
1	1					4,0		6300	1,52E+03	9,99E+03
2	1	18			1	2,0		3200	1,86E+04	1,86E+05
3	1	18			4	1,8		2800	5,71E+04	5,52E+05
4	1	18			11	1,2		1900	9,19E+05	9,46E+06
5	1		18		1	2,0		3200	4,93E+04	5,16E+05
6	1		18		4	1,8		2800	1,56E+05	1,71E+06
7	1		18		11	1,2		1900	2,62E+06	2,93E+07
8	1					4,0	3800		1,84E+03	1,17E+04
9	1					4,0	5600		1,55E+03	1,01E+04
10	0,5			18	1	2,0		3200	7,68E+04	8,62E+05
11	0,5			18	4	1,8		2800	2,46E+05	2,86E+06
12	0,5			18	8	1,5		2300	1,21E+06	1,42E+07

(shaded) = Used for the present study

*) In any case 1 cm is inner steel liner of concrete shielding, the other "cm" are additional shielding (i.e. 3 cm, 10 cm or 7 cm)

Table 8-6: Specific activity for Co-60 in Bq/g for KONRAD Type II-Container to comply with the transport regulations

No.	Shielding Concrete 2,35 g/cm³ [cm]	Shielding Concrete 3,30 g/cm³ [cm]	Shielding Steel [cm]	Inner Volume [m³]	Mass Waste [kg]	Specific Actvity (Co-60) 0,1 mSv/h 1 m distance [Bq/g]	Specific Actvity (Co-60) 2,0 mSv/h Surface [Bq/g]
1	18			0,286	450	3,25E+04	1,30E+05
2	16		3	0,219	340	1,15E+05	4,84E+05
3	18		6	0,164	260	3,96E+05	1,70E+06
4	18		9	0,118	190	1,41E+06	6,10E+06
5		18		0,286	450	7,35E+04	3,18E+05
6		18	3	0,219	340	2,64E+05	1,18E+06
7		18	6	0,164	260	9,18E+05	4,14E+06
8		18	9	0,118	190	3,31E+06	1,48E+07
9	18		0,15	0,207	320	4,02E+04	1,55E+05
10		18	0,15	0,207	320	8,92E+04	3,70E+05

(shaded) = Used for the present study

Table 8-7: Specific activity for Co-60 in Bq/g for 1000-l container to comply with the transport regulations

No.	Shielding Steel	Inner Volume [m³]	Mass Waste [kg]	Specific Actvity (Co-60) 0,1 mSv/h 1 m distance [Bq/g]	0,2 mSv/h Surface	2,0 mSv/h Surface	4 mSv/h Surface	10 mSv/h Surface
1	0,15	0,20	320	5,73E+03		1,12E+04		
2	0,15	0,20	320		1,12E+03			
3	0,15	0,20	320				2,25E+04	
4	0,15	0,20	320					5,62E+04

Table 8-8: Specific activity for Co-60 in Bq/g for 200-l drums to comply with COVRA limits

Container Type	Packed Mass [Mg]	Number of Container [-]	Storage Volume [m³]
1000-l Container (NC) / 60mm Fe	0,7	3	2,5
200-l Drum	472,8	2503	608,4
KONRAD Type II	750,6	149	686,8
KONRAD Type II / 180mm NC	127,4	42	195,7
KONRAD Type II / 180mm NC / 30 mm Fe	26,7	10	44,0
MOSAIK Type II / 100mm Fe	5,6	17	23,1
Total:	**1383,8**	**2724**	**1560,5**

Table 8-9: Container type, packed mass, number of containers and storage volume (Best estimate: Kememergiewet)

Container Type	Packed Mass [Mg]	Number of Container [-]	Storage Volume [m³]
1000-l Container (NC) / 60mm Fe	0,7	3	2,5
200-l Drum	472,8	2503	608,4
KONRAD Type II	936,0	197	912,4
KONRAD Type II / 180mm NC	127,4	42	195,7
KONRAD Type II / 180mm NC / 30 mm Fe	26,7	10	44,0
MOSAIK Type II / 100mm Fe	5,6	17	23,1
Total:	**1569,2**	**2772**	**1786,1**

Table 8-10: Container type, packed mass, number of container and storage volume (Best estimate: IAEA)

8.9 Figures

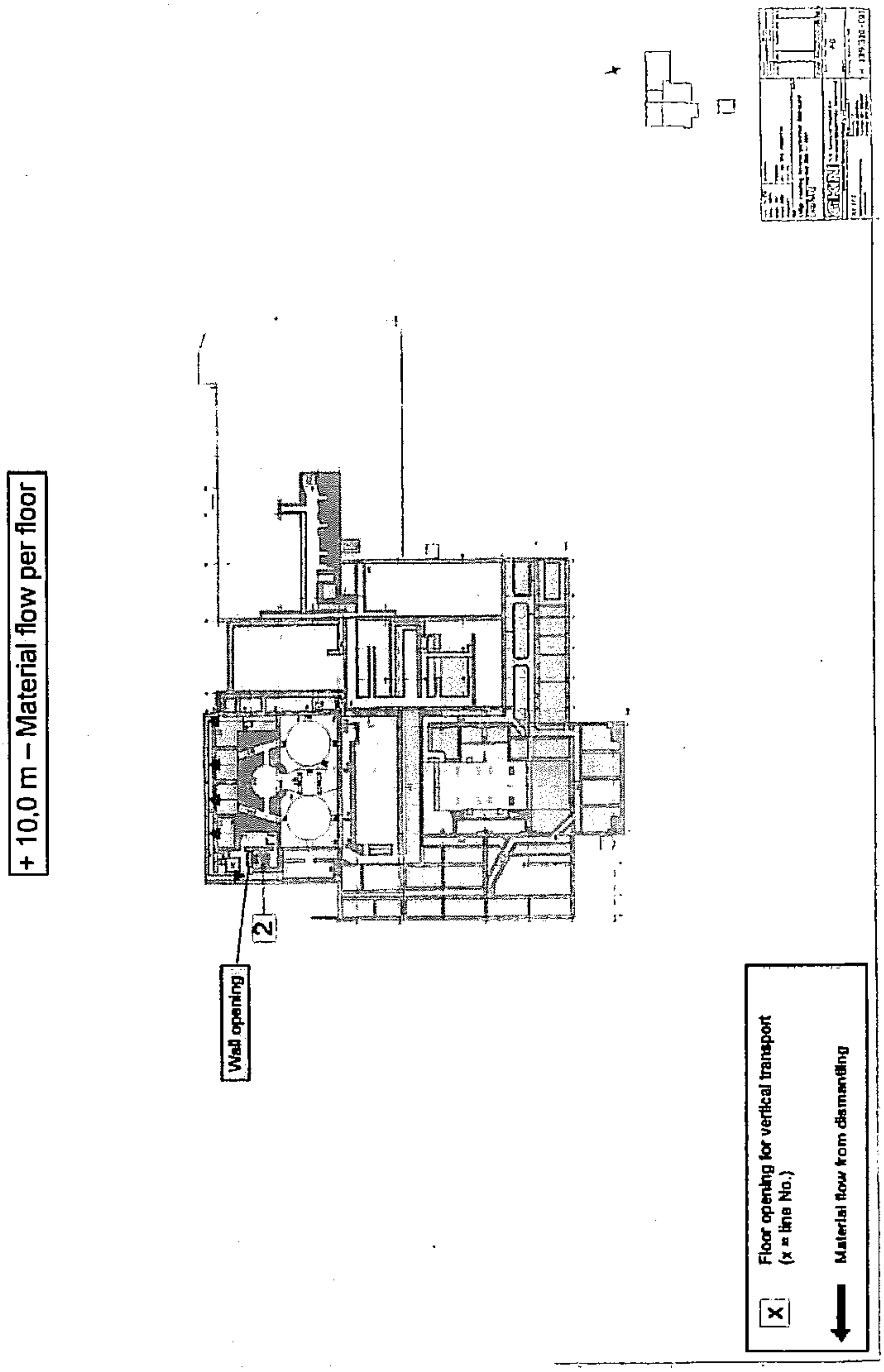

Figure 8-1: Transport routes (level A - 10,0 m)

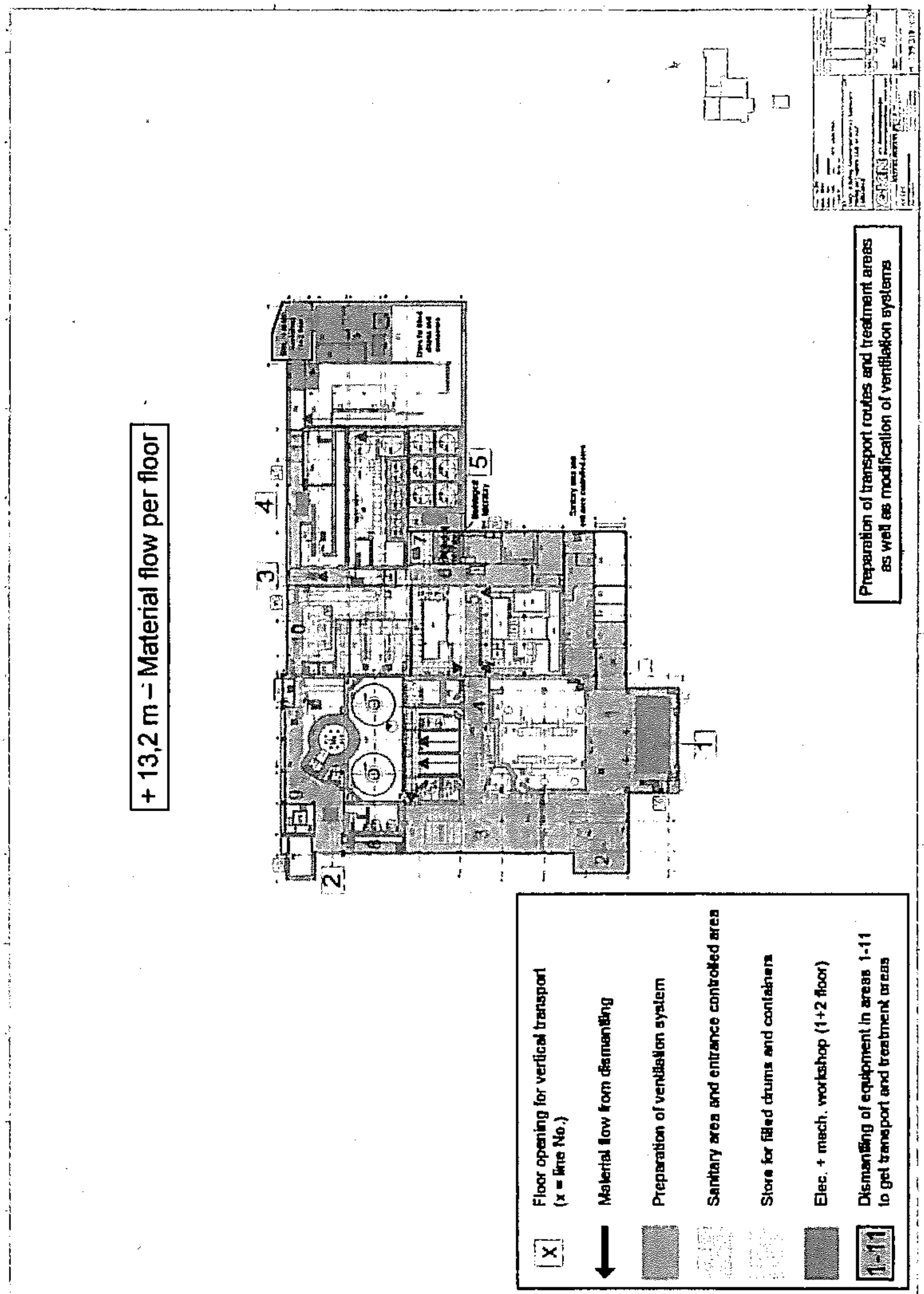

Figure 8-2: Transport routes (level B - 13,2 m)

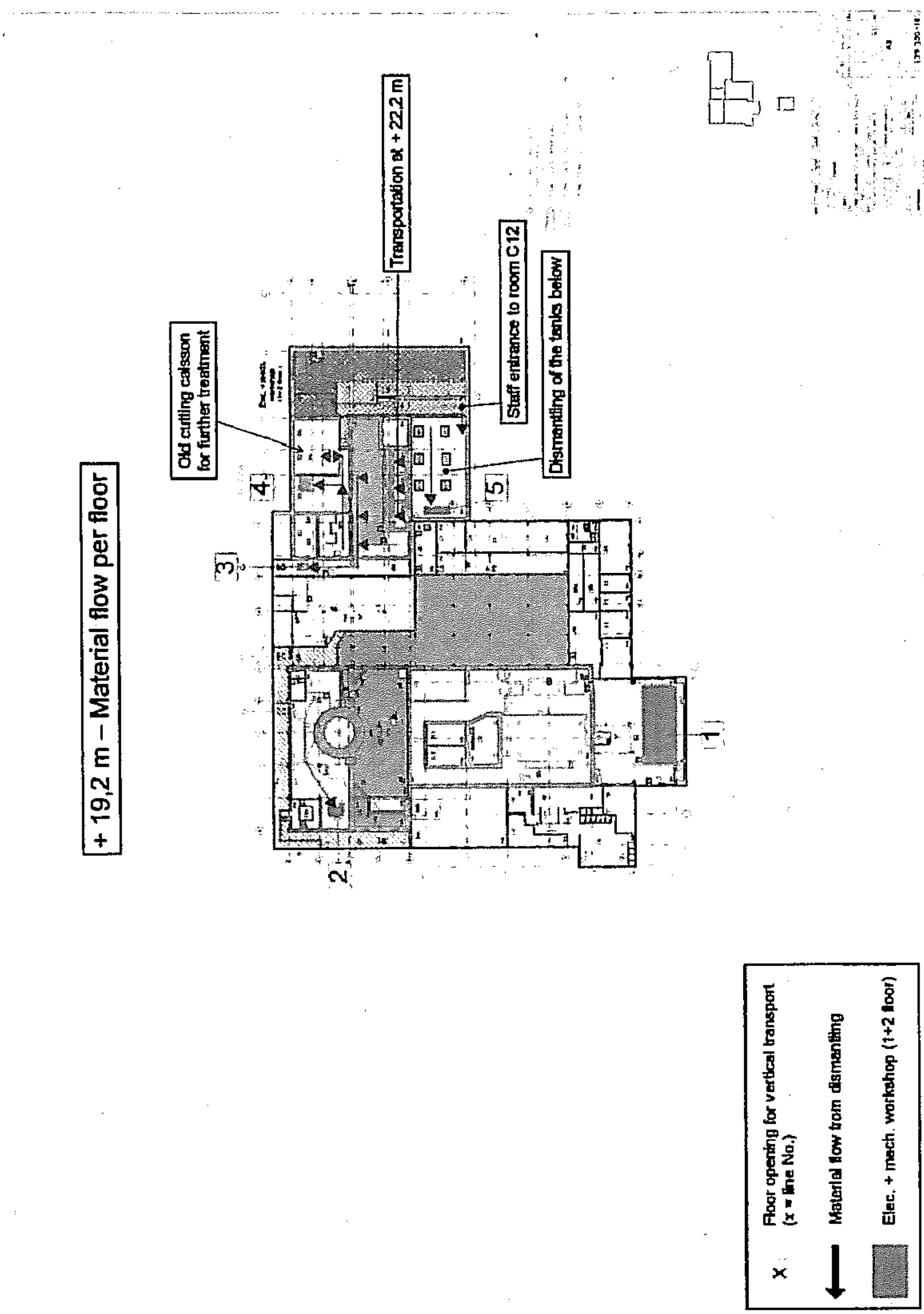

Figure 8-3: Transport routes (level C - 19,2 m)

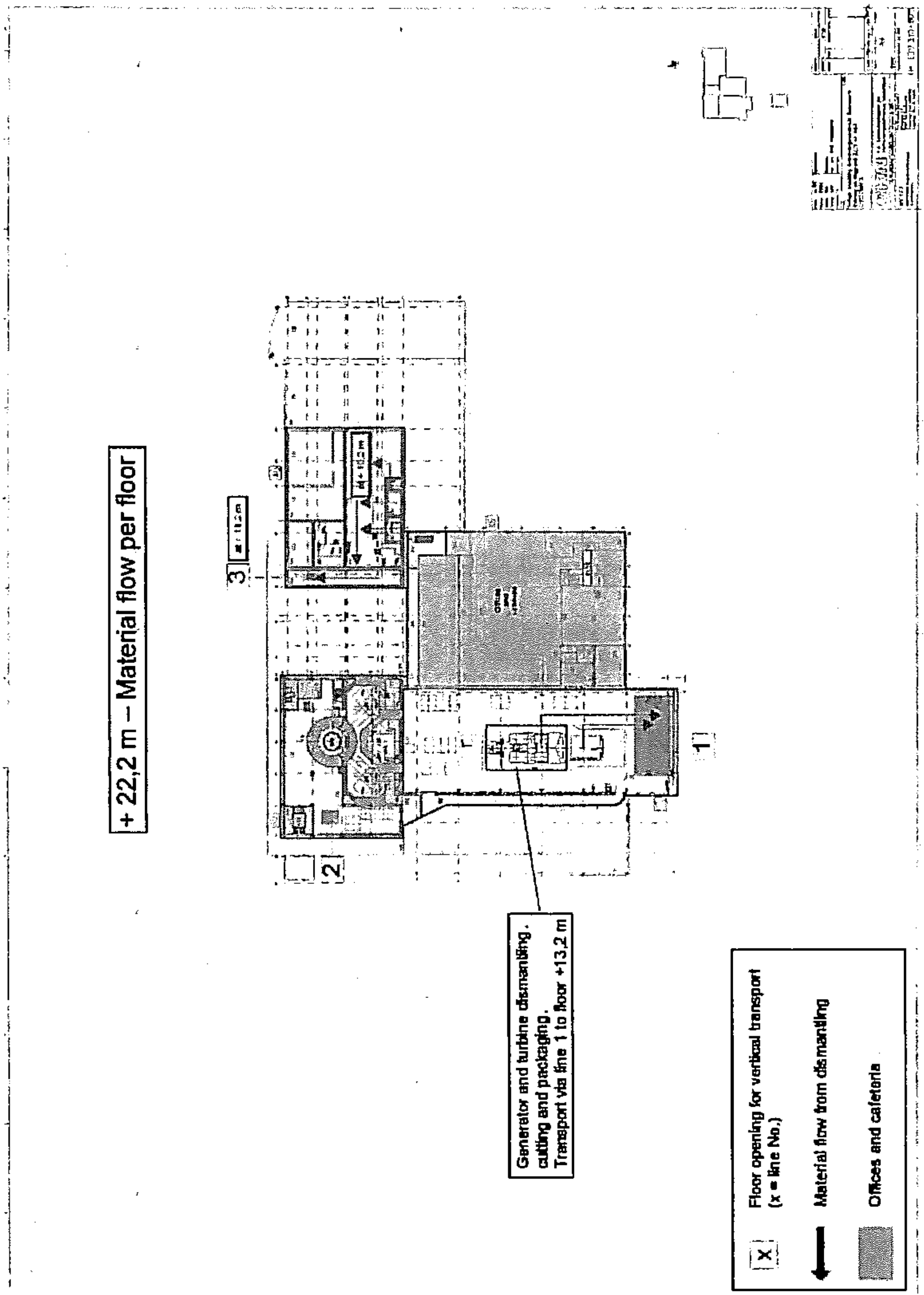

Figure 8-4: Transport routes (level D - 22,2 m)

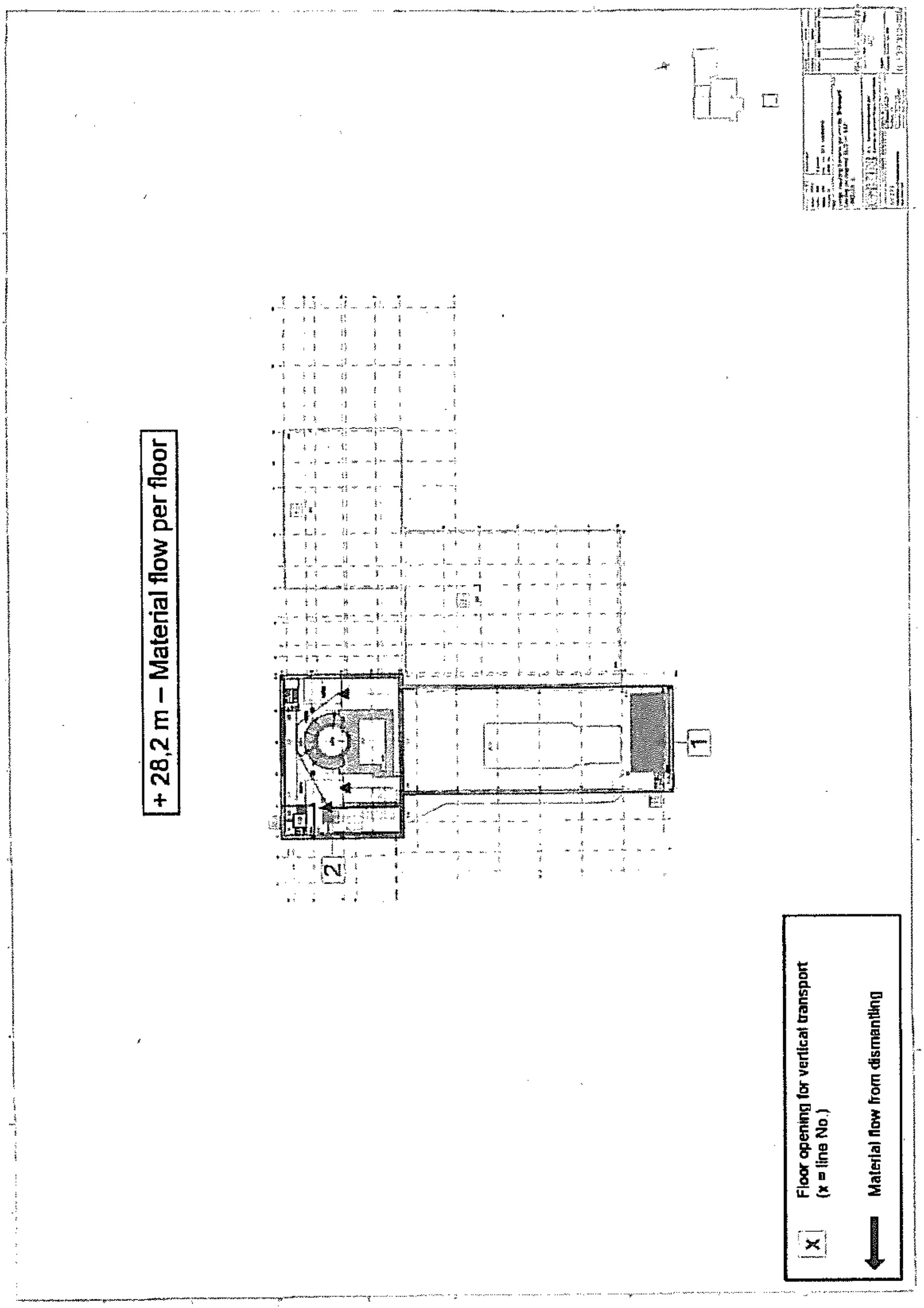

Figure 8-5: Transport routes (level D - 28,2 m)

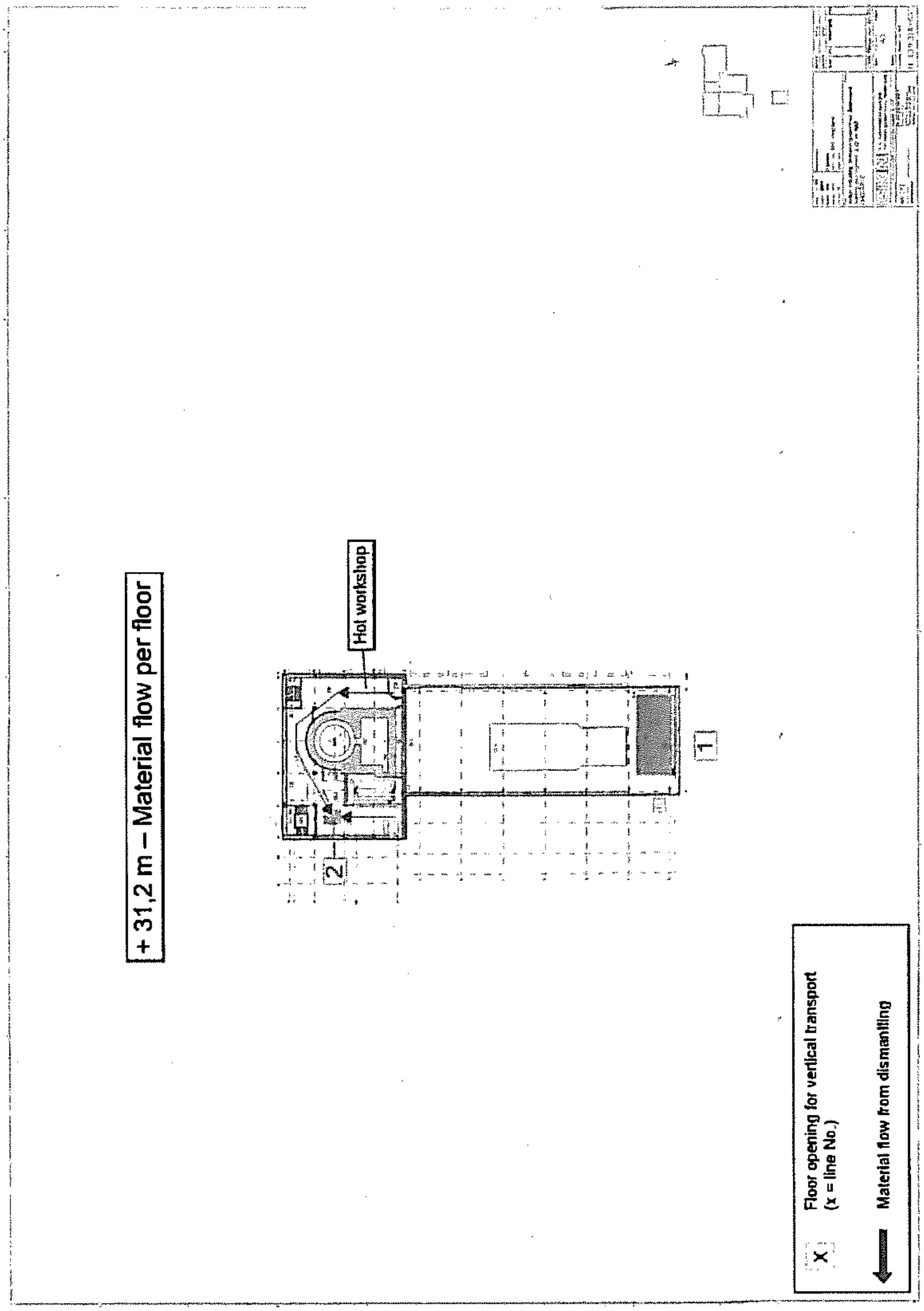

Figure 8-6: Transport routes (level E - 31,2 m)

Figure 8-8: Layout of treatment area (Turbine building level B – 13,2 m)

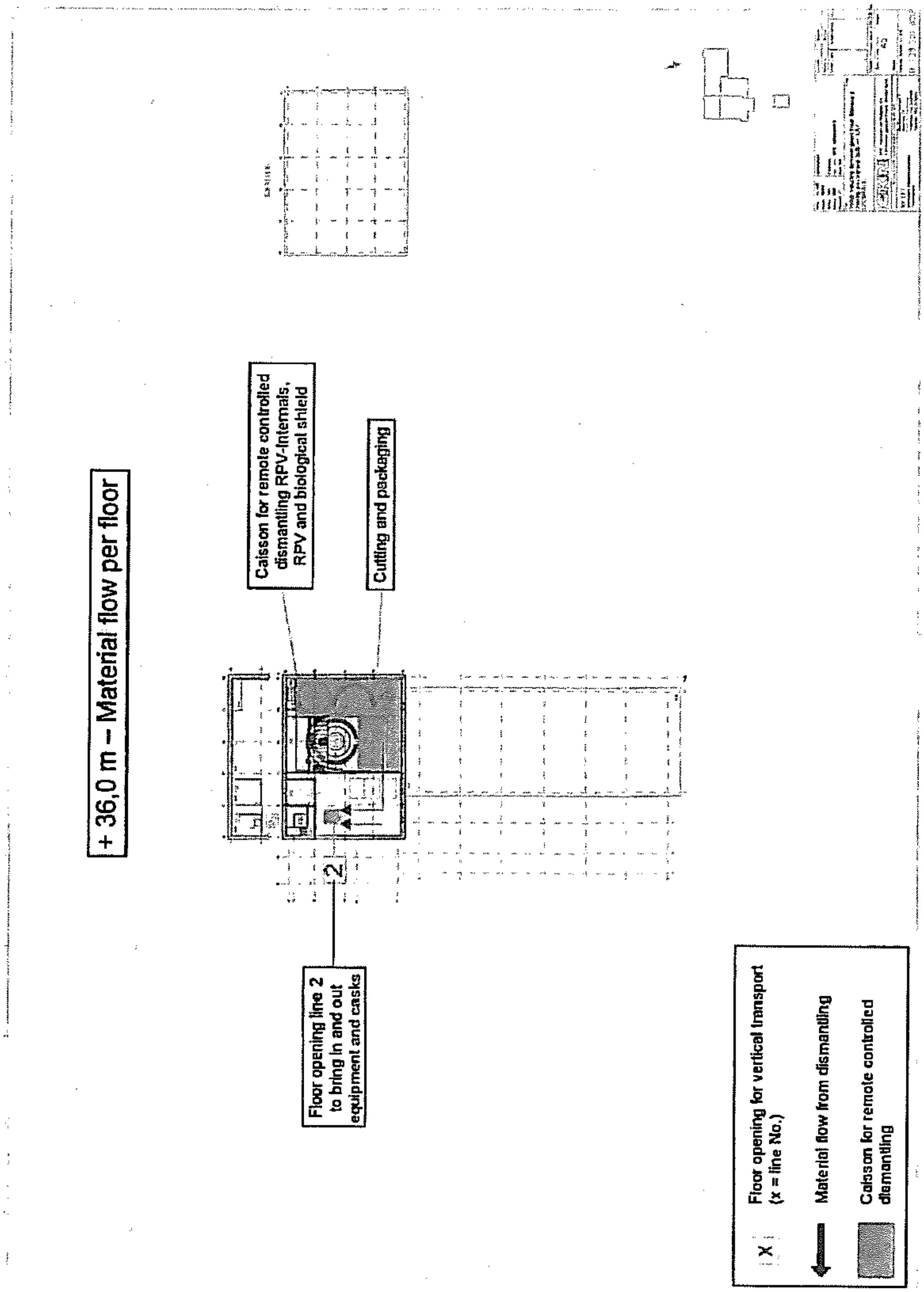

Figure 8-7: Transport routes (level F - 36,0 m)

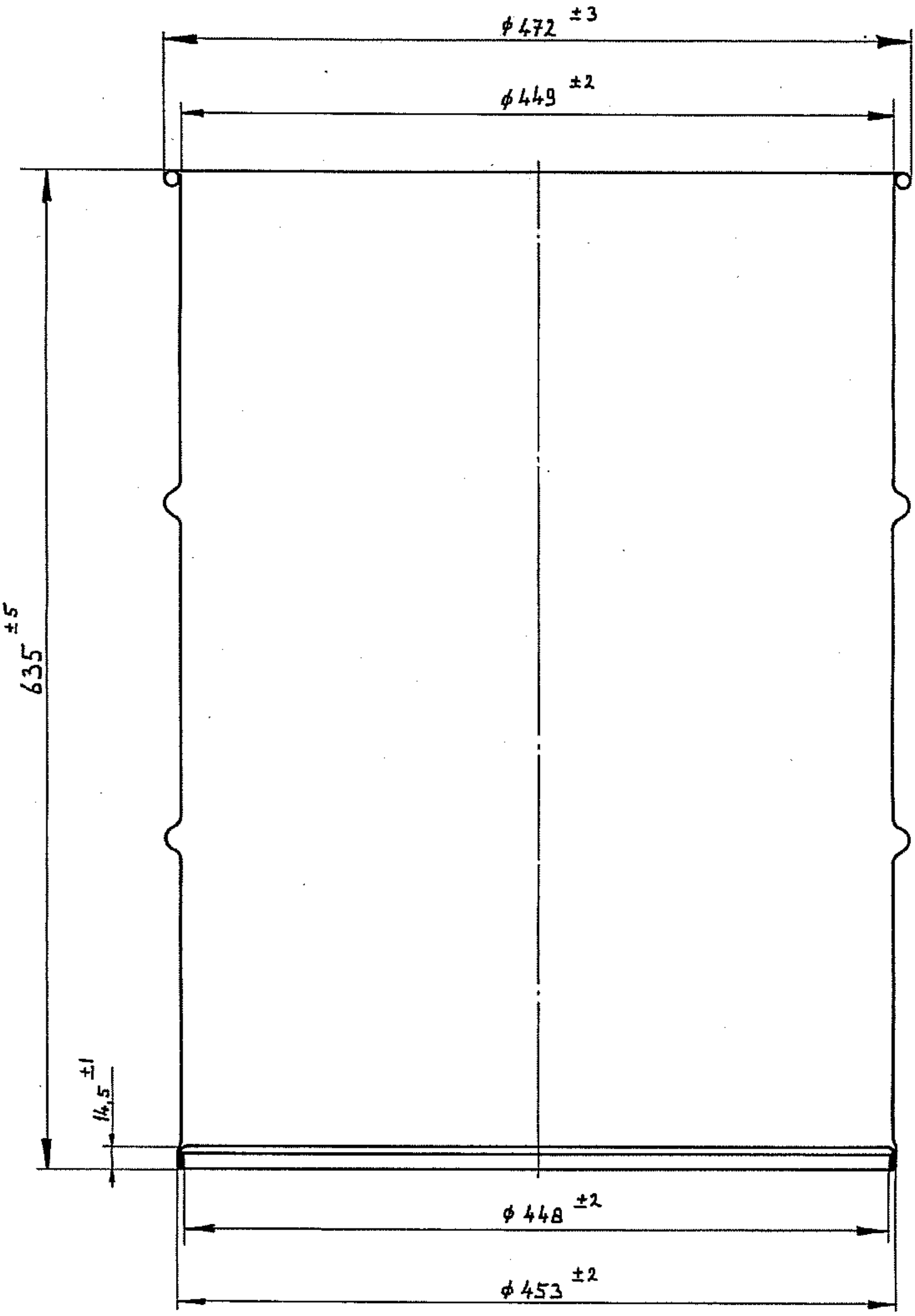

Figure 8-9: 90-l Drum for super-compaction

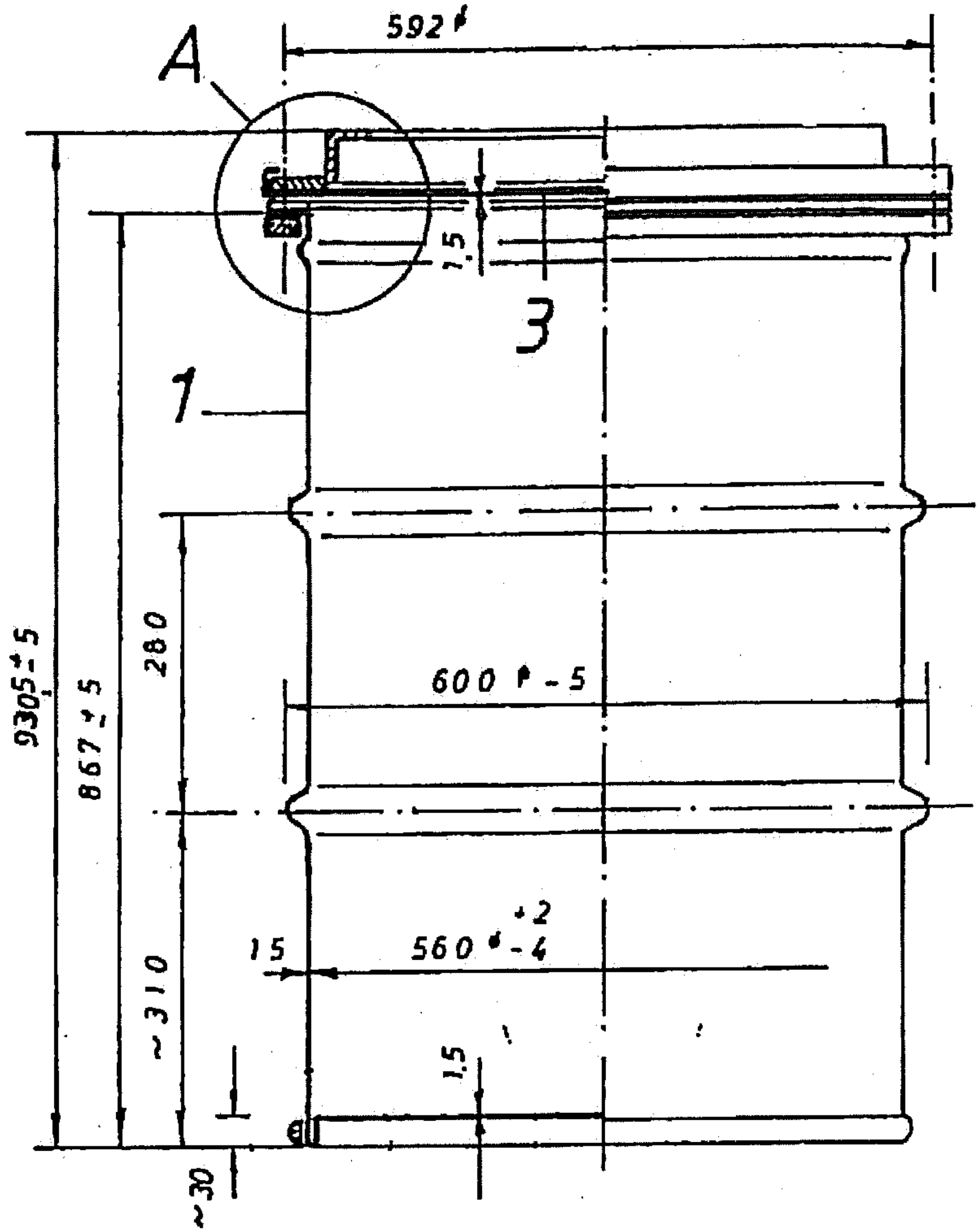

Figure 8-10: 200-l Drum

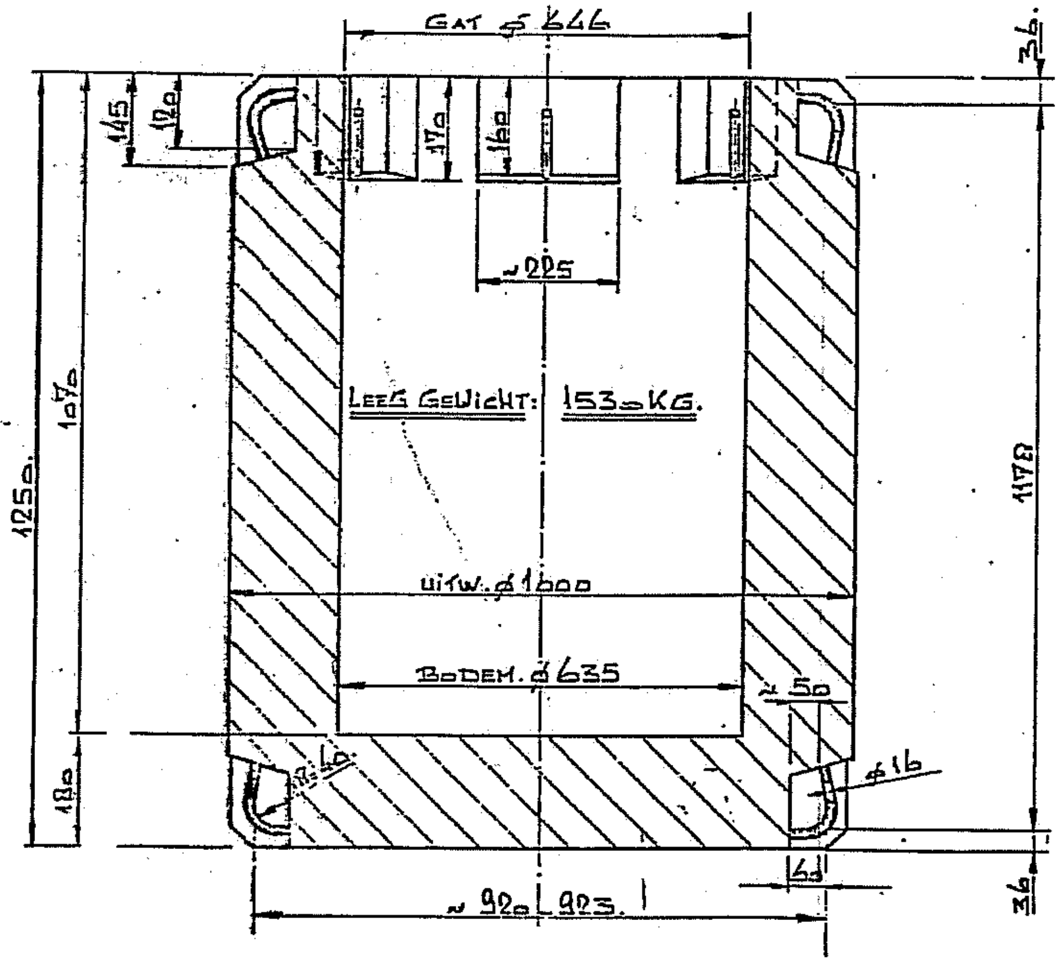

Figure 8-11: 1000-l Container

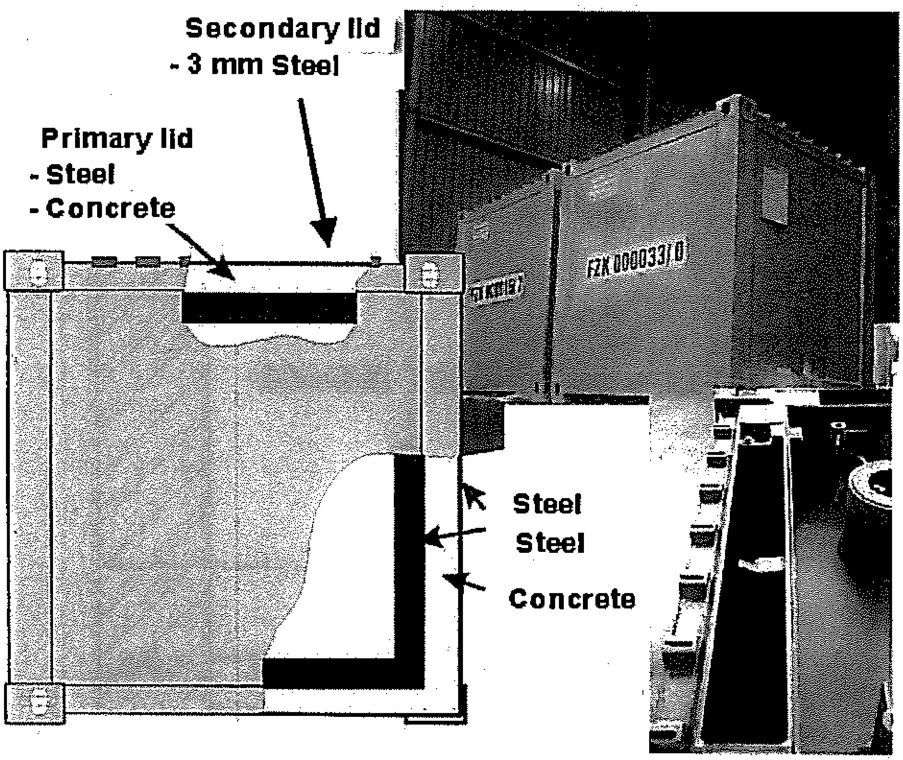

Figure 8-12: KONRAD Type II – Container (Picture by courtesy of Siempelkamp)

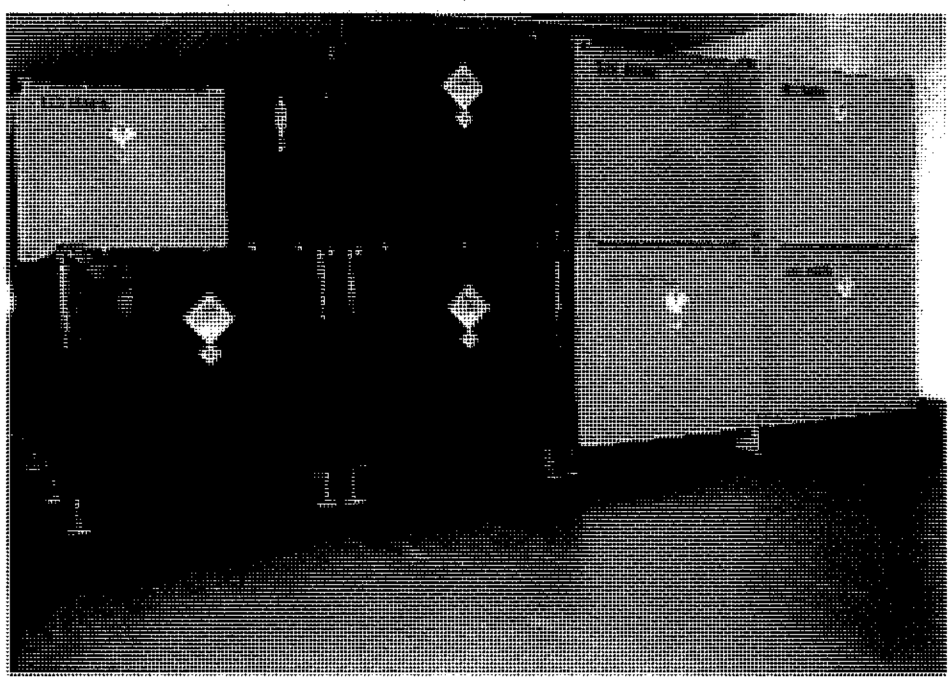

Figure 8-13: Storage of KONRAD Type II - Container (Picture by courtesy of GNS)

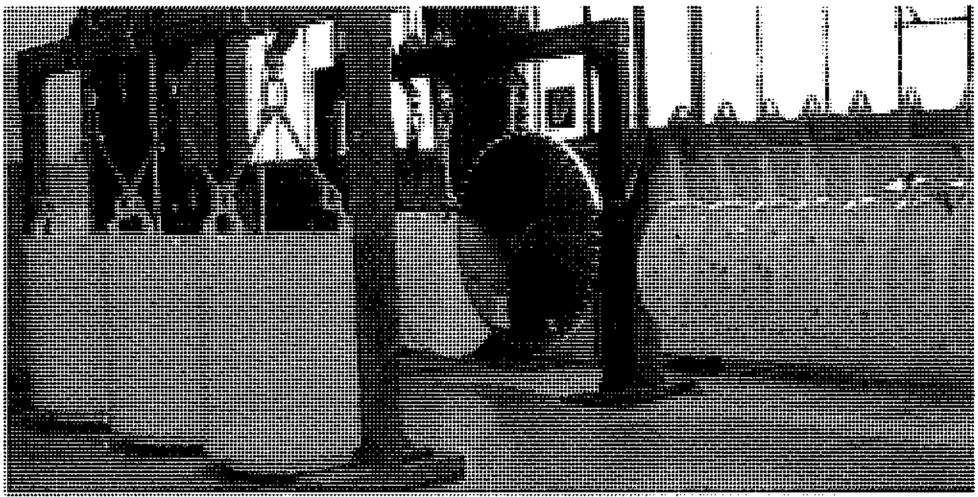

Figure 8-14: MOSAIK Type II - Containers (Picture by courtesy of Siempelkamp)

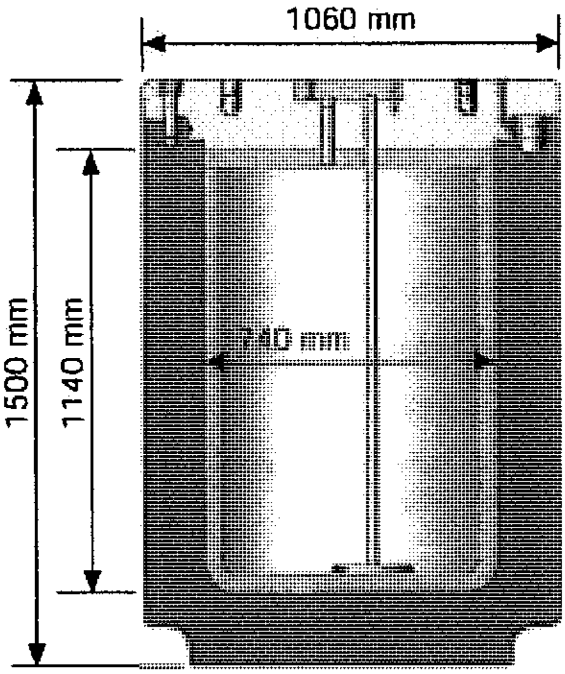

Figure 8-15: Cross-Section MOSAIK Type II - Container (Picture by courtesy of GNS)

9 Planning

9.1 Scope of present report

The present report includes the Best estimate, i.e. an estimate of the decommissioning costs as really expected based on an agreed scenario and boundary conditions. Two tasks are examined:

- Task 1.1: Best estimate assumptions, including clearance levels as defined in the Dutch "Kernenergiewet"
- Task 1.2: Best estimate assumptions, including "IAEA RS-G-1.7" clearance levels

The following statements apply accordingly to both tasks. Where additional information is necessary it is given.

9.2 Work Breakdown Structure (WBS)

The decommissioning project KCD is structured in a hierarchical organisation in accordance (but not identical) with the IAEA "Standardized List of Cost Items for Decommissioning". The Work Breakdown Structure (WBS) is mandatory for the planning activities as well as for the cost estimate.

The WBS "describes" the project. The overall project is divided in subprojects, tasks, etc. until the lowest level is reached where the individual activities can be calculated.

Example:

04 Dismantling Controlled Area (Contaminated)

.04.01 Reactor building

04.01.01 Planning and Engineering

04.01.02 Attendant Measures

04.01.03 Execution

The WBS is adapted and the individual activities are defined according to the needs of the plant specific decommissioning plan.

9.2.1 Level 1: Working packages (WP)

The first level divides the decommissioning project in several separate working packages defined in the IAEA List of Standardised Cost Items but completed by some more working package items. Additionally the order of the working packages is following the course of a real decommissioning project (the projects allow a time schedule with reasonable time bars in the first level, IAEA original list of projects have time bars in all the same length). Following working packages are defined:

- WP 01: Pre-Decommissioning Actions;
- WP 02: Licensing Procedure;
- WP 03: Preparatory Work;

- WP 04: Dismantling Controlled Area (contaminated) – CA-C1;
- WP 05: Dismantling RPV Internals;
- WP 06: Dismantling RPV;
- WP 07: Dismantling Drywell;
- WP 08: Dismantling Biological Shield;
- WP 09: Dismantling Remaining Systems and Components (contaminated) – CA-C2;
- WP 10: Clearance of Building Structures;
- WP 11: Waste Processing, Transport, Storage and Disposal;
- WP 12: Conventional Demolishing;
- WP 13: Site Restoration and Landscaping;
- WP 14: Asbestos Removal;
- WP 15: Project Management, Engineering and Site Support;
- WP 16: Site Security, Surveillance and Maintenance;
- WP 17: Authorities.

Some working packages are like a subproject (for example: Dismantling RPV), others are like an ongoing task for a department (like: Waste Processing, Transport, Storage and Disposal). The content of the working packages is described in section 9.4.

9.2.2 Levels 2, 3, etc.

The levels 2, 3, etc. are not pre-defined. This means that for example number "01" at level 2 can mean whatever the CALCOM user needed: pre-planning, shutdown of systems, or anything else.

These levels are used to refine the structure and to make it so detailed that it contains all activities that are needed to plan the decommissioning project.

As far as possible, the same or similar structures are used for similar activities.

9.3 Generic Sequence for the decommissioning project

The generic sequence for the decommissioning project is schematically shown in Figure 9-1.

Regarding the course of the activities the following general strategy has been chosen to realise the project.

- First, the planning and licensing has to be performed in order to receive the decommissioning and dismantling license for NPP Dodewaard. It is planned that only one "Kernenergiewet" (Kew) license and one "Water" license (Wvo) are needed for the decommissioning. A construction license is needed for the erection of temporary buildings. The licenses are prepared before the end of Safe Enclosure period. After submitting all necessary licensing documents (e.g. Safety Report, Environmental Impact Assessment Report) to the authorities the Dutch authorities will need 6 month to issue the dismantling license.
- Parallel to the licensing process, the planning of the new buildings and new installations will start. The erection of the new buildings can start when the dismantling license is available.
- The dismantling starts with the preparation of the treatment areas and the transport routes for the dismantled components.
- When the treatment areas are installed the dismantling of the contaminated equipment will start with dismantling in the reactor building on level 36 m to get the space for the remote controlled dismantling equipment for the dismantling of the activated parts (RPV internals, RPV, etc.).
- After installation of the remote controlled equipment the dismantling of the RPV internals starts as soon as possible followed by the RPV and the internals of the drywell.
- The Biological Shield and the remaining systems in the controlled area which are not needed anymore are dismantled afterwards.
- Parallel to these actions in the reactor building the dismantling of the systems in the turbine building and the rest of the controlled area are performed.
- The dismantled activated parts (e.g. RPV internals and RPV) will be packed directly into appropriate containers while the dismantled contaminated components are transported to the new installed treatment area in the turbine building for further treatment, packaging or release after corresponding measurements.
- When all installations are removed the building structure will be decontaminated and released.
- At the end of the project the buildings themselves are demolished and the complete site will be restored (including removing of the piles).

This leads to the simplified/summarized time schedule shown in Figure 9-2 and to a more detailed time schedule in Figure 9-3. A complete time schedule will be delivered on a CD, which will be provided together with the present study.

9.4 Content of the working packages

The numbering of the WPs is user-defined, but NIS uses a standard numbering system which makes comparisons between different projects more easy. This NIS internal standard is followed in the present report.

9.4.1 WP 01: Pre-Decommissioning Actions

The first working package includes the activities to place a contract with a Main Contractor, e.g.:

- Definition of final plant status;
- Specification of the decommissioning project;
- Tender documents;
- Call for tenders;
- Negotiations;
- Contract awarding.

At the beginning of the project, the conceptual planning has to be made, which will help to find the right decision regarding the decommissioning strategy. Furthermore, it describes the concepts of the different works to be done. The relevant Authorities will be informed. For example following activities have to be performed:

- Check of documentation;
- Verification / collection of technical data (technical and radiological status of the plant);
- Strategy analyses;
- Structure of documentation;
- Planning of the staff and the general course of the works;
- Final decommissioning plan;
- Definition of WBS;
- Cost estimates.

The working package will already start before the end of Safe Enclosure period.

9.4.2 WP 02: Licensing Procedure

All documents and reports which are necessary to apply for the decommissioning license have to be prepared. During the licensing procedure a lot of discussions with the experts and the authorities will take place. Besides a lot of technical documents the following documents have to be prepared:

- Environmental Impact Assessment Report;
- Safety Report.

Additionally the 6 month before the authorities will issue the license are taken into account in this working package (no costs).

Besides the decommissioning license there are also other licences which are necessary and have to be applied for, e.g.:

- Construction license;
- Waste water and gaseous release licenses.

At the end of the working package all necessary licenses are available. In the present study it is assumed that the end of Safe Enclosure period and the issuing of the license will be at 01.07.2045.

9.4.3 WP 03: Preparatory Work

The activities on site of the working package "Preparatory Work" are starting after granting the license. Some planning works, negotiations with sub-contractors, etc. will be carried out still during the end of the Safe enclosure period.

The necessary investments are described in section 7 and section 8.

Furthermore the following activities (including the investments) are planned and studied under WP 03:

- Modification of control room and former visitor room to get new office rooms;
- Installation of equipment in the offices;
- Modifications in the waste building to prepare mechanical and electrical work shops;
- Installation of equipment in the work shops;
- Erection of new free release building and entrance buffer;
- Modification and installation of new entrance to the controlled area;
- Modification and installation of new sanitary area;
- Installation of HP equipment; e.g.:
    - Radiological laboratory equipment;
    - Monitoring equipment;
    - Other HP equipment (e.g. measuring devices).
- Modification / Installation of electrical equipment;
- Modification / Installation of ventilation system;
- Preparation of treatment areas with necessary dismantling of systems and components (within Turbine building);
- Modification of buildings;
- Installation of treatment equipment; e.g.:
    - Decontamination equipment;
    - Cutting equipment;
    - Super-compaction station;

- Immobilization/Cementation facility;
- Free release measurement facility.

– Preparation of transport routes inside the buildings with necessary dismantling of disturbing installations;

– Modification of buildings (e.g. enlarging of openings);

– Installation of handling devices, e.g. cranes.

Additionally all necessary planning work, attend measures and commissioning of the modifications and installation are considered in the working package.

9.4.4 WP 04: Dismantling Controlled Area (contaminated) – CA-C1

WP 04 covers the dismantling work in the controlled area for all components and equipment other than electrical equipment, ventilation systems and steel construction which will be dismantled at the end of the project (see WP 09: Dismantling Remaining Systems and Components (contaminated) – CA2). During the detailed design phase the partition between WP 04 and WP 09 will be done on the basis of detailed analyses on which systems can be dismantled under WP 04 and which will be needed until the end of the project. For the purpose of the present study the above mentioned distribution has been taken into account.

For the planning of the sequence of the dismantling activities and the estimate of the corresponding costs following assumptions have been made:

– Dismantling building by building;

– Dismantling "top to bottom", i.e. starting at the highest level of the building going down to the lowest level;

– Dismantling of peripheral equipment first (e.g. motors, valves, piping) followed by large components (e.g. pumps, tanks, heat exchangers).

Some examples (not all steps) within the respective buildings are given below:

– Reactor building:
  - Level 36,0 m: Div. components;
  - Level 36,0 m: Condenser;
  - Level 36,0 m: Refuelling machine / bridge;
  - Level 31,2 m: Room 04 components;
  - Level 28,2 m: Pumps;
  - Level 19,2 m: Room 11.1/11.2 overflow pipes;
  - Level 17,2 m: Room 09 heat exchangers;
  - Level 13,2 m: Div. components;

- Level 13,2 m: Room 05C-F tanks;
- Level 10,0 m: DVV east;
- Level 10,0 m: DVV west;
- Level 10,0 m: Room 02/02A components.

– Waste building:
  - Level 17,2 m: Div. components;
  - Level 17,2 m: Room 13/13A components;
  - Level 13,2 m: Room 12A/B components;
  - Level 13,2 m: Room 12A/B pumps;
  - Level 13,2 m: Room 12A tanks (AWO T3 & T4);
  - Level 13,2 m: Room 12B heat exchanger;
  - Level 10,0 m: Room 01A-F tanks (AOT T7 to T12).

– Auxiliary building:
  - Level 19,2 m: Div. components;
  - Level 19,2 m: Room 10 pumps;
  - Level 13,2 m: Room 01 tanks.

– Ventilation building:
  - Level 19,2 m: Div. components.

– Turbine building:
  - Level 22,2 m: Generator;
  - Level 22,2 m: Turbine;
  - Level 17,2 m: Room 08 to 11 components;
  - Level 13,2 m: Div. components;
  - Level 13,2 m: heat exchangers;
  - Level 13,2 m: Room 06 large pipes;
  - Level 10,0 m: Room 04 div. components;
  - Level 10,0 m: Condensers.

In addition to the dismantling activities also attendant measures (building by building) have been taken into account like:

– Implementation planning;

- Supervision;
- Radiation protection;
- Internal transport;
- Accompanying decontamination.

9.4.5 WP 05: Dismantling RPV Internals

WP 05 contains the activities to dismantle the RPV internals. This includes:

- Call for tenders / Negotiations / Contract awarding;
- Detailed planning of remote controlled equipment and dismantling;
- Design, procurement, and testing of special tooling/equipment for remote dismantling work;
- Simulation of complex work on models and training of staff;
- Installation of equipment in the Reactor building;
- Dismantling of the RPV internals from the top to the bottom (without water);
- Directly packaging into suitable containers (e.g. MOSAIK-type);
- Attendant measures:
  - Implementation planning;
  - Supervision;
  - Radiation protection;
  - Internal transport;
  - Accompanying decontamination.

9.4.6 WP 06: Dismantling RPV

The working package "Dismantling RPV" includes the dismantling, cutting and packaging of the RPV. The RPV dismantling is carried out in dry conditions and in parallel with the dismantling of the Drywell internals. The cutting occurs from the top to the bottom in defined rings. First, ring by ring, the surrounding equipment inside the drywell is removed before the RPV rings are cut. The costs for the removal of the drywell components are considered in WP 07 "Dismantling Drywell". The attendant measures as described in section 9.4.5 have also been taken into account.

9.4.7 WP 07: Dismantling Drywell

WP 07 contains the activities of the dismantling of the drywell internals and the drywell wall. The dismantling is carried out from the top to the bottom in dependency on the dismantling of the RPV (see section 9.4.6). Also the attendant measures are considered.

9.4.8 WP 08: Dismantling Biological Shield

The working package includes the dismantling of the biological shield. Only the activated part of the biological shield is considered in this WP, the not activated part will be demolished with the building structures under conventional conditions.

The biological shield is dismantled by cutting pieces from the activated part of the biological shield. The activation calculations have revealed that there is no significant difference between the regions where concrete is activated and where reinforcement steel is activated. This means that if the activation level is above the limit for clearance, then both steel and concrete are above the limit. By consequence a separation of (activated) steel from (not activated) concrete is not meaningful. So the pieces can be cut directly to suitable dimensions for packaging.

The actual cutting work is done remotely controlled in dry conditions. Access to the biological shield is minimised and limited to the installation and adjustment of the tools for drilling holes and for wire cutting of the pieces. The pieces are cut to dimensions suitable for packaging in KONRAD-Containers.

Attendant measures like implementation planning, supervision, radiation protection, internal transports, accompanying decontamination have been taken into account.

In case of task 1.2 more concrete structures are above the clearance levels and have to be dismantled under controlled area conditions. This leads to a longer duration for the dismantling of the biological shield.

9.4.9 WP 09: Dismantling Remaining Systems and Components (contaminated) – CA-C2

As mentioned in section 9.4.4 the WP 09 includes the dismantling of the remaining systems and components after removing the other contaminated and all activated parts of the plant. The work is carried out building by building from the highest level down to the lowest but the last level will be level B (level of treatment area and exit to surrounding area). For the purpose of the present study the remaining electrical equipment, ventilation systems and steel constructions have been taken for the planning of the duration and sequence as well as the cost estimate.

9.4.10 WP 10: Clearance of Building Structures

The WP 10 includes:

- Decontamination of the building structures after the removal of all potentially radioactive inventory;
- Clearance measurements to demonstrate that the remaining structures are below the clearance limits;
- Clearance measurements to demonstrate that the outside areas (structures outside the controlled area, roads, earth) are also below the clearance limits;
- Official clearance procedure for the respective area or for the site.

After the official clearance procedure the respective area or site is free from nuclear regulations. All further activities on site are conventional measures (e.g. building demolishing).

The sequence of the building decontamination and the release measurements of the building structures are in the same order as described in section 9.4.9, i.e. phase out from the point most far away from the exit to the exit of the Turbine building and its extensions.

9.4.11 WP 11: Waste Processing, Transport, Storage and Disposal

Working package 11 comprises activities aiming for the preparation of the dismantled components either for final disposal as radioactive waste, or for clearance and recycling, i.e.:

- On-site treatment:
  - Cutting;
  - Decontamination;
  - Shredding of cables;
  - Super-compaction;
  - Packaging;
  - Immobilization/Cementation of containers;
  - Release measurements;
- Attendant measures:
  - Supervision;
  - Radiation protection;
  - Internal transports;
  - Accompanying decontamination.
- External treatment, like incineration and liquid waste treatment;
- Container costs for radioactive waste:
  - Press drums;
  - 200-l containers;
  - MOSAIK-Containers;
  - KONRAD Type II-Containers.
- Transport, Interim storage at COVRA, and Disposal (used in the present study):
  - 200-l containers, with surface dose rate <= 0,2 mSv/h;
  - MOSAIK-Containers;
  - KONRAD Type II-Containers.

9.4.12 WP 12: Conventional Demolishing

WP 12 considers the conventional part of plant decommissioning. It involves:

- Call for tenders / Negotiations / Contract awarding;
- Detailed planning;
- Licensing procedure (no costs);
- On-site supervision;
- Demolition of buildings;
- Removal of foundation piles;
- External treatment of concrete rubble;
- Reuse of building rubble/reinforcement.

The cost estimates are based on data given by a Dutch company:

- Staff qualifications and corresponding wages (see Table 4-1);
- Specific factors for transport and treatment of concrete rubble and steel (see Table 10-5).

9.4.13 WP 13: Site Restoration, Cleanup and Landscaping

After removing of all buildings the site has to be restored to the conditions before a nuclear power plant was built. Therefore following activities are planned:

- Site restoration (removing of ground);
- Refilling of pits and port with ground;
- Transport and treatment of remaining ground.

The costs are evaluated using specific cost factors given by a Dutch company experienced in this area /11/. The staff costs are included in these factors.

9.4.14 WP 14: Asbestos Removal

From previous investigations it is known that an accurate asbestos inventory in the Dodewaard installations is available. Asbestos was found in both contaminated and conventional installations or building structures.

Companies well experienced in asbestos removal suggest not speeding up the removal too much as this lead to higher incident and accident rates. Therefore, for the purpose of the present study it is considered that the asbestos will be removed in parallel to the dismantling of the contaminated equipment and later during conventional building demolition. The asbestos removal is not on the critical path of the project.

Following aspects have been taken into account for the cost estimate in the present study:

- Verification of asbestos locations;

- Additional investigations;
- Analyses of additional samples;
- Technical specification and tender;
- Asbestos removal work (incl. erection of scaffolds, tents, etc.)
  Spot by spot has to be decided how to do it, because this will be different from location to location;
- Follow-up of the work.

9.4.15 WP 15: Project Management, Engineering and Site Support

This WP includes general project tasks, which have to be administrated by both GKN and the Main contractor. During the project the operating expenses (staff and specific yearly costs) can be reduced. Table 9-1 shows how this has been taken into account in the present study.

9.4.15.1 GKN

- Site / Plant management;
- Finance and accountancy (e.g. administration of bills);
- Staff management;
- Secretary / Archive:
  - Correspondence;
  - Documentation.
- Quality assurance and quality control;
- Licensing coordinator / Contacts with authorities;
- Site procedures / Preparation of internal instructions;
- Supervision of the project;
- Follow up the project schedule;
- Commercial activities.

9.4.15.2 Main contractor

- Project management;
- Finance and accountancy;
- Staff management;
- Secretary / Archive:
  - Correspondence;

  - Documentation of operating data;
  - Documentation of dismantling activities;
  - Documentation of staff dosimetry;
  - Documentation of residual materials;
  - Documentation of radioactive waste;
  - Documentation of release measurements;
  - Transport documentation;
  - Etc.
- Quality assurance and quality control;
- Preparation of internal instructions;
- Supervision of the project;
- Follow up the project schedule;
- On-site coordination;
- Commercial activities;
- IT-Services (Hardware and Software);
- Revenues for sold components and scrap.

9.4.16 WP 16: Site security, surveillance and maintenance

Following tasks in WP 16 have to be carried out also with a GKN part and a Main contractor part. During the project the operating expenses (staff and specific yearly costs) can be reduced. Table 9-1 shows how this has been taken into account in the present study.

9.4.16.1 GKN

- Plant operation;
- Provision of Electricity;
- Provision of water (e.g. showers, cementation);
- Routine measurements;
- Balancing of radioactivity discharged with in the air and in the sewage;
- Operation of radiological laboratory (only routine measurements);
- Implementation of in-service inspections at radiation protection equipment;
- Site maintenance:
  - Work shops;

- Mechanical equipment incl. recurring checks;
- Electrical equipment incl. recurring checks;
- Civil engineering incl. recurring checks.

– Survey of occupational safety;
– Other costs (insurance, mail, communication, office material, medical service, etc.);
– Guarding of the site.

9.4.16.2 Main contractor

– Plant operation;
– Laundry costs (external);
– Sanitary area;
– Entrance to controlled area;
– Individual monitoring with operation of personal dosimetry and body counter;
– Environmental monitoring;
– Operation of radiological laboratory;
– Implementation of in-service inspections at radiation protection equipment;
– Activity calculations of waste containers;
– Radiological processing of radioactive transports;
– Site maintenance:
  - Work shops;
  - Mechanical equipment incl. recurring checks;
  - Electrical equipment incl. recurring checks;
  - Civil engineering incl. recurring checks.
– Survey of occupational safety;
– Maintenance and implementation of in-service inspections of fire protection equipment;
– Maintenance and implementation of in-service inspections of the site security equipment;
– Housekeeping;
– Outdoor area / terrain;
– Canteen;

- Cleaning;
- Other costs (mail, communication, office material, etc.).

9.4.17 WP 17: Authorities

This working package contains the expenses for the authorities during the whole decommissioning project (15.000 € per year).

9.5 Tables

Description of Tasks	Percentage in Period			
	A	B	C	O
WP 15: Project Management, Engineering and Site Support				
GKN:				
Site / Plant Management	100%	100%	100%	100%
Finance and accountancy	0%	100%	100%	100%
Secretary / Archive	0%	100%	100%	100%
Quality Assurance	0%	100%	100%	0%
License coordinator	0%	100%	100%	0%
Site procedures	0%	100%	100%	0%
EDV / IT	100%	100%	75%	50%
Main Contractor:				
Project Management	100%	100%	100%	0%
Finance and accountancy	0%	100%	100%	0%
Secretary / Archive	100%	100%	100%	0%
Quality Assurance	0%	100%	100%	0%
EOV / IT	100%	100%	75%	0%
WP 16: Site Security, Surveillance and Maintenance				
GKN:				
Workshops (Mech., Electr., Civil)	0%	100%	75%	0%
Laundry costs (external service)	0%	100%	75%	0%
Provision of Energy	0%	100%	75%	0%
Provision of Water	0%	100%	100%	0%
Radiological Protection/Health Physics	0%	100%	100%	0%
Fire Protection (external service)	0%	100%	100%	0%
Guards	0%	100%	100%	0%
Other Cost:				
Insurance	0%	100%	75%	0%
Mail, Communication	0%	100%	75%	50%
Office material	0%	100%	75%	50%
Staff training	0%	100%	50%	0%
Medical Service	0%	100%	75%	0%
Main Contractor:				
Operation Entrance Controlled Area	0%	100%	100%	0%
Operation Nuclear Laundry / Substitution Clothes	0%	100%	100%	0%
Operation Nuclear Sanitary	0%	100%	100%	0%
Generation of operational / working orders	0%	100%	100%	0%
Maintenance / Mechanical	0%	100%	50%	0%
Maintenance / Electrical	0%	100%	50%	0%
Maintenance / Civil Engineering	0%	100%	50%	0%
Radiological Protection/Health Physics	0%	100%	100%	0%
Housekeeping	0%	100%	100%	0%
Plant Outdoor Area	0%	100%	100%	0%
Canteen	0%	100%	100%	0%
Cleaning Staff (Conventional)	0%	100%	100%	0%
Other Cost (e.g. Mail, Communication, Office material)	0%	100%	75%	0%

A = Start of Project until Granting the Licence
(Main Contractor: After being selected by GKN until the license is granted)
B = After Granting the Licence until End of Oismantling the Biological Shield (BS)
C = End of Dismantling BS until end of Building Decontamination
D = During Building Demolition and Site Recovery

Table 9-1: Reduction of manpower requirements and specific costs in WP 15 and 16

9.6 Figures

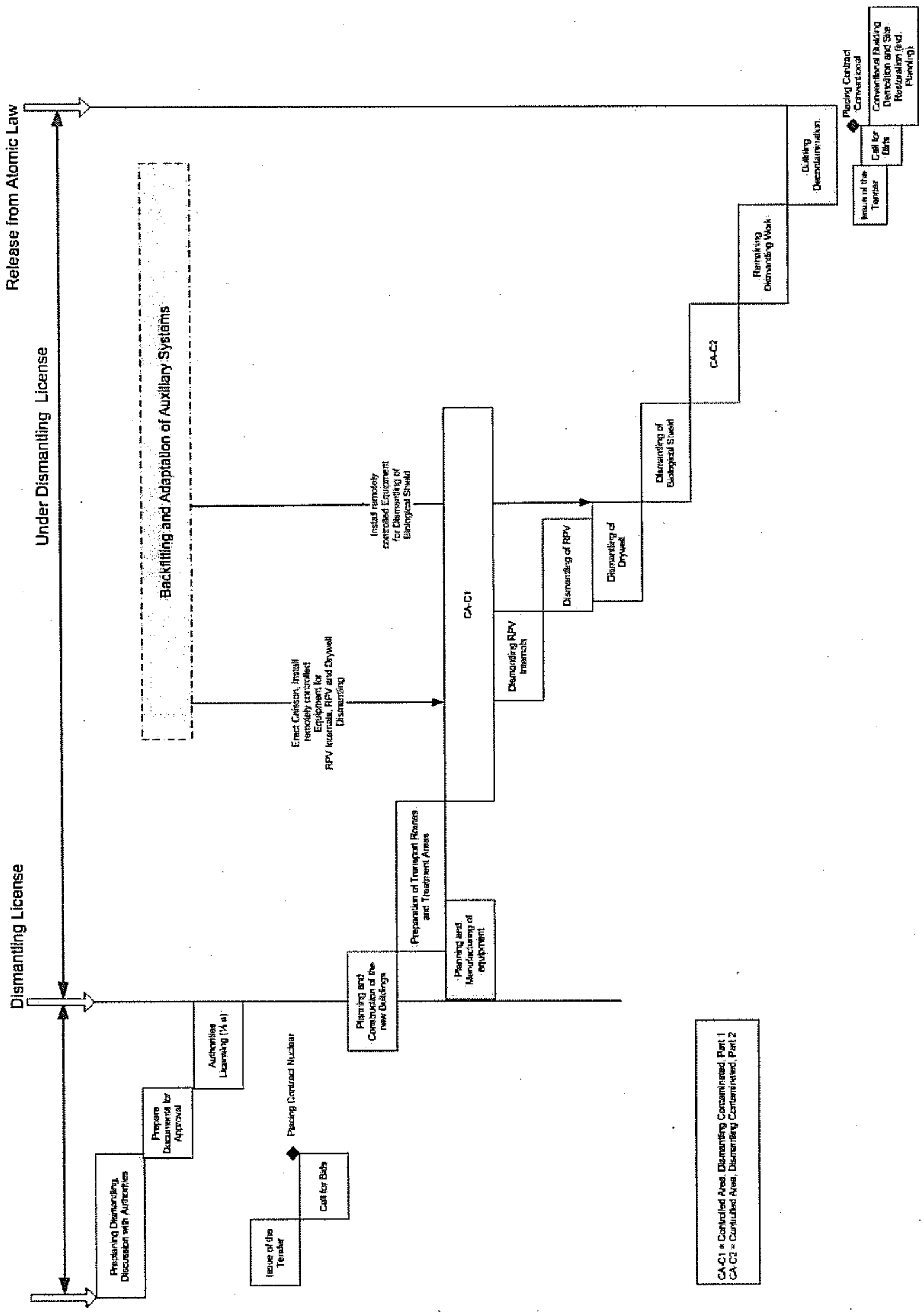

Figure 9-1: Generic sequence for the decommissioning project

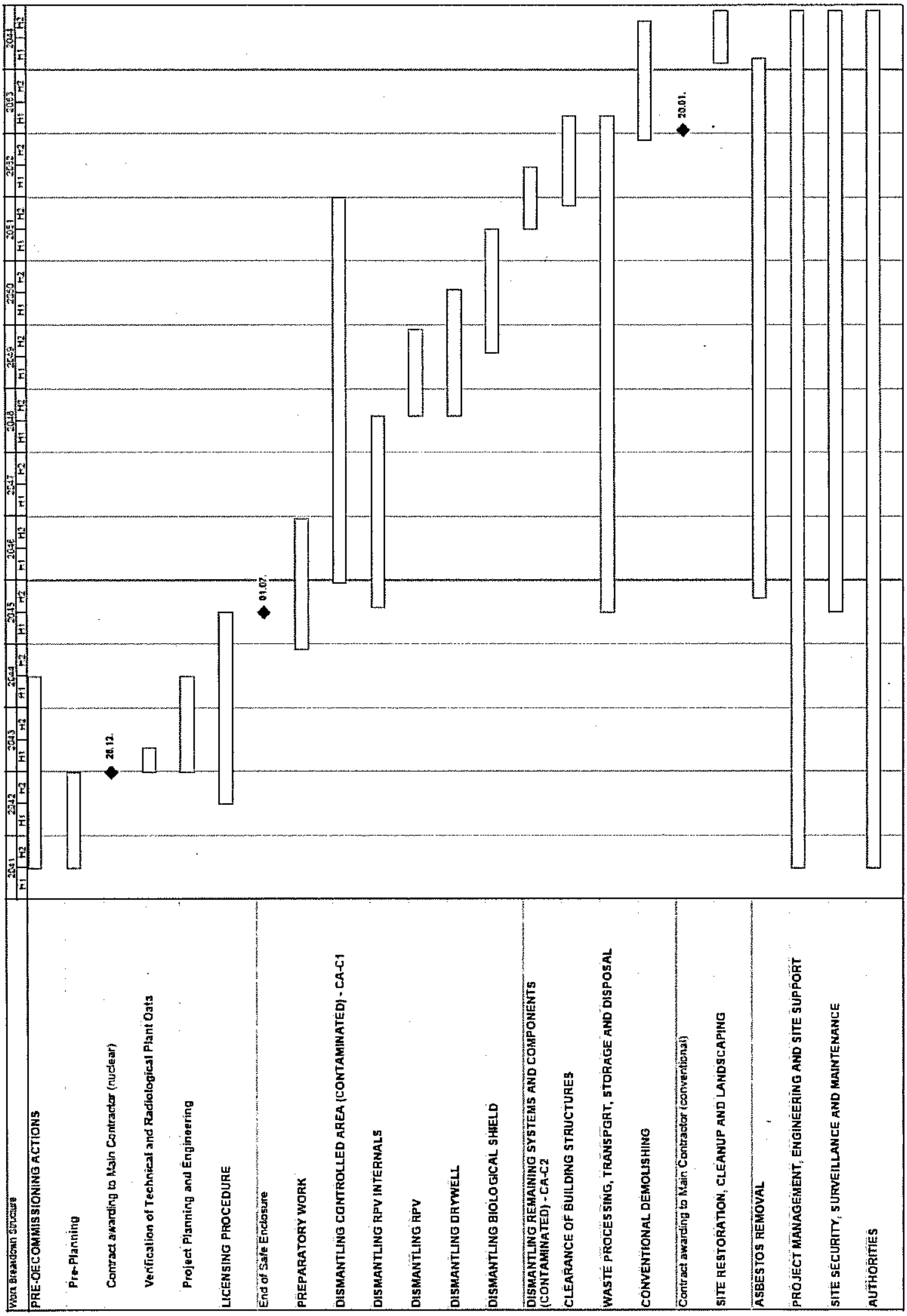

Figure 9-2: KCD Decommissioning – Time schedule (overview)

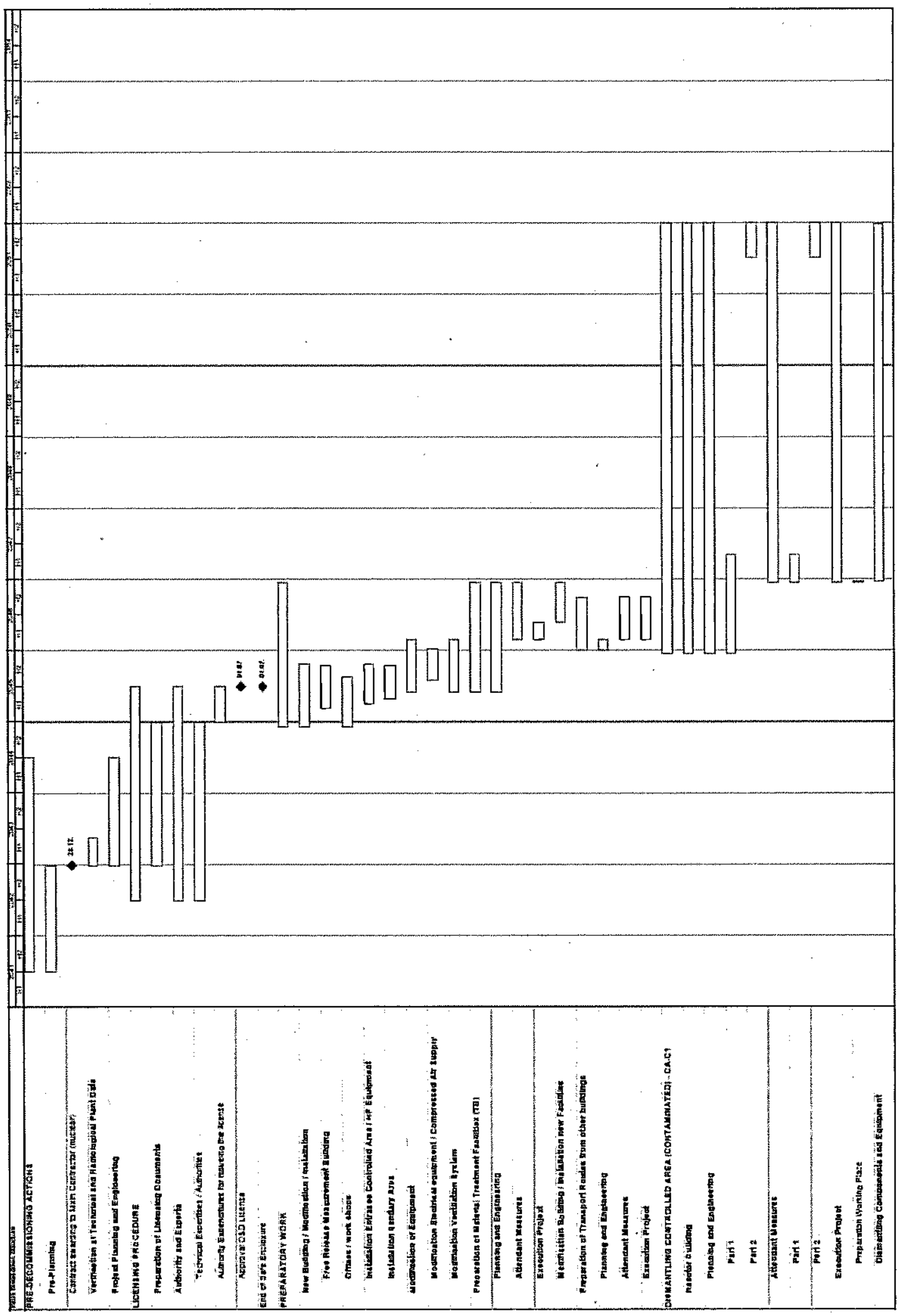

Figure 9-3: KCD Decommissioning – Time schedule (detailed)

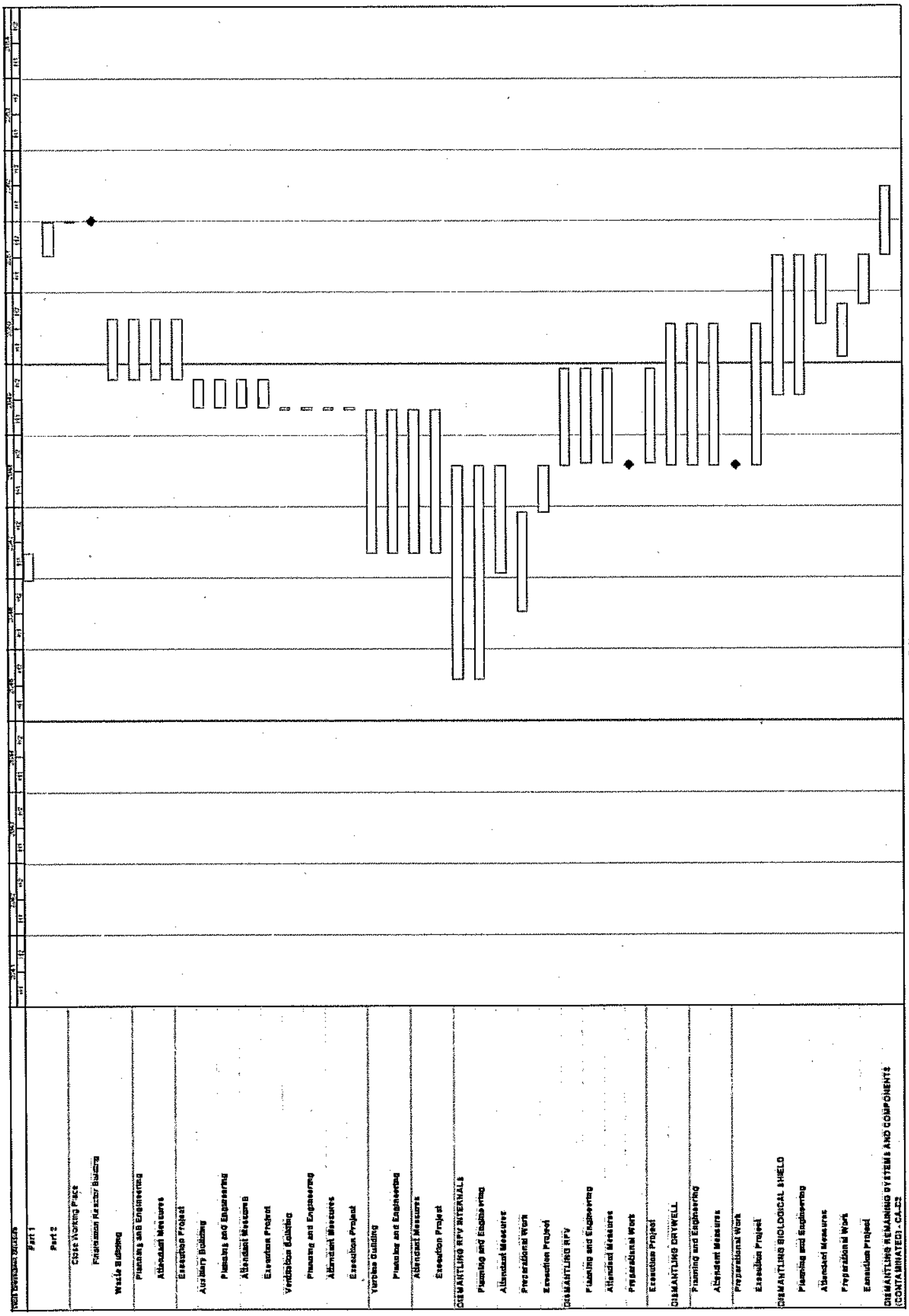

Figure 9-3: KCD Decommissioning – Time schedule (detailed); continued

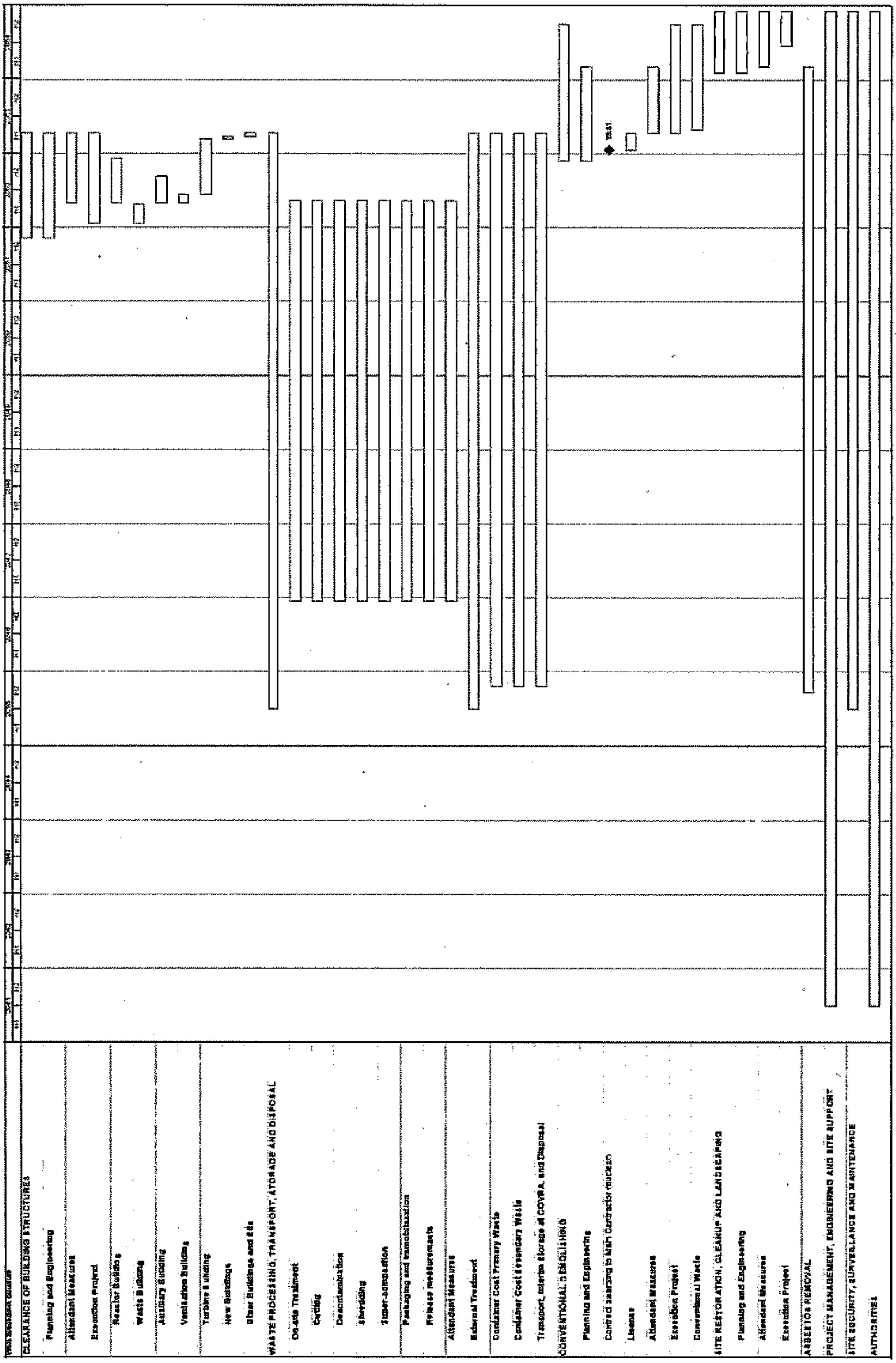

Figure 9-3: KCD Decommissioning – Time schedule (detailed); continued

10 Decommissioning Costs

10.1 Introduction

For almost 30 years now NIS has been involved in nuclear decommissioning projects and has analyzed 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 /7/.

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 decommissioning 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 decommissioning 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 decommissioning 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 in Karlsruhe were calculated in 1995 and updated in 2007. In 2008 the owner 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 decommissioning 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 decommissioning 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.

10.2 Audits

10.2.1 Quality Assurance – Regular Audits

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.

10.2.2 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;
- January till September 2007: Extensive audit by PricewaterhouseCoopers (in the course of the year-end audit of two German utilities by PwC).

10.3 Computer Code CORA & CALCOM

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. The CORA & CALCOM 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 decommissioning project/costs.

10.3.1 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.

Based on the technical and the radiological data of the plant inventory CORA calculates the needed waste management data, containing:

- Material distribution – radioactive waste, reusable non radioactive material (also after decontamination);
- Packaging data – numbers and types of needed waste containers;
- Calculation of the needed repository volume;
- Calculation of the expected secondary waste during the decommissioning period;
- Balances of the radioactive inventory;
- Collection of room data (surfaces, contamination, properties of surfaces).

CORA calculates the expected amount of secondary waste depending on the mass of the existing component in two ways:

- Secondary waste generated during the dismantling work: clothes, gloves, foils, cleaning material, joint material;
- Secondary waste generated during the treatment of components: decontamination.

The results are presented by several lists.

10.3.2 CALCOM: Project Cost Estimate and Planning Module

CALCOM basically provides possibilities for:

- Project planning;
- Project management structure setup and maintenance;
- Management of project schedule;
- Resource management;
- Cost Estimates;
- Data exchange with MS-PROJECT or Primavera P6 project management software.

10.3.2.1 Project Management Structure Setup

The structure of a project management plan is hierarchical and can be defined considering the needs of individual facilities and the actual boundary conditions for the decommissioning project. It is compliant with the standardised OECD/IAEA Decommissioning Cost Items[1]. The number of hierarchical levels is – theoretically – unlimited, but experiences revealed, that a maximum of 8 levels is adequate to setup a project plan even for large decommissioning projects.

CALCOM allows to define and to calculate working tasks at any level of the project structure. The setup of project structure may start with preliminary planning at superior hierarchy levels and may be subsequently refined by defining sub levels providing more detailed planning data for these levels. The superior level will then summarise the results for the subsidiary tasks.

The module will provide for the possibility to enter, store, edit and extract from the centralised DB the following data regarding the project management structure:

- Task name and description;
- Start date, finish date, duration;
- Predecessor and successor of working task (one to many);
- Level in project hierarchy;
- Status;

[1] EC/IAEA/OECD: A Proposed list of terms for Costing Purposes in the Decommissioning of Nuclear Installations

- Milestones;
- Work progress,
- Remarks,
- Dependencies and relationships between tasks.

10.3.2.2 Project Cost Calculation and Resource Management

The base of the cost calculation is the technical and radiological inventory of the plant, which is normally set-up during mass and radiological data collection campaign and evaluated using the Registration Module (see above). 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, final repository).

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

- 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 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 (m^2) of a building area, will be used in combination with a specific working factor (Mh/kg or Mh/m^2) 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 (Mh/Mh).

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 decommissioning 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.

10.3.2.3 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-hr factors can be used for the calculation of the dismantling effort; factors for Man-hr (radiation protection) / Man-hr (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 30 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 fine-tuning for each individual activity depending on the different circumstances.

10.4 Basic Assumptions

10.4.1 Boundary Conditions

Since the PDP is generated for the decommissioning of the KCD NPP starting in 2045 several boundary conditions must be assumed yet. Basis for the present report is the Technical Requisition File (TRF) /6/ given by the client. The enclosed list gives some important definitions for the present cost estimates.

1. The goal of the decontamination and dismantling activities is to reach green field. The dismantling includes the removal of the buildings, of all the various underground structures, including among others the foundation piles, the cooling water inlet structures, and bringing the soil of the site to get the same level as the surroundings.

2. Non-radioactive concrete rubble is reused or sent to a landfill. Following specific cost figures, given by a Dutch company (see /11/ and Table 10-5), are used:
   - Transport and treatment of rubble (concrete, bricks 10 1 c [redacted]
   - Transport and treatment of steel [redacted]
   - Removal, transport and treatment of soil [redacted]
   - Delivery of clean soil [redacted]

3. The PDP is based on the equipment and materials database developed for Dodewaard NPP (DIS: "Dodewaard Information System).

4. Costs related to the Authorities have been included and represent [redacted]

5. The costs for GKN management and site support activities are considered (e.g. requirements by Dutch law on Health physics and security).

6. All planning and execution works will be performed by two external main contractors (one for the "nuclear" part and one for the conventional part) each in a frame of a single contract.

7. The wages used (GKN and Main contractor for the nuclear part) are based on relevant wages of German companies active in decommissioning activities. The wages used for conventional demolition are given by a Dutch company /11/ experienced in this area.

8. The decommissioning costs cover all expenses related to the dismantling preparation phase as well as for the dismantling phase.

9. 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.

10. All materials in the controlled area are supposed as being radioactive, unless measurements indicate that the contamination is below the clearance levels. Two cases are considered as discussed and agreed with the Regulator:

    a) The clearance levels are those specified in the "Kernenergiewet", e.g. 1 Bq/g for Co-60, 10 Bq/g for Eu-152 and for Eu-154

    b) IAEA RS-G-1.7 clearance levels to be complied with 0,1 Bq/g for Co-60 and 0,1 Bq/g for Eu-152 and for Eu-154

The surface specific clearance levels are taken from the German "Strahlenschutzverordnung" (Radiation Protection Ordinance) /5/, e.g. 1 Bq/cm² for Co-60, Eu-152 and for Eu-154, and agreed with the Dutch Regulator.

11. The costs of incineration of radioactive waste (including transport) are based on actual costs of existing European facilities. The specific cost figure is given in Table 10-5. The figure does include all transports, incineration and packaging (200-l drums) of the produced waste.

12. The COVRA waste management costs given in the Appendix 7 of the TRF /6/ updated to 2009 costs by E-mail (dated 25. Feb. 2009) have been used. The costs for "Transport, Interim Storage at COVRA, and Disposal" for KONRAD Type II containers are based on an E-Mail from COVRA dated 7. Oct. 2009 /10/. The COVRA waste management costs used are also given in Table 10-5 to Table 10-7.

13. The cleaning of the personnel contaminated clothes (overalls, masks, etc.) are subcontracted to an external service company (no laundry at the site). GKN has specified the cost for leasing clothes /12/. For the amount specified the clothes are collected every month, washed and returned. The given prices are in € per piece:
    - Overalls €
    - Lab-coats €
    - Overshoes €
    - Socks €
    - Underwear shirts €
    - Underwear shorts €
    - Towels €
    - Bag for collecting laundry

    The yearly costs for the external laundry service is assumed to be € (see Table 10-3). The cost figure is used during the whole decommissioning project (except building demolition and site recovery).

14. The discharges limits and conditions for radioactive effluents are given in Appendix 8 of the TRF /6/. GKN will apply for the following release limits:
    - Air: Aerosols 1 GBq per calendar year, no sampling for H-3 and / or C-14.
    - Water: Total Beta/Gamma 100 GBq. No sampling for H-3 and / or Alpha.

    It is assumed that the emissions are below these limits in any case.

15. The site security meets the rules defined by VROM.

16. The existing on-site infrastructure is not suitable for decommissioning because most pipelines are cut, the old electrical system has been destroyed and the evaporator is broken and cannot be repaired anymore. Recovery of existing equipment is limited to some of the storage tanks.

17. The asbestos inventory in the KCD installations has been taken into account.

18. Both absolute and net present value costs are estimated; the discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk) is 4 % above inflation. This figure serves as a standard indexing number, as it was chosen in the past. Therefore, it is used in the present study as well, in order to make a comparison between studies possible.

19. The reference date for the price level of the cost estimation is taken as 01.01.2009.

20. VAT is not included in the costs.

10.4.2 Specific factors

Specific factors, i.e. cost factors or working factors are important for planning and calculation. These factors provide two opportunities:

- They allow a direct comparison between different decommissioning projects.
- The calculation is comprehensibly and easily adaptable to future knowledge.

The main cost factors for the PDP KCD are given below. All cost factors used are contained in the calculation database CALCOM.

The list of specific factors used is collected and evaluated during a cost estimation work of more than 30 years by NIS, starting with the first reactor which was completely dismantled; the German NPP Niederaichbach. The factors are adapted in periodically actualisations year by year based on the real experiences in the decommissioning projects Würgassen, Stade, Lingen, Mühlheim-Kärlich and Obrigheim.

10.4.2.1 Staff costs

The staff organisation and the staff costs (wages) are discussed in section 4. The hourly wages are shown in Table 4-1.

The wages are based on relevant wages of German companies active in D&D projects as agreed in the TRF /6/[2] and for conventional demolition on wages given by Dutch Company experienced in this area /11/.

10.4.2.2 Working factors

Working factors are used for the calculation of the working effort and the amount of working hours. The working factors used for the PDP KCD can be divided into two groups:

- Mass, Surface, Volume, Number, etc. related factors which will be used with an plant specific indicator; mainly for dismantling and decontamination.
- Work related factors which will be used with a calculated work effort, mainly for attended measures, like planning, radiation protection or internal transport.

Table 10-1 shows a selection of typical working factors used in the calculation for the PDP. The number of factors used is reduced to a number of basic factors which will be adapted during the calculation work within the CALCOM code. The factors shown in Table 10-1 are referenced to the actual decommissioning projects Greifswald, Würgassen, Stade and Obrigheim.

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[2] Remark from NIS: These new wages are higher for some qualifications (e.g. Project Manager, Engineer) compared to only price escalated figures from the previous study. This leads to an increase in staff costs compared with the previous study (in a rough approach about 10 M€).

During the calculation in the CALCOM software the factors can be adapted to the local situation by additional factors. Table 10-2 shows possible local situations and the possible range of working factors. The adaptation or variation factors allow the consideration of the local situation:

- **Size of Component**: If a dismantling work has been carried out for a component or a batch of components with a low mass amount, the preparation of work site and some adjustment times of used equipment is much more influencing the total working time as for a component with a bigger mass amount. So the productivity of a dismantling work (kg/Man-hr) is higher in the case of a bigger working mass.
- **Accessibility**: If the work has to be carried out in less space circumstances the productivity will be lower as in good accessibility. No accessibility means also shielding measurements or at last remote control work. Special attention is paid to this aspect. During visits on site and detailed studies of drawings the situation was checked. This led to longer durations for the dismantling and for instance in the case of the large tanks in the waste building additional investments (special tools and necessary activities to reach the tanks) have been taken into account to dismantle and remove these tanks (e.g. tanks AOT-T1 to AOT-12) in a save way.
- **Protective Measures**: So as air breathing filters or full protective clothes will be lower the productivity of work. Factor above 1 means working in non controlled area.
- **Hoisting or Lifting Devices**: No lifting devices require more cutting work to smaller sizes. In maximum the cut pieces must be transported by manual work. If a device is available it could be a small one (Factor lower than 1) or a big one.
- **Scaffolding**: The work productivity will be lowered if the workers must use scaffoldings.

At last the specific factor used in the calculation is a multiplication of the basic factor from Table 10-1 and the adaptation factors from Table 10-2.

10.4.2.3 Specific cost factors

Specific cost factors are needed for consumables, invest cost, and for external service. The factors given are mainly defined as yearly costs or as mass related values. Table 10-4 and Table 10-5 give a survey on the factors used.

10.4.2.4 Waste packages

The container types used for the PDP KCD are defined in Section 8.4. Costs for the several containers were taken from the price lists of different German companies and COVRA. The cost figures given in Table 10-6 contain the containers which are analysed and evaluated during the cost estimate.

10.4.2.5 Transport, Interim Storage at COVRA, and Disposal

All radioactive waste has to be handed over to COVRA. The waste packages produced during the decommissioning of KCD will be transported to COVRA for Interim Storage and later for final disposal.

Besides the few MOSAIK-Containers (containing high activated parts of the RPV internals) all other containers are filled with cement for immobilization of the content.

For the purpose of the present study COVRA has provided specific cost figures per kind of container depending on the surface dose rate of the containers. The given figures are shown in Table 10-7.

10.5 Investments

Table 10-8 contains the list of investments as used in CALCOM for KCD. Waste packages (which are also calculated under "investments") are not included here.

10.6 Radiation exposure

The radiation exposure is not a direct cost item but the exposure is calculated together with the costs and therefore the results are presented here.

It is clear that the calculation of the expected radiation exposure as explained below can not replace the measurements and calculations to be performed during work preparation and during the dismantling work. The calculation with CALCOM is used by NIS to see if the calculation reveals any activities with an unexpected high result for the radiation exposure. If so, then special measures like remote controlled work, additional shielding, another technique, etc. can be considered (in such a case of course they must be considered also in the costs). For selected activities, typical values from real projects are known from our own experience or from literature, and NIS can compare the results of the CALCOM calculations with the data from experience.

The procedure is as follows:

First a set of dose rate classes are defined for different types of work in the controlled area. The dose rate class is defined as an average dose rate taking into account that the working time consists of:

- Time for work close to a component;
- Time for walking to reach or leave a working place;
- Time outside controlled area.

Based on dose rate figures stored in DIS and considering the above mentioned aspects the following classes were defined for the present study:

- Class 1: Outside controlled area 0,0 μSv/h;
- Class 2: Corridors 0,5 μSv/h;
- Class 3: Low level areas 1,5 μSv/h;
- Class 4: Medium level areas 3,0 μSv/h;
- Class 5: High level areas 6,0 μSv/h;
- Class 6: Upper level areas (e.g. RB-B, Rooms 5 C-F) 10,0 μSv/h;

One of these factors is assigned to each activity in the controlled area. CALCOM multiplies the man-hours for each activity with the factor from the dose rate class.

10.7 Results for Task 1.1: Best estimate (Kernenergiewet)

10.7.1 Decommissioning Costs

The cost estimates summarised in the following chapter use a best estimate strategy for all cost items such as cost per hour, cost for consumables, investments, work efficiency, etc.

The clearance levels from the Dutch Kernernergiewet are used.

More details on the cost estimation results are given in the CALCOM software which is a part of the NIS deliveries (read only CD).

The costs are estimated as an absolute value and a net present value. The net present value is estimated with 4 % real interest rate. The price level for the estimates is 01.01.2009.

The total decommissioning costs (absolute value) for KCD are **M€** (Net present value: **M€)**

The more detailed results are given for the absolute value only.

The decommissioning costs per working package and cost type are listed in Table 10-9. The percentage distribution to the cost types is shown in Figure 10-1. On the same level of detail (working package) Table 10-10 gives information about the yearly distribution of the costs. The total costs per year are shown in Figure 10-2.

In Table 10-11 the yearly costs are broken down to level 3 of the Work Breakdown Structure (WBS).

In Table 10-9 under working package 11 "Waste processing, Transport, Storage and Disposal" the "Container costs" and the costs for "Transport, Interim storage at COVRA and Disposal" are included as "Investment costs" and "Other costs" respectively. These costs are given in Table 10-12 separately for the different kind of containers.

A special task in the decommissioning project is the removal of asbestos. The total costs for this task are estimated to be **k€**. The figure is not estimated with CALCOM but the result is implemented in CALCOM to show a complete picture of the decommissioning costs. Table 10-13 shows how the asbestos removal costs are estimated.

10.7.2 Man-power requirement and staff capacity

The man-power needed for the decommissioning of KCD is estimated to **754 man-years** in total.

The yearly distribution of the total man-power broken according to GKN staff and Contractors staff is shown in Figure 10-3.

Figure 10-4 to Figure 10-6 show the estimated man-power per year and qualification for GKN staff, Contractors staff (nuclear) and Contractors staff (conventional). The corresponding numbers are given in Table 10-14.

10.7.3 Radiation exposure per working package

Taking into account the dose rate classes described in Section 10.6, the required man-power and the estimated durations for the dismantling activities lead to a radiation exposure as shown in Table 10-15. The occupational dose is estimated in total with 1,4 Man-Sv.

10.8 Results for Task 1.2: Best estimate (IAEA)

Besides the clearance levels all other assumptions / boundary conditions are unchanged compared to Task 1.1 (Best estimate including clearance levels as defined in the "Kernenergiewet").

The clearance levels underlying the results given in this section are based on IAEA RS-G-1.7 /4/.

Compared to Task 1.1 the amount of radioactive waste has increased and it will need more time to dismantle the activated part of the Biological Shield. Due to the longer duration all time dependent activities are increased too (especially WP 15 and WP 16).

The costs are estimated as an absolute value and a net present value. The net present value is estimated with 4 % real interest rate. The price level for the estimates is 01.01.2009.

The total decommissioning costs (absolute value) for KCD are **M€**
(Net present value: **M€)**

The decommissioning costs per working package and cost type are listed in Table 10-16. On the same level of detail (working package) Table 10-17 gives information about the yearly distribution of the costs. The new figures for "Container costs" and costs for "Transport, Interim storage at COVRA and Disposal" are shown in Table 10-18.

The man-power needed for the decommissioning of KCD (Task 1.2) is estimated to **765 man-years** in total.

10.9 Summary

An overview of the results of the new Decommissioning Cost Estimate KCD is given in the next two tables.

The first table gives an overview of the produced amount of radioactive waste, the necessary packages, the waste storage volume as well as the costs for transport, interim storage at COVRA and final disposal.

Task No.	Free Release Levels taken from	Packed Mass [Mg]	Number of Disposal Containers [-]	Disposal Containers Costs [M€]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal [M€]
1.1	KEW NL	1134,8	2316		1168,1	
1.2	IAEA	1344,3	2371		1423,2	

10.10 Tables

Factor	Basic Value	Values used in CALCOM (reduced by 5 %) *)
Dismantling Contaminated Components		
Dismantling Concrete Structures in Containment		
Dismantling Large Components		
Dismantling RPV Internals Remote Controlled		
Dismantling RPV Remote Controlled		
Dismantling Drywell		
Dismantling Biological Shield (activated)		
Dismantling Remaining Equipment		
Building surfaces: Decontamination and Release Measurements		
Implementation planning		
Project management		
Supervision		
Radiation Protection		
Internal Transport		
Accompanying Decontamination		

*) The factors for dismantling RPV internals and RPV have not been reduced because they are still removed remote controlled; the factor for decontamination and release measurements of building surface is also not changed because advantages in decontamination work will be counterbalanced by disadvantages in measurements (due to nuclide vector).

Table 10-1: Typical working factors

The second table shows the results of the cost estimate considering the different tasks.

Task No.	Free Release Levels taken from	Costs	
		Absolute Value [M€]	Net Present Value (4% above inflation) [M€]
1.1	KEW NL		
1.2	IAEA		

In all tasks the actual dismantling work starts in 2045 while the planning and preparation starts 4 years earlier. The overall duration of the project (starting with planning and ending with "Green field" conditions) takes about 14 years.

Local Situation	Value of Factor Variation		Value of Factor Variation	
Size of Component	Small	0,2 - 1	Big	1 - 3
Accessibility	Bad	0,4 - 1	Good	1
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

Table 10-2: Adaptation of working factors to local situations

Clothes	Price per piece and month [€]	Assumed number per person and day	Number per person and month (21 days/month)	Price per person and month [€]	Price per person and year [€]
Overalls Lab-coats Overshoes Socks Underwear shirts Underwear shorts Towels Bag for clollecting	[redacted]				
Total costs per person and year					
Average number of persons assumed: [redacted]			Total cost per year:		
Costs per year used in the present study:					

Table 10-3: Evaluation of yearly costs for external laundry service

Factor	Value	
Authorities	[redacted]	€/year
Insurance	[redacted]	€/year
Guarding of the site (without staff on site)	[redacted]	€/year
Consumable Maintenance (Mech.)	[redacted]	€/year
Consumable Maintenance (Electr.)	[redacted]	€/year
Consumable Maintenance (Civil)	[redacted]	€/year
Consumable Workshop (Mech./Electr./Civil)	[redacted]	€/year
Staff training	[redacted]	€/year
Rad. Laboratory	[redacted]	€/year
Fire Protection Sytems Maintenance	[redacted]	€/year
IT Hardware	[redacted]	€/year
IT-Hardware Maintenance	[redacted]	€/year
IT-Software	[redacted]	€/year
Recurring Safety Checks (Electr.)	[redacted]	€/year
Recurring Safety Checks (Mech.)	[redacted]	€/year
Mail, Communication (GKN)	[redacted]	€/year
Mail, Communication (External contractors)	[redacted]	€/year
Laundry (External Service)	[redacted]	€/year
Medical Service	[redacted]	€/year
Office Material (GKN)	[redacted]	€/year
Office Material (External contractors)	[redacted]	€/year
Provision Electricity (Assumption: 1 MW incl. Heating)	[redacted]	€/year
Water (Connection to net)	[redacted]	€/year

Table 10-4: Specific cost factors (€/year)

Factor	Value	
Water used	[redacted]	€/m³
Water (release to Sewage system)	[redacted]	€/m³
Electricity (plain price, transport costs, transformer costs)	[redacted]	€/kWh
Consumable costs regular dismantling	[redacted]	€/kg
Consumable costs complex dismantling	[redacted]	€/kg
Consumable costs remote controlled dismantling	[redacted]	€/kg
Consumable costs demolition	[redacted]	€/kg
Consumable costs surface abrasion	[redacted]	€/m²
Consumables Cutting	[redacted]	€/kg
Consumables Immobilization	[redacted]	€/kg
Consumables Super-compaction	[redacted]	€/kg
Consumables Shredding	[redacted]	€/kg
Consumable costs RPV-Internals remote controlled dismantling	[redacted]	€/kg
Incineration	[redacted]	€/kg
Liquid waste treatment at COVRA (Liquid Class II per standard 60-l drum)	[redacted]	€/drum
Consumables Blasting Decontamination	[redacted]	€/kg
Consumables Release Measurement	[redacted]	€/kg
Selling Metal scrap	[redacted]	€/kg
Selling Copper scrap	[redacted]	€/kg
Selling Alu scrap	[redacted]	€/kg
Selling Lead scrap	[redacted]	€/kg
Transport and treatment of concrete rubble (conventional)	[redacted]	€/kg
Transport and treatment of steel (conventional)	[redacted]	€/kg
Refilling ground	[redacted]	€/kg
Remove and treatment of ground material (incl. Transport)	[redacted]	€/kg

Table 10-5: Specific cost factors (€/kg, €/m³, etc.)

Container type	Container costs [€]
90-l Press drum	[redacted]
200-l drum	
KONRAD Type II	
KONRAD Type II / 180 mm NC	
MOSAIK Type II / 60 mm Fe (Type B (U))	

Table 10-6: Costs for waste packages / containers

Container type	Costs per Container [€]
200-l container, with a surface dose rate <= 0,2 mSv/h	[redacted]
200-l container, with a surface dose rate > 0,2 <= 2,0 mSv/h	
200-l container, with a surface dose rate > 2,0 <= 2,5 mSv/h	
200-l container, with a surface dose rate > 2,5 <= 4,0 mSv/h	
200-l container, with a surface dose rate > 4 <= 10,0 mSv/h	
1000-l container, with a surface dose rate <= 0,2 mSv/h	
1000-l container, with a surface dose rate > 0,2 <= 2,0 mSv/h	
1500-l container, with a surface dose rate <= 0,2 mSv/h	
1500-l container, with a surface dose rate > 0,2 <= 2,0 mSv/h	
MOSAIK-container	
KONRAD-container Type II	

Table 10-7: Costs for transport, interim storage at COVRA, and disposal

No.	Description	Costs [€]	Associated WP
1	New free release measurement building	[redacted]	3
2	Clearance Measurement Facility incl. other measuring equipment		3
3	Storage areas / Internal transport equipment (fork lifts, lattice boxes, etc.)		3
4	Entrance Controlled Area and HP equipment		3
5	Modification Ventilation system		3
6	Modification Sewage water treatment (incl. Waste water release line)		3
7	Modification Hot Shower water treatment		3
8	Lifting devices (incl. handling ropes of Reactor- and Turbine building crane)		3
9	Modification electrical installations (incl. cranes) and pressurized air supply		3
10	Modification / Equipment electr. and mechanical work shops		3
11	Modification / Equipment offices		3
12	Modification / Equipment of radiological laboratory		3
13	Packaging Station (cementation)		3
14	Decontamination equipment (decontamination area)		3
15	Cutting devices (Cutting area: band saw, shredder, etc.)		3
16	Super-compaction station		3
17	Cutting and Manipulator equipment RPV Internals (incl. Drywell Internals)		5
18	Cutting and Handling RPV (incl. Drywell)		5
19	Cutting and Handling Biol. Shield		8
20	Dismantling equipment (tools, scaffolds, portable filters, tents, etc.)		3
21	Dismantling equipment for large components (TB)		4
22	Dismantling equipment for large components (WB)		4
23	Equipment for building and site decontamination		10
	Total		

Table 10-8: Investment costs used in the decommissioning cost estimate

WP No.	Working Package	Total costs [M€]	Staff costs [M€]	Investment costs / Revenues [M€]	Consumable costs *) [M€]	Other costs [M€]
01	PRE-DECOMMISSIONING ACTIONS					
02	LICENSING PROCEDURE					
03	PREPARATORY WORK					
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1					
05	DISMANTLING RPV INTERNALS					
06	DISMANTLING RPV					
07	DISMANTLING DRYWELL					
08	DISMANTLING BIOLOGICAL SHIELD					
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2					
10	CLEARANCE OF BUILDING STRUCTURES					
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL					
12	CONVENTIONAL DEMOLISHING					
13	SITE RESTORATION, CLEANUP AND LANDSCAPING					
14	ASBESTOS REMOVAL					
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT					
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE					
17	AUTHORITIES					
SUM						

*) "0,0" M€ means that the estimated costs are below 0,05 M€.

Table 10-9: KCD Decommissioning costs per working package and cost type

WP No.	Working Package	Total [k€]	2041 [k€]	2042 [k€]	2043 [k€]	2044 [k€]	2045 [k€]	2046 [k€]	2047 [k€]	2048 [k€]	2049 [k€]	2050 [k€]	2051 [k€]	2052 [k€]	2053 [k€]	2054 [k€]
01	PRE-DECOMMISSIONING ACTIONS															
02	LICENSING PROCEDURE															
03	PREPARATORY WORK															
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1															
05	DISMANTLING RPV INTERNALS															
06	DISMANTLING RPV															
07	DISMANTLING DRYWELL															
08	DISMANTLING BIOLOGICAL SHIELD															
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2															
10	CLEARANCE OF BUILDING STRUCTURES															
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL															
12	CONVENTIONAL DEMOLISHING															
13	SITE RESTORATION, CLEANUP AND LANDSCAPING															
14	ASBESTOS REMOVAL															
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT															
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE															
17	AUTHORITIES															
Sum																

Table 10-10: KCD Decommissioning costs per working package and per year

WBS	Working Packages with sub-levels	Total [k€]	2041 [k€]	2042 [k€]	2043 [k€]	2044 [k€]	2045 [k€]	2046 [k€]	2047 [k€]	2048 [k€]	2049 [k€]	2050 [k€]	2051 [k€]	2052 [k€]	2053 [k€]	2054 [k€]
01	PRE-DECOMMISSIONING ACTIONS															
01.01	Pre-Planning															
01.01.01	Start of Project / Planning to Stop Safe Enclosure															
01.01.02	Project Specifaction / Tender documents															
01.01.03	Call for Tenders / Nagotiations / Contract award															
01.02	Varification of Technical end Radiological Plant Data															
01.02.01	Check of documentetion															
01.02.02	Technical Plant Status															
01.02.03	Radiological Plent Stetus															
01.03	Project Planning end Engineering															
01.03.01	Strategy Analyses															
01.03.02	Concept for a Decommissioning Documentation															
01.03.03	Final Dacommissioning Plan (incl. Costs)															
01.03.04	Work/Cost Breakdown Structure															
01.03.05	Time Schedule															
01.03.06	Parsonnel Requirements and Radiation Exposura															
02	LICENSING PROCEDURE															
02.01	Preparation of Licensing Documents															
02.01.01	Safaty Analysis Report															
02.01.02	Environmental Impact Assessment															
02.01.03	Technical Documants															
03	PREPARATORY WORK															
03.01	Naw Building / Modification / Installation															
03.01.01	Free Release Measurement Building															
03.01.02	Offices / work shops															
03.01.03	Installation Entranca Controlled Area / HP Equipment															
03.01.04	Installation Sanitary Area															
03.02	Modification of Equipment															
03.02.01	Modification Electrical equipment / Compressad Air Supply															
03.02.02	Modification Ventilation System															
03.03	Preparation of Material Treatment Facilities (TB)															
03.03.01	Planning and Engineering															
03.03.02	Attendant Measures															
03.03.03	Execution Project															
03.03.04	Modification Building / installation new Facilities															
03.04	Preparation of Transport Routes from other buildings															
03.04.01	Planning and Engineering															
03.04.02	Attendant Measures															
03.04.03	Execution Project															

Table 10-11: Detailed KCD Decommissioning costs per year

WBS	Working Packages with sub-levels	Total [k€]	2041 [k€]	2042 [k€]	2043 [k€]	2044 [k€]	2045 [k€]	2046 [k€]	2047 [k€]	2048 [k€]	2049 [k€]	2050 [k€]	2051 [k€]	2052 [k€]	2053 [k€]	2054 [k€]
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1	72												1		
04.01	Reactor Building															
04.01.01	Planning and Engineering															
04.01.02	Attendant Measures															
04.01.03	Execution Project															
04.02	Waste Building															
04.02.01	Planning and Engineering															
04.02.02	Attendant Measures															
04.02.03	Execution Project															
04.03	Auxiliary Building															
04.03.01	Planning and Engineering															
04.03.02	Attendant Measures															
04.03.03	Execution Project															
04.04	Ventilation Building															
04.04.01	Planning and Engineering															
04.04.02	Attendant Measures															
04.04.03	Execution Project															
04.05	Turbine Building															
04.05.01	Planning and Engineering															
04.05.02	Attendant Measures															
04.05.03	Execution Project															
05	DISMANTLING RPV INTERNALS															
05.01	Planning and Engineering															
05.01.01	Implementation planning															
05.01.03	Detailed Planning															
05.02	Attendant Measures															
05.02.01	Project management															
05.02.02	Supervision															
05.02.03	On Site Radiological Protection															
05.02.04	Internal Transport															
05.02.05	Accompanying Decontamination															
05.03	Preparational Work															
05.03.01	Preparation Reactor Floor and Pool															
05.03.02	Remote Controlled Dismantling Equipment															
05.03.03	Training of Staff															
05.04	Execution Project															
05.04.01	Removing Drywell Head															
05.04.02	Cutting Drywell Head															
05.04.03	Removing RPV Head (incl. Steam dryer)															
05.04.04	Cutting RPV Head (incl. Steam Dryer)															
05.04.05	Dismantling and Cutting Uper Internals															
05.04.06	Dismantling and Cutting Chimney (incl. FWS)															
05.04.07	Dismantling and Cutting Core grid & Fuel support plate															
05.04.08	Dismantling and Cutting Lower RPV Internals															
05.04.09	Dismantling and Cutting Shroud															
05.04.10	Close Working Place															

Table 10-11: Detailed KCD Decommissioning costs per year (continued)

WBS	Working Packages with sub-levels	Total [k€]	2041 [k€]	2042 [k€]	2043 [k€]	2044 [k€]	2045 [k€]	2045 [k€]	2047 [k€]	2048 [k€]	2049 [k€]	2050 [k€]	2051 [k€]	2052 [k€]	2053 [k€]	2054 [k€]
06	DISMANTLING RPV															
06.01	Planning and Engineering															
06.01.01	Implementation planning															
06.02	Attendant Measures															
06.02.01	Project management															
06.02.02	Supervision															
06.02.03	On Site Radiological Protection															
06.02.04	Internal Transport															
06.02.05	Accompanying Decontamination															
06.04	Execution Project															
06.04.01	Dismantling RPV-Insulation															
06.04.02	Cutting RPV-Flange															
06.04.03	Add Cut RPV-Flange															
06.04.04	Dismantling RPV-Insulation (26 to 29 m)															
06.04.05	Cutting RPV-Cylindrical part (26 to 29 m)															
06.04.06	Add Cut RPV-Cylindrical part (26 to 29 m)															
06.04.07	Dismantling RPV-Insulation (24,5 to 26 m)															
06.04.08	Cutting RPV-Cylindrical part (24,5 to 26 m)															
06.04.09	Add Cut RPV-Cylindrical part (24,5 to 26 m)															
06.04.10	Dismantling RPV-Insulation (21,5 to 24,5 m)															
06.04.11	Cutting RPV-Cylindrical part (21,5 to 24,5 m)															
06.04.12	Add Cut RPV-Cylindrical part (21,5 to 24,5 m)															
06.04.13	Dismantling RPV-Insulation (Bottom and Support ring)															
06.04.14	Cutting RPV-Bottom and Support ring															
06.04.15	Add Cutting RPV-Bottom and Support ring															
06.04.16	Close Working Place															
07	DISMANTLING DRYWELL															
07.01	Planning and Engineering															
07.01.01	Implementation planning															
07.02	Attendant Measures															
07.02.01	Project management															
07.02.02	Supervision															
07.02.03	On Site Radiological Protection															
07.02.04	Internal Transport															
07.02.05	Accompanying Decontamination															
07.04	Execution Project															
07.04.01	Dismantling Drywell internals above 29 m															
07.04.02	Dismantling Drywell internals between 26 and 29 m															
07.04.03	Dismantling Drywell internals between 24,5 and 26 m															
07.04.04	Dismantling Drywell internals between 21,5 and 24,5 m															
07.04.05	Dismantling Drywell internals between 17,5 and 21,5 m															
07.04.06	Dismantling Drywell internals below 17,5 m															
07.04.07	Dismantling Insulation inside Drywell															
07.04.08	Dismantling Drywell Wall															
07.04.09	Close Working Place / Dismantling new equipment															

Table 10-11: Detailed KCD Decommissioning costs per year (continued)

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NIS

Siempelkamp
NIS Ingenieurgesellschaft mbH

TECHNICAL DOCUMENT

Document No.: 8229 / CA / F 008240 8 / 00

Title: ***GKN – Evaluation of Decommissioning of the Dodewaard NPP -New Decommissioning Cost Estimate-***

Task 2: Deferred Scenario
Starting date of decommissioning: 2045
Clearance levels: KEW and IAEA

Customer: B.V. Gemeenschappelijke Kernenergiecentrale Nederland (GKN)

00	16.04.2010			
Rev.	Release Date	BU / (Name) Prepared	(Signed) Reviewed	(Signed) Approved

Rev.	Chapter	Description of changes
00	All	First Edition

Executive Summary

The objective of the present study is to provide a new cost estimate for the complete dismantling of the "Kernenergiecentrale Dodewaard" (KCD) after Safe Enclosure (SE) called "KCD new Decommissioning Cost Estimate".

The KCD new Decommissioning Cost Estimate is evaluated in the frame of a **"Deferred Decommissioning Scenario"**. Under this scenario, it is assumed that the actual KCD dismantling works start in **2045**. Licensing and preparation start about 4 years earlier.

Two different tasks are evaluated:

Task 1.1:

Using best estimate assumptions, including clearance levels as defined in the Dutch "Kernenergiewet" /3/.

Task 1.2:

Using best estimate assumptions, but with IAEA RS-G-1.7 /4/ clearance levels.

The new cost estimate is performed in a frame of a Preliminary Decommissioning Plan (PDP). The sections of the present study represent a table of content for this PDP as given in Appendix 1 of the Technical Requisition File (TRF) /6/. The level of detail provides a full understanding how the decommissioning costs are obtained and shows that they are in compliance with Dutch Laws and context specifications taking into account all KCD conditions.

The present study is prepared by NIS Ingenieurgesellschaft mbH (NIS). For almost 30 years now NIS has been involved in nuclear decommissioning projects and has analyzed 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 /7/.

The main assumptions made in the present study are:

- The decommissioning costs of the "Deferred Decommissioning Scenario" are extrapolated from the decommissioning cost estimate under the "Reference Scenario" /14/.
- Only dismantling costs (incl. licensing and preparation) are estimated. Operational costs for Safe Enclosure (SE) are not included. Based on present expenses the yearly costs for SE period are ., M€ per year.
- Costs related to Authorities are included with 10 1 c [redacted]
- The wages used (GKN and Main contractor for the nuclear part) are based on relevant wages of German companies active in decommissioning activities. The wages used for Building demolition and the Site recovery are given by GKN based on information from a Dutch demolition company.
- The goal of the decontamination and dismantling activities is to reach "Green field". The dismantling includes the removal of the buildings, of all the various underground structures, including among others the foundation piles, the cooling water inlet structures, and bringing the soil of the site at the same level as the surroundings.

- An updated status of KCD (using the most recent physical and radiological data inventories stored in Dodewaard Information System - DIS) has been taken into account.
- All materials in the controlled area are supposed as being radioactive, unless measurements indicate that the contamination is below the clearance levels.
- 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.
- The COVRA waste management costs given in the Appendix 7 of the TRF /6/ updated to 2009 costs by E-mail (dated 25. Feb. 2009) have been used. The costs for "Transport, Interim Storage at COVRA, and Disposal" for KONRAD Type II containers are based on an E-Mail from COVRA dated 7. Oct. 2009 /10/.
- Both absolute and net present value costs are estimated; the discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk) is 4 % above inflation. This figure serves as a standard indexing number, as it was chosen in the past. Therefore, it is used in the present study as well, in order to make a comparison between studies possible.
- The reference date for the price level of the cost estimate is taken as 01.01.2009. VAT is not included in the costs.

The results of the new Decommissioning Cost Estimate KCD are as follows. The first table gives an overview of the produced amount of radioactive waste, the necessary packages, the waste storage volume as well as the costs for transport, interim storage at COVRA and final disposal.

Task No.	Free Release Levels taken from	Packed Mass [Mg]	Number of Disposal Containers [-]	Disposal Containers Costs [M€]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal [M€]
1.1	KEW NL	1134,8	2316		1168,1	
1.2	IAEA	1344,3	2371		1423,2	

The second table shows the results of the cost estimate considering the different tasks.

Task No.	Free Release Levels taken from	Costs	
		Absolute Value [M€]	Net Present Value (4% above inflation) [M€]
1.1	KEW NL		
1.2	IAEA		

It should be noted that it is rather difficult to anticipate and evaluate the uncertainties on the decommissioning costs resulting from some fifty years time-scale period (between now and the end of the decommissioning).

The overall duration of the project (starting with planning and ending with "Green field" conditions) takes about 14 years.

More detailed results can be found in the following sections of the study or on the CD (delivered in the frame of the present study).

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List of Abbreviations

Abbreviation	Description
AB	Auxiliary Building
AG	Afvalgebouw
ALARA	As Low As Reasonably Achievable
BS	Biological Shield
CA	Controlled Area
CALCOM	Calculation and Cost Management
CORA	Component Registration and Analysis
COVRA	N.V. Centrale Organisatie Voor Radioactief Afval
D&D	Decommissioning & Dismantling
DF	Distribution Factor
DIS	Dodewaard Information System
EWN	Energiewerke Nord GmbH
GKN	B.V. Gemeenschappelijke Kernenergiecentrale Nederland
GNS	Gesellschaft für Nuklear-Service mbH
HP	Health Physics
HTP	Hoofd Toegangs Poort
IAEA	International Atomic Energy Agency
KCD	Kernenergiecentrale Dodewaard
KEW	Kernernergiewet
NC	Normal Concrete
NG	Nevengebouw
NIS	NIS Ingenieurgesellschaft mbH
NL	The Netherlands
NPP	Nuclear Power Plant(s)
PDP	Preliminary Decommissioning Plan
PSE	Preparation for Safe Enclosure
QA	Quality Assurance
RB	Reactor Building
RG	Reactorgebouw
RPV	Reactor Pressure Vessel
SE	Safe Enclosure
TB	Turbine Building
TE	Tractebel Engineering S.A.
TG	Turbinegebouw
TRF	Technical Requisition File
VAT	Value Added Tax
VB	Ventilation Building
VG	Ventilatiegebouw
VROM	Volkshuisvesting, Ruimtelijke Ordening en Milieu
WAS	Water Abrasive Suspension
WB	Waste Building
WBS	Work Breakdown Structure
WP	Working Package

1 Introduction

The Dodewaard NPP (KCD) has been shut down on March 26th 1997. The dismantling strategy is a complete dismantling of the plant to Greenfield Conditions after a waiting period of several years as a so called Safe Enclosure (SE).

On April 23rd 2003, after the last spent fuel was transported from site, the phase Preparation for Safe Enclosure (PSE) started. This phase lasted till June 30th 2005. On July 1st 2005, the phase Safe Enclosure (SE) started. This phase is planned to last for 40 years.

After the SE phase the NPP will be completely dismantled to so-called Greenfield Conditions.

has performed cost studies for the decommissioning of the Dodewaard NPP under different contracts.

The first one in 1994 /1/ in the frame of two scenarios: immediate dismantling after a planned final shutdown in 2004 and deferred dismantling scenario, i.e. dismantling 40 years after a planned reactor final shutdown.

A second study was performed in 1999 /2/ in the frame of deferred dismantling scenario, i.e. to cover the costs for Preparation for Safe Enclosure, the Safe Enclosure (40 years) and the Dismantling to "green field".

The objective of the present study is to provide a new cost estimate for the complete dismantling of the "Kernenergiecentrale Dodewaard" (KCD) after SE called "KCD new Decommissioning Cost Estimate". This new cost estimate is established using the inputs – at their best knowledge – of following parties:

- B.V. Gemeenschappelijke Kernenergiecentrale Nederland (GKN) supported by Tractebel Engineering S.A. (TE);
- Volkshuisvesting, Ruimtelijke Ordening en Milieu (VROM);
- N.V. Centrale Organisatie Voor Radioactief Afval (COVRA).

A working group constituted by representatives of these parties has set-up a Technical Requisition File (TRF) /6/ that takes into account the inputs and contributions of each involved party and serves as basis for the present study.

The KCD new Decommissioning Cost Estimate is evaluated in the frame of a **"Deferred Decommissioning Scenario"**. Under this scenario, it is assumed that the actual KCD dismantling works start in 2045.

This cost estimate will:

- be performed using CORA/CALCOM programmes, taking advantage of the return of experience from past and on-going D&D projects (in particular in Germany);
- address the concerns (see Appendix 3 of the TRF /3/) expressed previously by the Task Force (TOK) having reviewed the previous cost estimates;
- take into account an updated status of KCD (using the most recent physical and radiological data inventories);
- take into account new boundary conditions.

Two different tasks are evaluated:

Task 1.1:

Using best estimate assumptions, including clearance levels as defined in the Dutch "Kernenergiewet" /3/.

Task 1.2:

Using best estimate assumptions, but with IAEA RS-G-1.7 /4/ clearance levels.

The new cost estimate is performed in a frame of a Preliminary Decommissioning Plan (PDP). The sections of the present study represent a table of content for this PDP as given in Appendix 1 of the Technical Requisition File (TRF) /6/. The level of detail is enabling GKN/VROM/COVRA/TE to fully understand how the decommissioning cost is obtained and that it is in compliance with Dutch Laws and context specifications taking into account all KCD conditions.

The assumptions, boundary conditions and results of the new Decommissioning Cost Estimate KCD are described in the following sections and, in addition, all results are provided on a CD.

2 Description of the Plant

2.1 Site

De inrichting ligt in de Over-Betuwe (provincie Gelderland), aan de rechteroever van de Waal. De vestigingsplaats, circa 20 km ten westen van Nijmegen en Arnhem, ligt in het gebied van de gemeente Neder Betuwe, dorp Dodewaard, circa 2 km ten zuidoosten van het centrum, in de Hiensche uiterwaarden (see Figure 2-1).

In het bestemmingsplan buitengebied van de gemeente Dodewaard is aan het terrein waarop de inrichting staat de bestemming "elektriciteitscentrale" toegekend. Dit terrein is 26 ha groot; het gedeelte waarop de gebouwen staan, is opgehoogd tot 13 m boven NAP. De vloerhoogte van de gebouwen is 13,20 m boven NAP.

The KCD is out of operation since March 26th 1997 and since July 1st 2005 the plant is in a Safe Enclosure status, i.e. the controlled area is reduced to a minimum and all buildings which are not necessary anymore are removed. All presently redundant systems have been retired. Briefly this means that these systems have been drained, oil removed and isolated mechanically and electrically. Other systems are still in operation to maintain the required safety level for personnel and environment.

2.2 Buildings on Site

Tot de Veilige Insluiting behoren de volgende gebouwen:

- Reactorgebouw;
- Turbinegebouw;
- Nevengebouw;
- Ventilatiegebouw;
- Afvalgebouw.

The plant layout during SE is shown in Figure 2-2.

Hieronder volgt per gebouw een globaal overzicht van de componenten, systemen en ruimten die zich in de Veilige Insluiting bevinden:

- in het reactorgebouw bevinden zich onder andere het reactorvat, de reactorkamer, het biologisch schild, het splijtstofopslagbassin, de drukvereffeningsvaten en een aantal systemen die tijdens vermogensbedrijf sterk radioactief besmet zijn geraakt, zoals bijvoorbeeld het reactorwaterzuiveringssysteem (see Figure 2-3 and Figure 2-4);
- in het turbinegebouw bevinden zich onder andere de turbine, de generator, de condensors, voedingwaterpompen en voorwarmers. Tevens bevinden zich in dit gebouw enkele ruimten waarin potentieel met radioactieve stoffen besmette systemen zijn ondergebracht;

- in het afvalgebouw bevinden zich onder andere systemen die zijn gebruikt voor de verwerking en opslag van radioactief afval, zoals een aantal tanks voor de opslag van radioactief afvalwater, de afvalwaterindamper, de afvalverwerkingstraat en de balenpers;
- in het nevengebouw bevindt zich onder andere de ruimte voor toevoer, filtering en ontvochtiging van de ventilatielucht. In dit gebouw bevindt zich ook de bewaking-/bedieningsconsole voor de Veilige Insluiting. In dit gebouw is de hoofdtoegang tot de Veilige Insluiting gelegen met bijbehorende HTC faciliteiten, laboratorium faciliteit en kantoren. Tot het nevengebouw behoren verder nog diverse ruimten die tijdens vermogensbedrijf een functie hadden zoals de regelzaal, waterbehandelingsruimte, elektrische ruimten, schakelruimten, transformatorruimten en kabelruimten;
- in het ventilatiegebouw bevinden zich onder andere de afvoerventilator en het afvoerfilter. Verder bevinden zich in dit gebouw componenten van het voormalige hoofdventilatiesysteem.

Naast bovengenoemde gebouwen staan op het terrein van de inrichting nog enkele andere gebouwen en opstallen, zoals het afgesloten koelwatergebouw, waarvan de opbouw en de componenten zijn verwijderd, de steiger en de HTP (HoofdToegangsPoort). De HTP heeft de functie van loge en bevat een deel van het elektriciteitsvoorzieningsysteem.

Het koelwatergebouw, waarvan de opbouw en de componenten zijn verwijderd en de toegangen zijn afgesloten, maakt evenals de lossteiger geen deel uit van de Veilige Insluiting, doch dient evenals het koelwater uitlaatwerk en de constructies rond de koelwater inlaathaven te worden verwijderd tijdens de eindontmanteling.

2.3 Physical Inventory

The physical or mass inventory of the KCD plant is based on a detailed data collection and the results are stored in the Dodewaard Information System (DIS). DIS allows a detailed evaluation of the inventory data regarding several criteria like component type, material, locations, activity classes and dose rates. These data are transferred to the database CORA to use all information for the new decommissioning cost estimate in the present study.

Some examples of different mass reports (based on DIS/CORA) are given in Table 2-1 to Table 2-3 (names and description are taken from DIS). The masses for the building structures are taken from previous studies /1/, /2/ and are listed in Table 2-4. All these masses are so called primary masses.

During dismantling and treatment of the dismantled components and equipment so called secondary masses (clothes, plastic foils, tools, etc.) are produced. For more information see section 8.

For dismantling, treatment, packaging or release of the plant inventory new equipment has to be installed. New temporary buildings for the release measurement facility and buffer storages for incoming empty containers and outgoing filled containers are erected on site. These new equipments and buildings are called tertiary/additional masses. An evaluation of these masses is given in Table 2-5. More details are given in section 9.

The plant layout during the dismantling phase is shown in Figure 2-5.

2.4 Overview of known incidents with building contamination at KCD

During the PSE phase a report was conducted by POVI group (group of engineers responsible for the design of the SE) in close cooperation with the Chemistry group, the Health Physics group, and the building and site maintenance group. The report was released on September 17, 1998. Report number is 98-009/POV/R, rev 0. The information from the report is incorporated in DIS. The report itself is stored in the 1999 Technical Information Package 1999 (TIP 99) archive under code number 3-4.

During the operational period of the plant, an overview of water transports in the plant was produced on a monthly basis. From these overviews, it was never possible to deduct a leakage or uncontrolled release of water to the environment.

Table 2-7gives an overview of incidents resulting in contamination of building structures. The amount of concrete involved has been taken into account in a conservative way in the evaluation of the concrete masses which have to be removed during building decontamination (see also section 8.3.2). The cement in the floor drain systems is removed completely.

2.5 Tables

Building / Building level	Description	Mass [Mg] original
AG-NG-VG	Afval gebouw-Neven gebouw-Ventilatie gebouw	10,84
AG-A	Afval gebouw 10 meter vloer	47,39
AG-B	Afval gebouw 13 meter vloer	292,82
AG-C	Afval gebouw 19 meter vloer	101,52
AG-D	Afval gebouw 22 meter vloer	11,43
NG-A	Neven gebouw 10 meter vloer	32,96
NG-B	Neven gebouw 13 meter vloer	162,95
NG-C	Neven gebouw 17 meter vloer	107,07
NG-D	Neven gebouw 22 meter vloer	3,92
NG-E	Neven gebouw dak	3,00
RG-A	Reactor gebouw	193,21
RG-B	Reactor gebouw 13 meter vloer	489,01
RG-C	Reactor gebouw 17 - 22 meter vloer	2410,74
RG-D	Reactor gebouw 28 meter vloer	31,76
RG-E	Reactor gebouw 31 meter vloer	46,41
RG-F	Reactor gebouw 36 meter vloer	32,61
RG-G	Reactor gebouw lift vloer	74,72
TG	Turbine gebouw	17,99
TG-A	Turbine gebouw 10 meter vloer	337,65
TG-B	Turbine gebouw 13 meter vloer	244,26
TG-C	Turbine gebouw 17 meter vloer	90,17
TG-D	Turbine gebouw 22 meter vloer	615,40
VG-A	Ventilatie gebouw 10 meter vloer	0,59
VG-B	Ventilatie gebouw 13 meter vloer	73,90
VG-C	Ventilatie gebouw 19 meter vloer	3,00
	Total	**5435,32**

Table 2-1: KCD plant inventory – Masses per building / building level

System	Description		Mass [Mg] original
ACB/WWB	AFVALCHEMICALIENBEHANDELING/WASWATERBEHANDELING		8,81
ACS	AIRCONDITIONINGSYSTEEM		0,40
ADS	AUTOMATISCH DRUKAFLAATSYSTEEM		2,15
AIS	AFVALWATERINDAMPSYSTEEM		9,28
AVT	AFTAP EN VLOERWATERTANKS		1,29
AWO	AFSCHERMWATER OPSLAGTANKS		40,54
BBS	BRANDBLUSSYSTEEM		1,12
BLW	BRON EN LEIDINGWATER SYSTEEM		3,02
BMI	BRANDMELDINSTALLATIE VI		0,02
CBW	CONDENSOR EN BEDRIJFSKOELWATER		2,80
CRS	CONDENSAATREINIGINGSSYSTEEM		6,63
CVS	CENTRALE VERWARMINGSSYSTEEM		15,21
DACO	NOODDIESELAGGREGAAT		9,64
DHS	DEMINWATER HYDROFOORSYSTEEM		4,27
GIS	GAS INERTISERINGSSYSTEEM		1,27
GKS	GESLOTEN KOELWATERSYSTEEM		11,24
HKS	HOOFDKONDENSAATSYSTEEM		71,35
HRS	HARSREGENERATIESYSTEEM		7,22
HSS	HOOFDSTOOMSYSTEEM		189,90
IRD	ISOLATIE REACTORKAMER EN DRUKVEREFFENINGSVATEN		0,13
KIS/DAS	KERNINUNDATIE/DRUKVEREFFENINGSVATENSYSTEEM		136,23
KKS	KONDENSORKOELWATERSYSTEEM		182,32
KSL	KOELSYSTEEMLEIDBUIZEN		1,22
KSR	KOEL SYSTEEM REAKTORKAMER		2,55
LAS	LUCHTAFZUIGSYSTEEM		1,84
LOS	LAGEROLIESYSTEEM		1,92
LVA	LICHT VERONTREINIGD AFVALWATERBEHANDELING		4,57
LVS	LUCHTVOORZIENINGSSYSTEEM		9,45
LWS	LENSWATERSYSTEEM		0,73
NAI	NUCLEAIRE AFVALWATER INSTALLATIE VI		0,53
NCS	NOODCONDENSATIESYSTEEM		17,49
NGS	NEUTRONENGIFSYSTEEM		1,69
NIJS	NEUTRONENFLUX IJKSYSTEEM		9,12
NKS/TOS	NEVENKONDENSAATSYSTEEM/TURBINE ONTWATERINGSSYSTEEM		4,28
OMS	ONGEVALLEN MONSTERSYSTEEM		0,36
PLS	PAKKINGBUSLEKSYSTEEM		2,28
RAS	REACTORAFKOELSYSTEEM		5,78
RAV/AOT	RADIOACTIEF AFVALBEHANDELINGSSYSTEEM EN AFVAL OPSLAG TANKEN		71,31
RBS	REACTORBEVEILIGINGSSYSTEEM		0,12
ROS	REGELOLIESYSTEEM		0,20
RSA	AANDRIJFSYSTEEM		20,21
RV	REACTORVAT		181,06
	included are:		
	- Drywell	82,07	
	- RPV Internals	6,62	
	- RPV Head	16,11	
	- RPV Cylindrical part and bottom	70,66	
	- RPV Insulation	5,20	
RZS	REACTORWATERZUIVERINGSSYSTEEM		15,44

Table 2-2: KCD plant inventory – Masses per system

System	Description		Mass [Mg] original
SBK/SRS	SPLIJTSTOFBASSIN KOELSYSTEEM/SLIJTSTOFOPSLAGBASSIN REINIGING		7,63
SHS/AG	SPERWATER HYDROFOORSYSTEEM IN AFVALGEBOUW		0,46
SSW	SPOEL EN SUPPLETIEWATERSYSTEEM		13,51
SWD	SUPPLETIEWATER DEMINERALISATIE INSTALLATIE		6,79
TKS	TRANSFORMATORKOELSYSTEEM		0,59
TSS	TURBINE SPERWATERSYSTEEM		0,03
VAS	VACUUMAFGASSYSTEEM		35,13
VEN	VENTILATIESYSTEEM		103,41
VWB	VLOERWATERBEHANDELING		1,93
VWS	VOEDINGSWATERSYSTEEM		16,15
WRS	WATERSTOFRECOMBINATIESYSTEEM		1,74
YDS	IJZERSULFAAT DOSEER SYSTEEM		0,80
NOT DEF	NO SYSTEM DEFINED in DIS, here are included:		4190,16
	- ELEKTRICITEITSKAST	45,74	
	- KABELGOOT	303,93	
	- APPENDAGES	5,25	
	- LEIDINGEN	171,08	
	- DVERIGEN OPSLAG	67,19	
	- POMP	2,40	
	- KOPEREN RAILS (AARDLEIDING)	4,30	
	- MOTOR	116,54	
	- TANK	50,18	
	- BORDES, TRAP, ONDERSSTEUNINGEN, HIJSBALK	687,72	
	- OVERIGEN EI	27,90	
	- LIFT, VERWARMING, AFSCHERMING,VLOER	46,80	
	- BIOLOGICAL SHIELO (activated and not activated part)	2336,48	
	- NOT DEFINED	34,22	
	- AFSCHERMING	247,74	
	- WARMTEWISSELAAR	0,02	
	- PE LEIDINGEN	2,65	
	- INSULATION	40,02	
	Total		**5435,32**

Table 2-2: KCD plant inventory – Masses per system (continued)

Material	Description	Mass [Mg] original
NOT DEF	NOT DEFINED	41,61
STAAL	KOOLSTOFSTAAL	2030,32
RVS	ROESTVRIJSTAAL	230,20
KOPER	KOPER	36,22
PE	POLYETHYLEEN (KUNSTSTOF	4,42
LOOD	LOOD	29,54
DIV	DIVERSEN DOOR ELKAAR HEEN	2,49
BETON	BETON incl. Mass of Biological Shield [Mg]: 2336,48	2633,80
ALU	ALUMINIUM	11,08
HOUT	HOUT	3,11
PVC	POLYVENYLCHLORIDE	0,54
ZNST	ZINKSTAAL	2,99
KGM	KABELGOOT MATERIAAL (KOPER, STAAL, PVC, ZNST)	302,15
EKM	ELEKTRICITEITS KAST MATERIAAL (KOPER, STAAL, PVC)	48,83
CEMENT	CEMENT	18,00
WOOL	INSULATION MATERIAL	40,02
	Total	**5435,32**

Table 2-3: KCD plant inventory – Masses per material

Description	Mass [Mg]
Controlled Area:	
RG - structures (without Biological Shield)	11160,0
TG - structures	15020,0
AG -, VG -, NG - structures	22800,0
Conventional Part:	
HTP Entrance building	140,0
KWG Cooling water building / channel	7860,0
Piles	7270,0

RG = Reactorgebouw
TG = Turbinegebouw
AG = Avfalgebouw
VG = Ventilatiegebouw
NG = Nevengebouw

Table 2-4: KCD plant inventory – Masses of building structures

Description	Mass [Mg]
Masses from Preparation for Safe Enclosure	30,0
Remote controlled equipment	265,0
Treatment facilities and installations	294,0
New installations (e.g. transport equipment, ventilation system)	73,5
New installations (e.g. waste water treatment, conv. installations)	135,0
New buildings	840,0
Total	**1637,5**

Table 2-5: Evaluated tertiary masses (new buildings and installations)

Description	Mass [Mg]	
Plant inventory:		**6.232,8**
- Primary mass (see Table 2-1 to 2-3)	5.435,3	
- Tertiary/additional mass (see Table 2-5)	797,5	
Building structures:		**65.090,0**
- KCD buildings (see Table 2-4)	64.250,0	
- New buildings (see Table 2-5)	840,0	
Total mass:		**71.322,8**

Table 2-6: Summary of KCD masses to be dismantled or demolished

Location	Description	Activity (Bq)	Status
TG-E01	Roof ventilator system	3 times the background level	Removed before start SE
Emergency exit RG	Outside building ground contamination	Up to 10 times the background level	Removed at start construction Aux building 2
All basements	Incoming water from river due to extreme high water level	None	Not confirmed. This was just a rumour.
Several walls	Minor cracks. Possibly contaminated	Unknown	All cracks checked and injected. No true cracks.
All buildings	Floor drain systems	Unknown	Filled with cement during PSE *)
NG-A02	Basement former laboratory. Leakage of LWS-T15	5 E +8 (1980) Co-60	In top floor and long crack. *)
Site	Particles found during routine checks	Above background	Removed when detected
RG-A04	AVT-T2. By drawing this floor should be covered by special bricks. In practice this is concrete.	High, as this was the RG sump.	Still in place. Change of airborne contamination. *)
RG-A02A	Overfill of AVT-T1 leads to floor contamination. Small cracks in floor paint and cover	High, as the water originated from RWCU resin transport	Partly cleaned. Due to high radiation from AVT-T1 no access to room. *)
VG-A01	Water leakage from drain system of HRS	High	Removed, including crack.
NG-A02 and NG-B01	Wall tumbled over. Open connection between LWS P5 and P6 to soil. Possible leak path.	Unknown	Can only be solved at final demolition. Non accessible. *)
Grounds surrounding NPP	Minor ground contamination	Below clearance levels	Reported to government. No action required.

*) Cement filled in floor drain systems is removed completely during decommissioning and the amount of contaminated concrete is considered together with the removed amount of concrete during building decontamination.

Table 2-7: Overview of incidents resulting in contamination of building structures

2.6 Figures

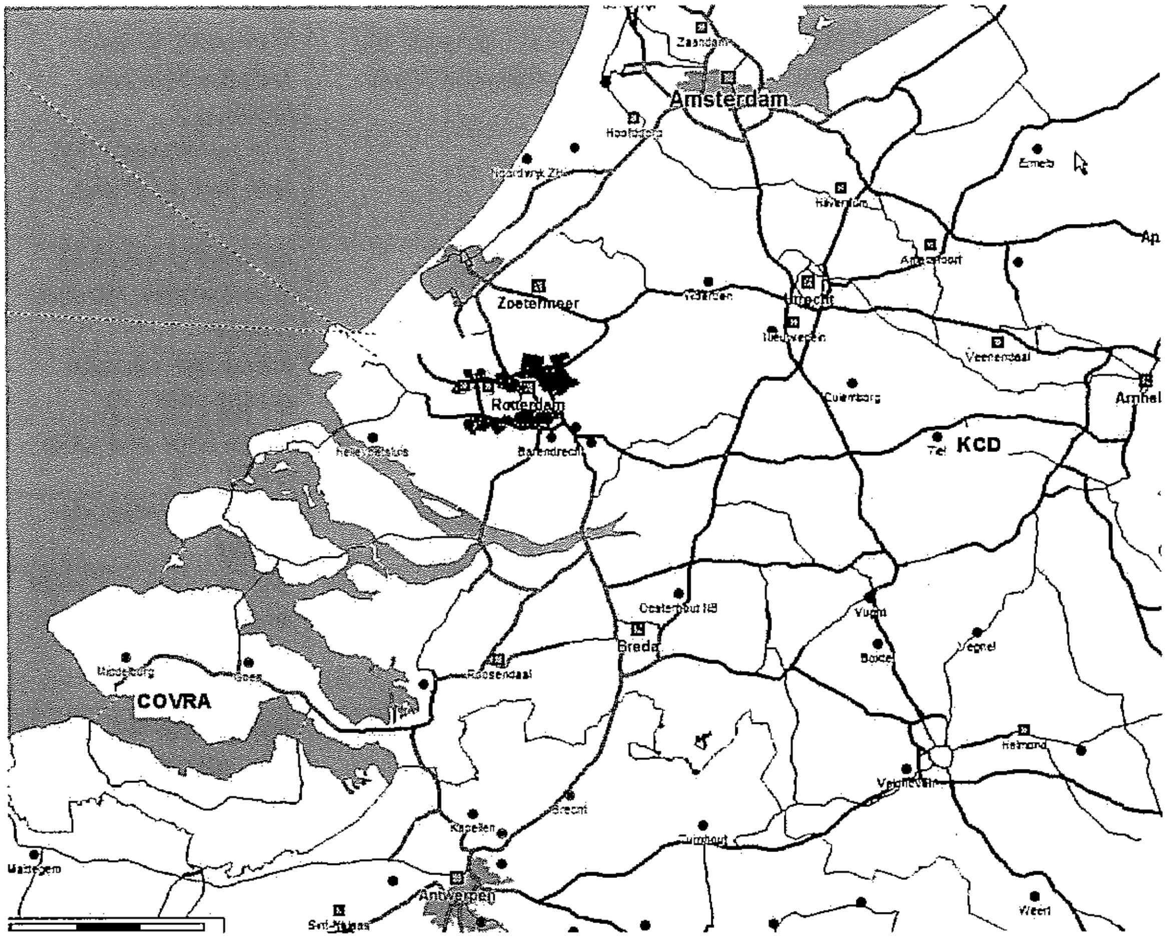


Figure 2-1: Location of the sites (KCD and COVRA)

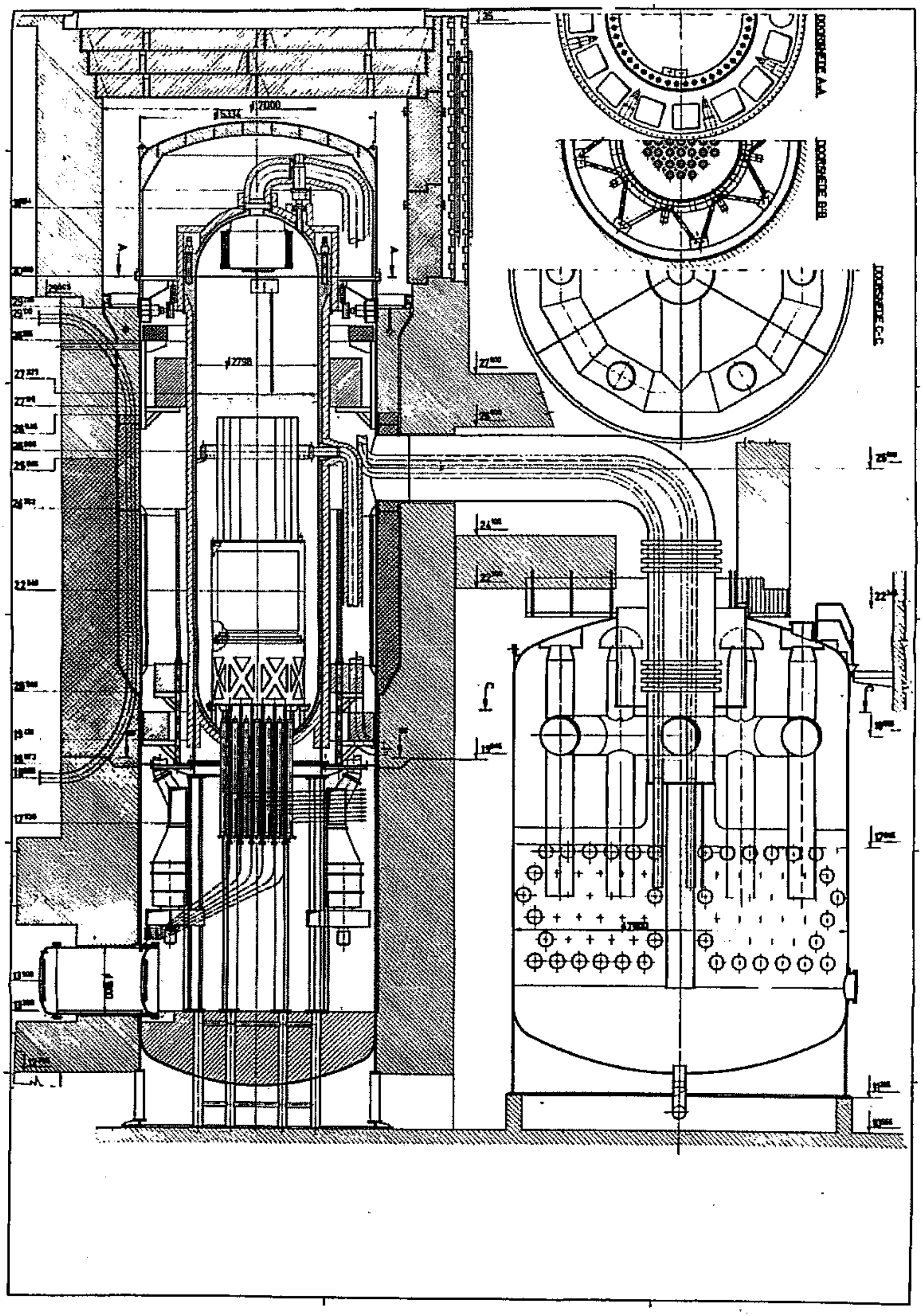


Figure 2-3: Section through Drywell and Internals (incl. Pressure Compensation Vessel)

10 1 b

[redacted]

Figure 2-2: Plant layout during Safe Enclosure Phase

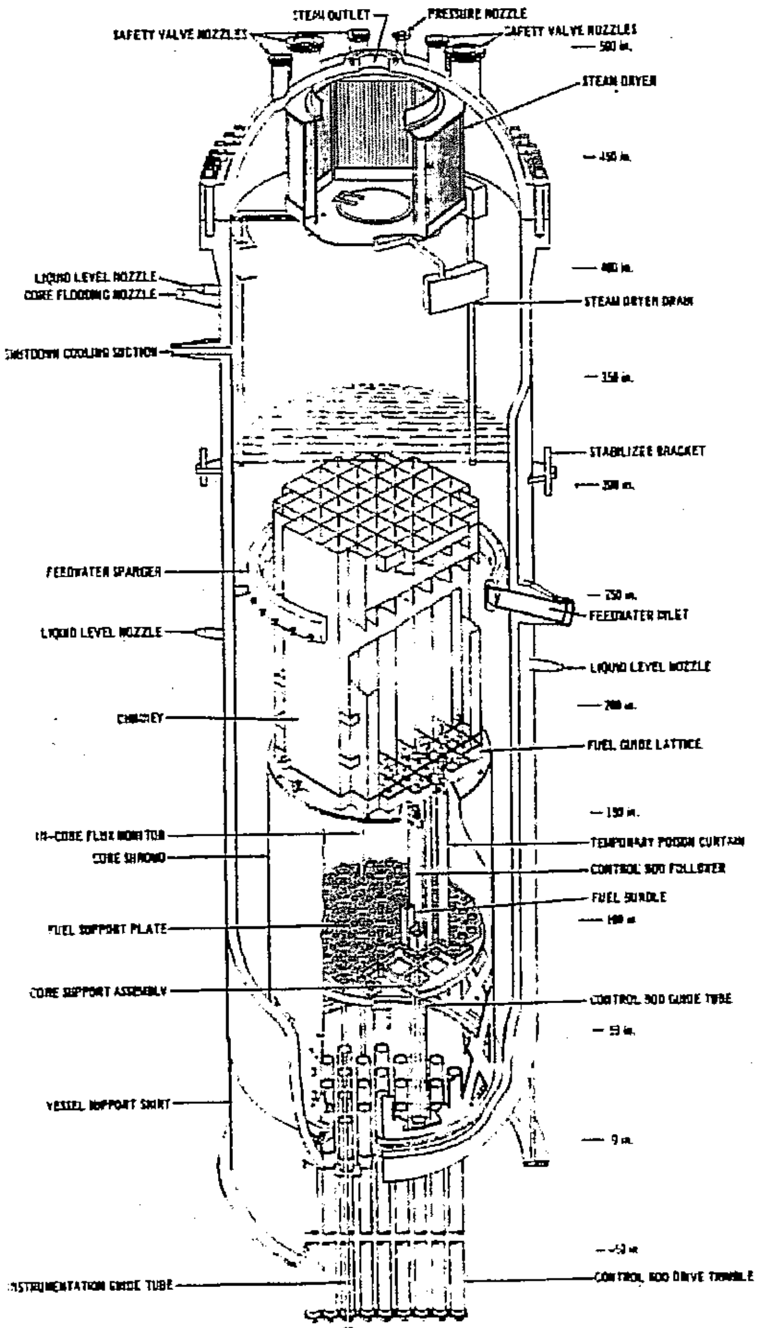


Figure 2-4: Section through Reactor Pressure Vessel and Internals

Figure 2-5: Plant layout during Dismantling Phase

3 Radiological Inventory of the Plant

The data of the radiological inventory of the KCD plant is also stored in DIS. DIS allows an evaluation of these data considering different decay times. So the radiological inventory is estimated at the planned date of dismantling. These data are transferred to the database CORA to use the information for the new decommissioning cost estimate.

Under the "Deferred Decommissioning Scenario", it is assumed that the actual KCD decommissioning starts in 2045. For the purpose of the study it is necessary to define a reference date where all evaluations (dismantling, waste management, radiation exposure, etc.) are based on. For the "Deferred Decommissioning Scenario" this date is assumed to be the 30.06.2047. This date has been chosen as a conservative date for the start of actual dismantling work. Until this date more or less only new installations and modification works will be carried out.

3.1 Radiological Inventory

The radioactivity and the nuclear decay is characterized by the nuclide vectors (= percentage of the different nuclides in a material). According to the earlier operation characteristics the nuclide vectors will be different in different buildings and/or systems.

The nuclide vectors were checked during the project and it was approved that the ones used for the previous study are still valid. No alpha-activity was found in samples taken, but trace amounts of alpha-emitting nuclides were found in the suction lines of the RPV. These trace amounts were below clearance levels. Sampling was done by GKN, while COVRA analyzed the samples /8/.

The nuclide vectors have then been changed corresponding to the nuclear decay of the different nuclides to show the situation at the reference date. Table 3-1 shows the nuclide vectors for the date of shutdown of the plant (26.03.1997) and the reference date (30.06.2047).

All material in the controlled area is supposed as being radioactive, unless measurements indicate that the contamination is below the clearance levels.

Two kinds of radioactivity have to be taken into account:

- Activation;
- Contamination.

The activation of the material was generated by neutron irradiation during reactor operation. Because of that the activated area is limited to the reactor area, i.e.:

- Reactor vessel and internals;
- Reactor chamber (drywell);
- Biological shield:

The range of radioactivity is largely spread within the group of the activated material. Therefore the total mass is divided in six Activation classes (A0 to A5).

The contamination of the material is spread over the whole controlled area. Two sources of contamination have to be considered:

- Air borne contamination at the outside of the systems and equipment;
- Deposits coming from the medium inside the systems.

The contamination is divided in five Contamination classes.

There is no radioactivity data available for different components, but it is known that the radioactivity is low or even not present. The masses of these components are marked with the radioactivity class "Not defined" (total value: 112,09 Mg).

The radioactivity classes (activation and contamination), the range of radioactivity and the masses per radioactivity class are shown in Table 3-2 for the activated materials and in Table 3-3 for contaminated materials for both the date of plant shutdown and the reference date for the present study.

The layers of the Biological Shield above activity class A0 with the corresponding masses are listed in Table 3-4 for the reference date 2047. Figure 3-1 shows the location of these layers schematically. Taking into account the two different clearance levels – Dutch law (KEW) and IAEA regulations (RS-G-1.7) – the amount of concrete considered as radioactive waste is given in Table 3-5. Taking into account the Dutch clearance levels (i.e. 1,0 Bq/g for Co-60) all activation classes above A1 are considered as radioactive waste and taking into account the IAEA regulations (i.e. 0,1 Bq/g Co-60) all activation classes above A0 are considered as radioactive waste.

3.2 Tables

Name of Nuclide Vector	Building or Component	Used for 1)	Used for 2)	Used for 3)	Reference Date	Mn-54	Fe-55	Co-60	Ni-63	Zn-65	Sb-125	Ba-133	Cs-134	Cs-137	Eu-152
						Nuclides Composition [%]									
AG	Waste Building	x		x	26.03.1997	17,8		79,1						3,1	
					30.06.2047			9,8						90,2	
BS-LB	Light concrete of biolog. shield		x		26.03.1997			28,0					9,0		63,0
					30.06.2047			0,8							99,2
BS-ZB	Heavy concrete of biolog. shield		x		26.03.1997	3,5		8,0		28,0		51,0	1,5		8,0
					30.06.2047			0,4				75,2			24,4
C-Staal	Steel	x	x		26.03.1997	3,2	92,6	4,2	<0,1						
					30.06.2047		0,4	7,4	92,2						
NG	Service Building	x		x	26.03.1997	34,0		63,6						2,4	
					30.06.2047			10,2						89,8	
RG	Reactor Building	x		x	26.03.1997	43,9		56,1							
					30.06.2047			100,0							
RVS	Stainless Steel	x	x		26.03.1997	4,2	69,3	24,5	2,0						
					30.06.2047		<0,1	2,3	97,7						
SB	Core Parts		x		26.03.1997			26,4			73,6				
					30.06.2047			99,3			0,7				
TG	Turbine Building	x		x	26.03.1997	51,9		45,7		1,3	0,7			0,4	
					30.06.2047			32,8			<0,1			67,2	
VG	Ventilation Building	x		x	26.03.1997	26,7		66,7						6,6	
					30.06.2047			4,1						95,9	

1) Used for the contamination of components
2) Used for the activation of components
3) Used for the contamination of room surfaces

26.03.1997 Values at the date of shutdown
30.06.2047 Values et reference date

Table 3-1: Nuclide vectors at the date of plant shutdown and the assumed date for decommissioning ("Deferred Decommissioning Scenario")

No.	Activation class	Activity range	Mass in [Mg] *)	
			1997	2047
1	A0	Activated <= 0,1 Bq/g	1.704,74	1987,75
2	A1	Activated > 0,1 Bq/g <= 1 Bq/g	166,79	292,91
3	A2	Activated > 1 Bq/g <= 100 Bq/g	409,16	352,84
4	A3	Activated > 100 Bq/g <= 10000 Bq/g	284,92	70,81
5	A4	Activated > 10000 Bq/g <= 1000000 Bq/g	100,72	3,63
6	A5	Activated > 1000000 Bq/g	45,00	3,39
		Total	**2.711,33**	**2.711,33**

*) 26.03.1997: Values at date of shutdown
30.06.2047: Values at reference date

Table 3-2: Activation classes, activity range and mass per activation class all the activated materials

No.	Contamination class	Activity range	Mass in [Mg] *)	
			1997	2047
1	C1	Contaminated <= 0,4 Bq/cm²	770,84	2.049,25
2	C2	Contaminated > 0,4 Bq/cm² <= 4 Bq/cm²	704,63	356,02
3	C3	Contaminated > 4 Bq/cm² <= 40 Bq/cm²	434,56	129,00
4	C4	Contaminated > 40 Bq/cm² <= 400 Bq/cm²	290,96	15,35
5	C5	Contaminated > 400 Bq/cm²	410,91	62,28
		Total	**2.611,90**	**2.611,90**
6	Not Defined		112,09	112,09

*) 26.03.1997: Values at date of shutdown
30.06.2047: Values at reference date

Table 3-3: Contamination classes, activity range and mass per contamination class for all the contaminated materials

Parts of Biological Shield with Activation above A0, i.e. > 0,1 Bq/g (location of different parts see Figure 3-1)	Layer thickness [cm]	Rad. Cat.	Mass [kg]
PART B (Normal Concrete above Reactor) 25.85 - 29.50 m	0-5	A2	5.151
	5-10	A2	5.247
	10-15	A2	5.343
	15-20	A2	5.439
	20-25	A2	5.534
	25-30	A2	5.630
	30-35	A1	5.726
	35-40	A1	5.822
	40-45	A1	5.918
PART C (Normal Concrete 3/4 around Reactor) 20.55 - 25.85 m	50-55	A1	16.687
	55-60	A1	16.829
	60-65	A1	16.971
	65-70	A1	17.113
PART I (Normal Concrete 1/4 around Reactor) 20.55 - 25.85 m	50-55	A1	3.789
	55-60	A1	3.821
	60-65	A1	3.853
	65-70	A1	3.886
PART D (Heavy Concrete around Reactor) 20.55 - 26.85 m	0-5	A3	18.327
	5-10	A3	18.674
	10-15	A2	19.020
	15-20	A2	19.367
	20-25	A2	19.713
	25-30	A2	20.059
	30-35	A2	20.406
	35-40	A2	20.752
	40-45	A2	21.099
	45-50	A2	21.445
PART E (Normal Concrete ONDERAAN Reactor) 12.80 - 20.55 m.	0-5	A1	15.170
	5-10	A1	15.311
	10-15	A1	15.453
	15-20	A1	15.594
	20-25	A1	15.736
	25-30	A1	15.877
	30-35	A1	16.018

Table 3-4: Layers of Biological Shield with activation classes and masses (see also Figure 3-1)

Biological Shield		
Concrete type	**KEW**	**IAEA**
	[Mg]	**[Mg]**
Normal concrete	32,34	241,92
Heavy concrete	198,86	198,86
Total	**231,21**	**440,78**

Table 3-5: Mass of Biological Shield considered as radioactive waste (clearance levels: KEW and IAEA)

3.3 Figures

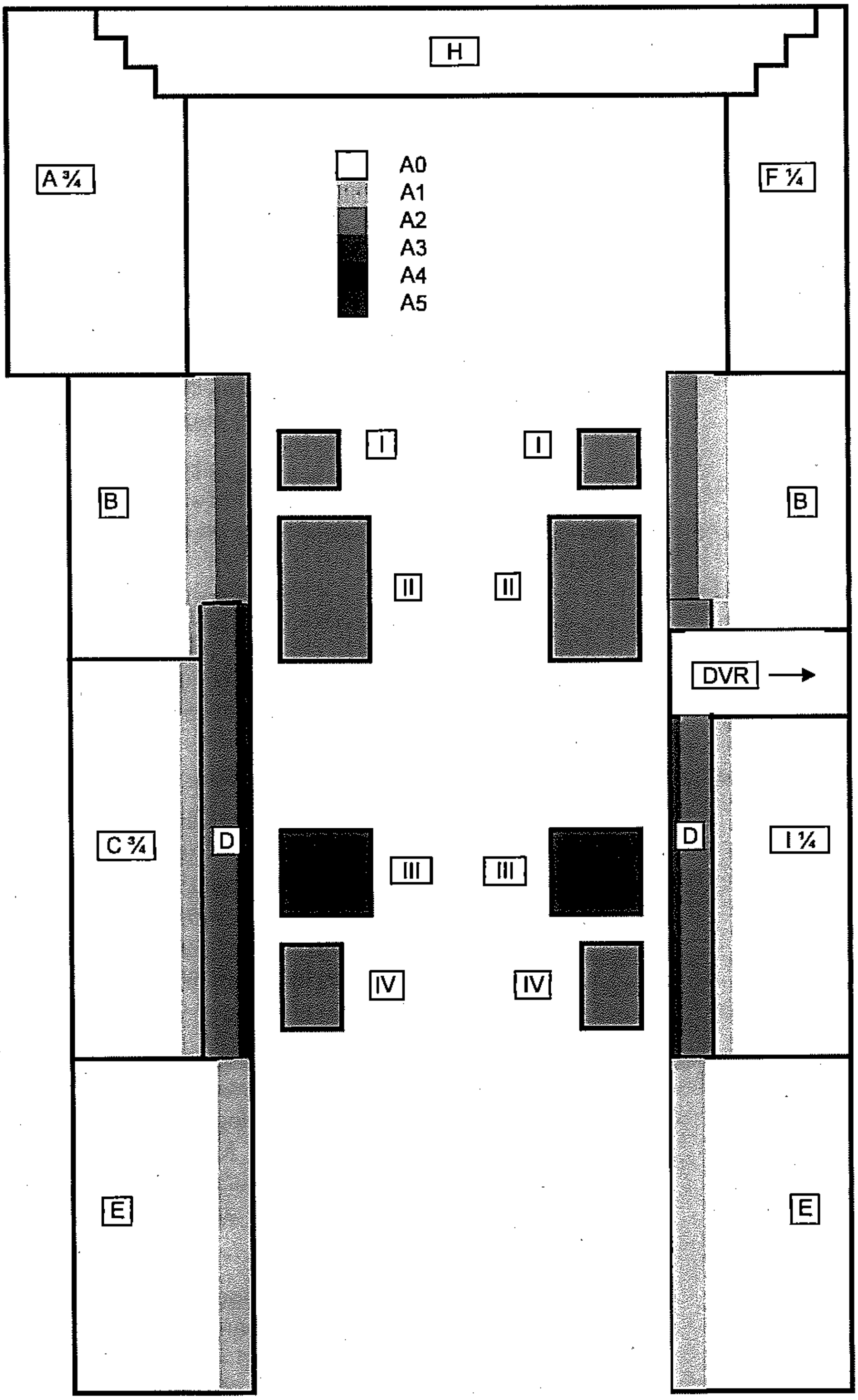


Figure 3-1: Activated layers of the Biological Shield (schematically)

4 Project Organization

4.1 Staff Qualifications

For the decommissioning cost of the NPP Dodewaard staff qualifications shown in the first column of the following table are considered, in relationship with the staff wages given in section 4.2 and Table 4-1. The second column comprises the description of the tasks and the work of the staff completed by examples explaining which qualification is required for special tasks during the decommissioning work.

Staff qualification	Description of tasks and work; examples
Project manager	He is an engineer with work experience of many years in project leading and management. In the assignment as a plant manager, he or his assistants have to co-ordinate all decommissioning activities and are responsible for safety and cost-efficiency of the whole decommissioning project. As an on-site manager he is responsible for all technical and economical aspects of individual fields during the decommissioning of a NPP. Following other on-site managers are assumed, e.g.: – 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	For instance engineers are used for the execution of the planning works and the licensing procedure, for the preparing of routine and special reports, for performing the radiation protection activities, for supervising the decommissioning and as shift engineers; e.g. the following positions are filled with 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 is working in the commercial department and is responsible for economical aspects (e.g. purchasing, contracts).
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), has to measure and record the on-the-job radiation dose information and operate the plant laboratory facilities including sampling and analysis; furthermore this personnel directs the work crews in the performance of the different decommissioning tasks (Crew leader); e.g. foremen are used as 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	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	Site security staff

Specific staff qualifications are requested for the conventional building demolition, as listed under section 4.2 and Table 4-1.

4.2 Wages

The wages (GKN and Contractor staff) used for the present decommissioning cost estimate are based on relevant wages of German companies active in D&D activities (see Appendix 6, item 6 and 7 of the Technical Requisition File /6/). The wages used for the conventional demolition are based on information from a Dutch company experienced in this area /11/. The Table 4-1 shows the wages for the above mentioned staff qualifications (price basis: 2009).

4.3 Staff Organization

It is very important to have a staff organization which fits to the needs of the decommissioning project. A general overview of the planned organization is shown in Figure 4-1.

The organization is divided up into four main parts:

- GKN;
- Main Contractor (nuclear);
- Sub-Contractors (nuclear);
- Main Contractor (conventional).

4.3.1 GKN

GKN will take care of overall plant management, finance and administration, license issues, health physics (partly), guarding (only management), operation of ventilation, electrical and waste water systems, electrical and mechanical maintenance. To fulfil these tasks a staff organization as shown in Figure 4-2 will be necessary. The total number will be 13 people.

The real decommissioning activities will be implemented by two Main Contractors, one for the nuclear decommissioning part and the other one for the conventional demolition and site restoration part.

4.3.2 Main Contractor (nuclear)

The Main Contractor is the only contact person for GKN and is managing the nuclear decommissioning of KCD, i.e. the dismantling as well as the on-site waste management activities. In this regard he is responsible for all Sub-Contractors involved in the decommissioning project. Additionally he will complement GKN in the operation of the site (maintenance, recurring checks of new installations/equipment, entrance to the controlled area, health physics, etc.). Figure 4-3 shows the tasks, the qualifications and number of staff needed for KCD decommissioning. A total number of 23,5 people will be permanent on site and additionally up to 50 people are necessary to implement the dismantling activities.

4.3.3 Sub-Contractors (nuclear)

Sub-Contractors are foreseen for following tasks:

- Preparatory work (installation of new equipment and buildings);
- Dismantling of contaminated components;

4.4 Tables

Qualification	Wages [€/h]
Decommissioning	
Project manager	
Engineer	
Accountant	
Foreman / master craftsman	
Craftsman	
Worker	
Guard (site security)	
Conventional Building Demolition	
Planner / Work organizer	
Foreman	
Craftsman / Crane operator	
Worker	

1) Possible increases:

Public holidays, weekdays:	60,5
Public holidays, weekend:	67,8
Overtime:	plus 10%
Call after stand by:	plus 30%

Table 4-1: Wages for different staff qualifications (price basis: 2009)

- Dismantling of activated components;
- Dismantling of activated part of biological shield;
- On-site waste management activities (e.g. free release, waste treatment and packaging)
- Asbestos removal;
- Building decontamination and building release.

The number of people on site will vary depending on the activities which have to be performed.

4.3.4 Main Contractor (conventional)

At the end of the nuclear dismantling the buildings are free of radioactivity above the clearance levels and the site is released from nuclear law.

The building demolition (including asbestos removal) and the site restoration is a conventional activity. Therefore the work will be done by an experienced demolition company.

This company replaces the Main Contractor (nuclear) as contact person for GKN.

4.5 Figures

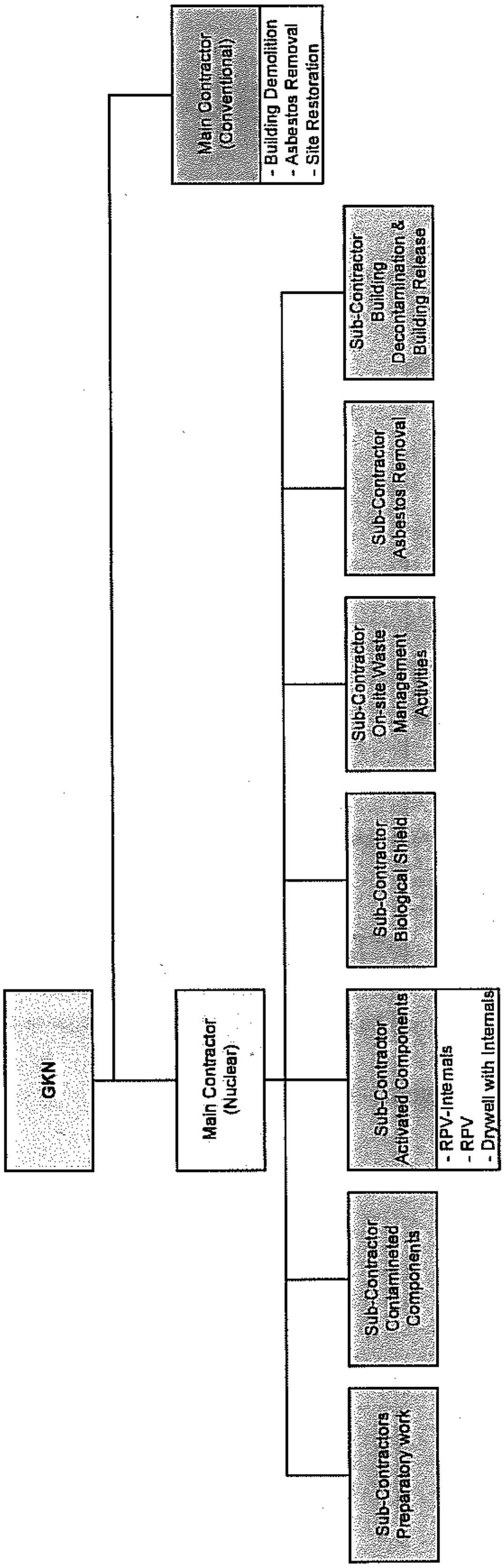
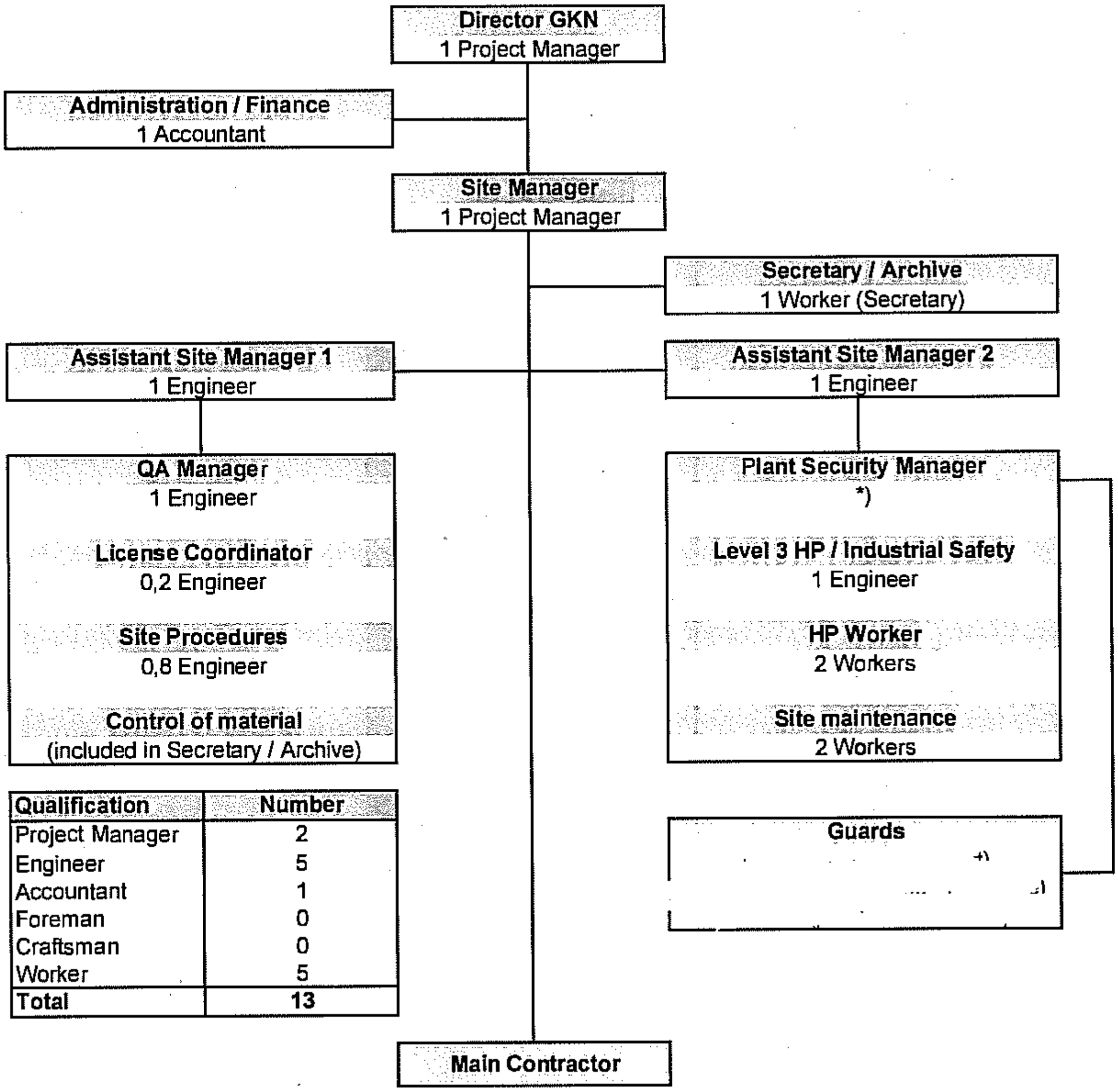


Figure 4-1: Project organization – Overview



Qualification	Number
Project Manager	2
Engineer	5
Accountant	1
Foreman	0
Craftsman	0
Worker	5
Total	**13**

*) Tasks of a Plant Security Manager will be carried out by the Site Manager or the Assistant Site Manager 2

Figure 4-2: Project organization – GKN

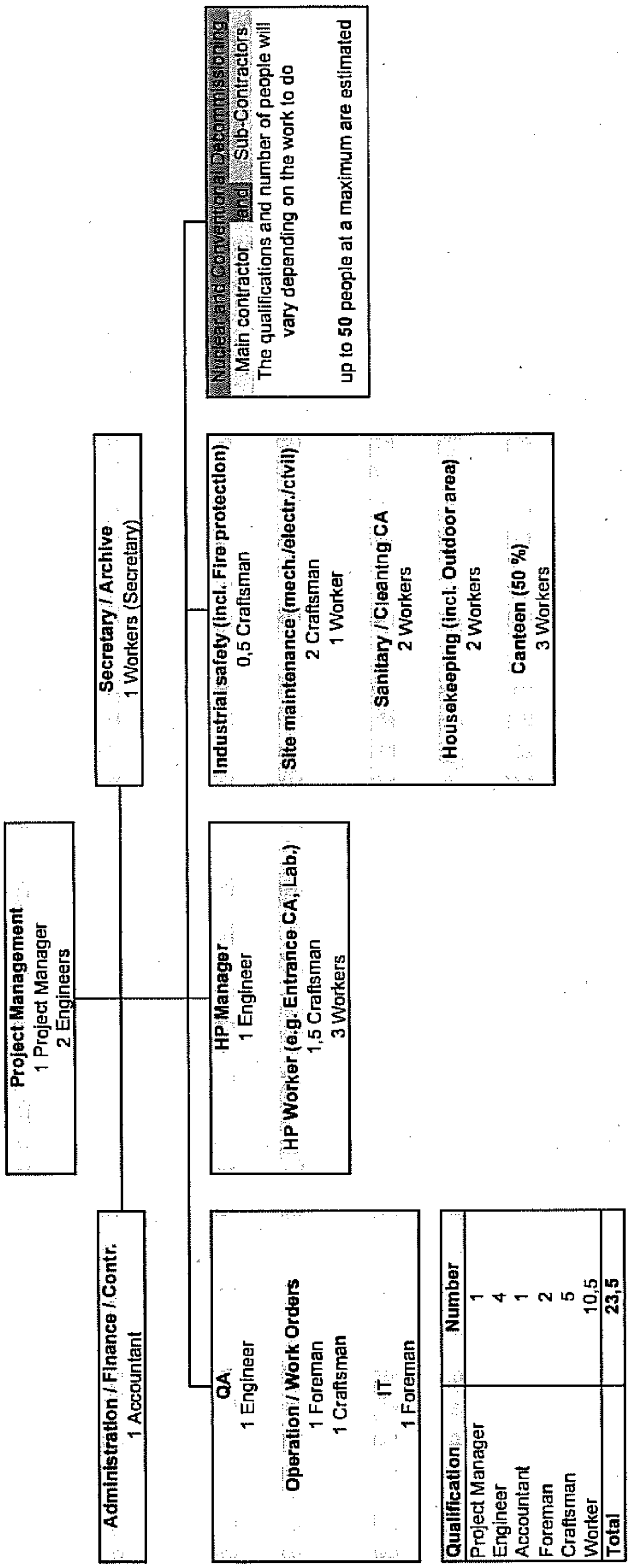


Figure 4-3: Project organization – Main contractor

5 Decommissioning Strategy

5.1 Site and surrounding characteristics

5.1.1 Nature of site

5.1.1.1 Situering van de inrichting (Site of plant)

Het terrein van de inrichting ligt op de noordoever van de Waal, op een kunstmatige verhoging in de Hiensche uiterwaarden, buiten de noordelijke Waalbandijk. De afstand tussen de beide bandijken ter plaatse van de inrichting is 1,3 km; de afstand van de inrichting tot het midden van de rivier bedraagt circa 400 m. De inrichting ligt hemelsbreed 2,2 km zuidoostelijk van het gemeentehuis van Dodewaard en 3,9 km ten westen van de plaats waar de snelweg A50 de Waal overbrugt. De snelweg A15 (Rotterdam-Nijmegen) ligt circa 2 km noordelijk van de inrichting, de dubbelbaans-spoorlijn Geldermalsen-Elst ongeveer 2,4 km. Enkele kilometers noordelijk van de inrichting bevindt zich de Betuwegoederenspoorlijn, parallel aan de A15.

5.1.1.2 De bevolking rondom de vestigingsplaats (Population in the vicinity of the plant)

De inrichting bevindt zich in de gemeente Dodewaard met ruim 4000 inwoners. De omliggende gemeenten Beuningen, Druten, Echteld, Kesteren en Valburg hebben samen ca. 75.000 inwoners (begin 1999, figure to be updated at time of preparing DP). De aanwezigheid van de inrichting levert geen beperking op voor de autonome ontwikkeling van de bevolking.

5.1.1.3 Grondgebruik en industrie (Land utilisation and industry)

Risicovolle ondernemingen, zoals chemische fabrieken, raffinaderijen en grootschalige faciliteiten voor de opslag van gevaarlijke stoffen, zijn in de omgeving van de inrichting niet aanwezig. Dit blijkt onder meer uit de gegevens van de Kamers van Koophandel, bestemmingsplannen en afgegeven Hinderwetvergunningen.

Militaire activiteit vindt plaats op ruime afstand van de inrichting. De meest nabijgelegen grote militaire faciliteiten zijn het vliegveld Deelen, een vaste luchtmachtbasis voor helikopters, op 20 km afstand en de schietterreinen op de Rozendaalse heide op 18 km. De grens van het militaire laag-vlieggebied Gilze-Rijen ligt op circa 8 km afstand van de inrichting. De dichtstbijzijnde munitiedepots bevinden zich op meer dan 5 km van de inrichting.

De landerijen rond de installatie worden voornamelijk gebruikt voor veeteelt en gewassen.

In de nabije omgeving van de inrichting bevinden zich de spoorlijn Geldermalsen-Elst, de Betuwe goederenspoorlijn, de snelweg A15 en de rivier de Waal. Alle vier hebben ter plaatse van de inrichting een oost-west oriëntatie en alle vier vormen een belangrijke verbindingsschakel tussen Rotterdam en het Duitse Ruhrgebied.

De rivier de Waal vormt een belangrijke transportroute voor schepen tussen Rotterdam en het Duitse Ruhrgebied. De schepen die een potentieel gevaarlijke lading vervoeren zijn (duw)tankschepen. Totaal passeren jaarlijks gemiddeld 23.100 tankers de inrichting.

5.1.1.4 Klimaat en weersomstandigheden (Climate and average weather conditions)

De inrichting ligt in een gebied met gematigd zeeklimaat. Een gematigd zeeklimaat wordt gekenmerkt door gematigde temperaturen, een neutrale tot stabiele atmosfeer en beperkt zicht. De regio van de vestigingsplaats is een landelijk en waterrijk gebied, met een hoge gewas- en bodemuitdamping.

De atmosfeer van de regio is, vooral in herfst en winter, regelmatig neutraal tot stabiel.

Pasquill klasse D (neutraal) overheerst en klasse F (stabiel) komt veelvuldig voor.

Gedurende de stabiele omstandigheden is de lucht overwegend koel en relatief vochtig, optisch gekenmerkt door beperkt zicht, met een laaghangend wolkendek. Onder andere weersomstandigheden is vaak sprake van een hoge luchtvochtigheid (heiig, sluierwolken) en stabiel weer. Gedurende 17% van de tijd is de atmosfeer onstabiel.

De inrichting ligt tussen de grote rivieren Waal en Neder-Rijn in een waterrijk, grotendeels agrarisch, vlak polderlandschap zonder uitgestrekte bossen. De relatieve vochtigheid is hoog, evenals de gemiddelde windsnelheid.

5.1.1.5 Kenmerken van de Waal (Characteristics of the River Waal)

De inrichting ligt op een kunstmatige verhoging met het maaiveld op 13 m boven Normaal Amsterdams Peil (NAP) in de uiterwaarden van de Waal. De Waal is een zijtak van de Rijn, die bij Lobith Nederland binnenkomt. De waterhuishouding van de Waal is gedeeltelijk gecontroleerd.

Van grote invloed op de waterhuishouding zijn de stuwen in de zijtakken van de Waal en de stuw in de Neder-Rijn bij Driel. Weigering van de stuw zou kunnen leiden tot dijkbreuk of overstroming. De bedrijfszekerheid is echter zeer hoog. Verder wordt de stuw geflankeerd door sluizen; elke stuw heeft bovendien een overloopdrempel, gebaseerd op het maatgevend hoog water.

Behalve de regulering van waterstanden zijn ook de waterverdedigingswerken van invloed op de waterhuishouding. Voor de Waal bestaan deze uit een systeem van uiterwaarden, zomerdijken en Waalbandijken. De Waalbandijken voorkomen overstroming van de binnendijkse gebieden. Deze dijken zijn alle in de periode na 1986 verbeterd, gebaseerd op het maatgevend hoog water zoals dat in 1986 is gedefinieerd. Recentelijk zijn meerdere dijktracés opgehoogd en verbeterd, tot een niveau dat voortvloeit uit het in 1993 opnieuw gedefinieerde maatgevend hoog water.

Tijdens de extreem hoge waterstanden in 1993 werd op 25 december, bij weinig wind, een hoogste stand van 11,8 m boven NAP gemeten. Bij de laatste hoge waterstand in januari 1995 is het waterpeil gestegen tot 11,95 m +NAP. Het terrein ligt op 13 m +NAP. Zelfs wanneer het water boven dit niveau zou stijgen zullen hoge golven, als gevolg van de geringe diepte van het water op het terrein, niet tot dynamische belastingen op de bouwconstructies leiden. De dijk nabij de inrichting is verbeterd in het kader van het dijkverzwaringsprogramma.

De hoogte van de Waalbandijk ten noorden van de inrichting is 14,15 m boven NAP. Statistisch zal de Waal de verbeterde dijk dan eens in de 1250 jaar doen breken of overspoelen. Ter plaatse van de inrichting moet men rekening houden met een hoogst mogelijke waterstand van 13,6 m +NAP, gebaseerd op een waterstand welke eens per 1250 jaar voorkomt (12,99 m +NAP) en een golfoploophoogte van 0,6 m.

Behalve de Waal zijn er nog enkele andere oppervlaktewateren in de omgeving van de inrichting. Een kleine rivier is de Linge, 6 km ten noorden van de inrichting.

De inrichting maakt alleen gebruik van grondwater als extra brandblusmiddel door gebruik te maken van een puls.

De bovenste bodemlagen van de Hiensche uiterwaarden zijn permeabel; dat wil zeggen dat regenwater in dit gebied vrij gemakkelijk naar de Waal afstroomt. Het dieper liggende, watervoerende pakket wordt afgeschermd door een kleilaag van 5 m dikte. Deze laag vormt de afsluiting van het onderliggende grondwater. De kleilaag komt in het binnendijkse gebied aan het oppervlak. De watervoerende laag, bij de inrichting meer dan 20 m diep, ligt in Andelst op 5 m diepte. Het diepere grondwater stroomt gemiddeld in westelijke richting, parallel aan de rivier.

5.1.1.6 Geologische kenmerken (Geological characteristics)

De inrichting is gelegen op een zandige ondergrond, met daarop een kleipakket dat doorsneden wordt door meer zandige (en soms grindrijke) rivierafzettingen.

Ook in geologisch rustige perioden beweegt de aardkorst. Dat gebeurt onder invloed van diepgelegen convectiestromen, waardoor grote schollen van de aardkorst ten opzichte van elkaar bewegen. De Boven-Rijndalslenk is een systeem dat samenhangt met de druk die de beweging van de Afrikaanse aardschol ten opzichte van de Europese teweegbrengt. Een uitloper is het systeem van de slenken en horsten in de Peel, dat zich - met afnemende intensiteit - voortzet in de richting van Amsterdam. Dodewaard ligt ongeveer op de rand van dit systeem.

Aardbevingen kunnen op verschillende wijzen worden ingedeeld. Meestal gebeurt dat volgens een van de volgende "schalen":

- de magnitudeschaal van Richter, die een maat is voor de hoeveelheid energie die in het hypocentrum vrijkomt en daarmee voor de sterkte van de aardbeving;
- de intensiteitschaal van Mercalli (eventueel die van Medvedev, Sponheuer & Karnik: de MSK-schaal), die aangeeft wat de uitwerking van de aardbeving is, daarbij rekening houdend met de opbouw van de ondergrond en de afstand tot het hypocentrum.

Een betrekkelijk grote aardbeving in Nederland, met een epicentrum nabij Roermond, vond plaats op 13 april 1992. Deze beving had een voor Nederlandse begrippen hoge magnitude, namelijk 5,8 op de schaal van Richter. De intensiteit ter plaatse bedroeg VII en volgens opgave van het KNMI bedroeg de versnelling in horizontale richting 0,5 m/s2. Deze voor Nederland zeer sterke aardbeving heeft geen enkele invloed gehad op de bedrijfsvoering van de centrale. In de afgelopen jaren hebben zich ook in het noorden en noordoosten van Nederland en in de provincie Noord-Holland enkele lichte aardbevingen voorgedaan. De grootste was die in Roswinkel op 19 februari 1997, met een magnitude van 3,4 op de schaal van Richter.

In Nederland worden door het KNMI sinds 1904 aardbevingen geregistreerd. Jaarlijks worden door de vier grote seismische stations (De Bilt, Witteveen, Winterswijk en Heerlen) ongeveer 1200 bevingen waargenomen, waarvan de epicentra verspreid liggen over de hele wereld. Daarnaast beschikt men over tal van historische gegevens over aardbevingen vanaf het jaar 330.

Uit deze gegevens zijn door het KNMI voor Nederland seismische intensiteitskaarten opgesteld; hierop is de maximale intensiteit van een aardbeving in een bepaald gebied aangegeven, afhankelijk van zijn waarschijnlijkheid van optreden. De inrichting ligt op de grens van zones met overgangen in de maximale intensiteiten. Om die reden is voor de locatie Dodewaard in 1993 een studie uitgevoerd naar mogelijke aardbevingsbelastingen, waarbij rekening is gehouden met:

- de aardbeving bij Roermond;
- een verfijning van de tektonische zones in het gebied rondom de inrichting;
- het optreden van regionale variatie binnen een tektonische zone;
- het locaal optreden van eventuele (minder sterke) aardbevingen.

De uitgevoerde studie heeft de bovenbeschreven kenmerken beschouwd en de volgende parameters bepaald:

- de intensiteit en de horizontale piekversnelling aan het aardoppervlak, afhankelijk van de waarschijnlijkheid van optreden;
- de vrije veld spectra vooreerdere waarschijnlijkheden van optreden van een aardbeving en de variatie in de grondsoort (de bovenste zachte lagen of de diepere, meer geconsolideerde zanden).

De inrichting ligt in een gebied (de Hiensche uiterwaard) dat sterk beïnvloed is door de veranderingen die in de laatste tienduizend jaar zijn opgetreden in de loop van de Waal. De hierdoor ontstane afwisseling van kleien en grovere pakketten kan als volgt worden gekarakteriseerd:

- de bodemgesteldheid van de hogere grondlagen wordt gekenmerkt door klei- en zandlagen met matige vastheden;
- op grotere diepten komen vastere zandlagen voor, doorsneden door lagen klei, leem, veen of grind;
- de diverse gebouwen van de inrichting rusten op een onderheide fundatie die via de heipalen steunt op de relatief vaste, zandige ondergrond.

De mogelijkheid van instabiel gedrag van de bodem en de fundatie moet vanwege de bodemkarakteristieken als verwaarloosbaar klein worden beschouwd.

5.1.2 Future use of the site

The current spatial planning plan ("Bestemmingsplan Buitengebied Dodewaard") for the area surrounding the plant is "Uiterwaard". The land is used for farming and recreation. The town council of Dodewaard decided in 1997 that after final dismantling of the plant the land must be turned into uiterwaard. In practice this means the land has to be lowered to the same level as the surroundings and the cooling water inlet and outlet have to be filled with the land that currently is the elevated ground on which the plant is situated. The parking lot must be removed. (Note: for practical reasons this might change as the parking lot is frequented by people walking in the uiterwaarden.)

5.2 Description of the Selected Strategy

The Dodewaard NPP (KCD) has been shut down on March 26th 1997. The dismantling strategy is a complete dismantling of the plant to Greenfield Conditions after a waiting period of several years as a so called Safe Enclosure (SE).

On April 23rd 2003 the phase Preparation for Safe Enclosure (PSE) started. This phase lasted till June 30th 2005. On July 1st 2005, the phase Safe Enclosure (SE) started. For the purpose of the present study this phase is planned to last until June 30th 2045.

After the SE phase the NPP will be completely dismantled to so-called Greenfield Conditions.

The decommissioning of KCD is implemented in three main steps:

- Preparation of the site for dismantling
- Dismantling and removing of all contaminated and/or activated installations and release of the building structures from nuclear regulations
- Conventional demolition of building structures and site restoration.

More details are given in section 9.

5.3 Deferred Decommissioning Scenario

The KCD new Decommissioning Cost Estimate is evaluated in the frame of an **"Deferred Decommissioning Scenario"**. Under this scenario, it is assumed that the actual KCD dismantling works start in 2045.

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WBS	Working Packages with sub-levels	Total [k€]	2041 [k€]	2042 [k€]	2043 [k€]	2044 [k€]	2045 [k€]	2046 [k€]	2047 [k€]	2040 [k€]	2049 [k€]	2050 [k€]	2051 [k€]	2052 [k€]	2053 [k€]	2054 [k€]
08	DISMANTLING BIOLOGICAL SHIELD															
08.01	Planning and Engineering															
08.01.01	Implementation planning															
08.01.03	Detailed Planning															
08.02	Attendant Measures															
08.02.01	Project management															
08.02.02	Supervision															
08.02.03	On Site Radiological Protection															
08.02.04	Internal Transport															
08.02.05	Accompanying Decontamination															
08.03	Preparational Work															
08.03.01	Preparation Reactor Pool															
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	Dismantling Biological shield (Part B up to 50 cm and Part D)															
08.04.02	Segmentation and Packaging BS parts (Part B up to 50 cm and Part D)															
08.04.03	Dismantling Biological Shield (other activated parts & Drywell bottom)															
08.04.04	Segmentation and Packaging BS parts (other activated parts & Drywell bottom)															
08.04.05	Close Working Place															
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2															
09.01	Planning and Engineering															
09.01.01	Implementation planning															
09.01.02	Detailed Planning															
09.02	Attendant Measures															
09.02.01	Project management															
09.02.02	Supervision															
09.02.03	On Site Radiological Protection															
09.02.04	Internal Transport															
09.02.05	Accompanying Decontamination															
09.03	Execution Project															
09.03.01	Reactor Building															
09.03.02	Waste Building															
09.03.03	Auxiliary Building															
09.03.04	Ventilation Building															
09.03.05	Turbine Building															
09.03.06	Other Buildings															
10	CLEARANCE OF BUILDING STRUCTURES															
10.01	Planning and Engineering															
10.01.01	Implementation planning															
10.01.03	Detailed Planning															
10.02	Attendant Measures															
10.02.01	Project management															
10.02.02	Supervision															
10.02.03	On Site Radiological Protection															
10.02.04	Internal Transport															
10.02.05	Accompanying Decontamination															
10.03	Execution Project															
10.03.01	Reactor Building															
10.03.02	Waste Building															
10.03.03	Auxiliary Building															
10.03.04	Ventilation Building															
10.03.05	Turbine Building															
10.03.06	New Buildings															
10.03.07	Other Buildings and Site															

Table 10-11: Detailed KCD Decommissioning costs per year (continued)

Working Packages with sub-levels	Total [k€]	2041 [k€]	2042 [k€]	2043 [k€]	2044 [k€]	2045 [k€]	2046 [k€]	2047 [k€]	2048 [k€]	2049 [k€]	2050 [k€]	2051 [k€]	2052 [k€]	2053 [k€]	2054 [k€]
WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL															
On-site Treatment															
Cutting															
Decontamination															
Shredding															
Super-compaction															
Packaging and immobilazation															
Release measurements															
Attendant Measures															
Supervision															
On Site Radiological Protection															
Internal Transport															
Accompanying Decontamination															
External Treatment															
Incineration															
External Treatment (Liquids)															
Container Cost Primary Waste															
Press drums															
200-l drums															
MOSAIK Type II															
KONRAD Type II															
Container Cost Secondary Waste															
Press drums															
200-l Drums															
Transport, Interim Storage at COVRA, and Disposal															
200-l container, (PW) with surface dose rate <= 0,2 mSv/h															
200-l container, (SW) with surface dose rate <= 0,2 mSv/h															
MOSAIK Type II															
KONRAD Type II															
CONVENTIONAL DEMOLISHING															
Planning and Engineering															
Project management															
Detailed Planning															
Attendant Measures															
Supervision															
Execution Project															
Preparation Working Place															
Demolition Buildings incl. Piles															
Conventional Waste															
Removal and treatment cost building rubble (incl. transport)															
Removal and treatment cost steel (incl. transport)															
SITE RESTORATION, CLEANUP AND LANDSCAPING															
Planning and Engineering															
Project management															
Detailed Planning															
Attendant Measures															
Supervision															
Execution Project															
Whole Site															
ASBESTOS REMOVAL															

Table 10-11: Detailed KCD Decommissioning costs per year (continued)

WBS	Working Packages with sub-levels	Total [k€]	2041 [k€]	2042 [k€]	2043 [k€]	2044 [k€]	2045 [k€]	2046 [k€]	2047 [k€]	2048 [k€]	2049 [k€]	2050 [k€]	2051 [k€]	2052 [k€]	2053 [k€]	2054 [k€]
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT															
15.01	GKN															
15.01.01	Plant Manegement															
15.01.02	Finance, accountancy and personnel															
15.01.04	Secretary / Archive															
15.01.06	Quality Assurance															
15.01.07	Licensa coordinator															
15.01.08	Site proceduras															
15.01.08	EDV / IT															
15.01.10	Revenues															
15.02	Main Contractor															
15.02.01	Project Management															
15.02.02	Finance, accountancy and personnel															
15.02.04	Secretary / Documentation															
15.02.06	Quality Assurance															
15.02.09	EDV / IT															
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE															
16.01	GKN															
16.01.01	Dparation, Maintenance															
16.01.02	Radiological Protection/Health Physics															
18.01.03	Industrial Safety															
16.01.05	Othar Operational Expenditures															
16.02	Main Contractor															
16.02.01	Operation, Maintenence															
16.02.02	Radiological Protection/Health Physics															
16.02.03	Industrial Safety															
16.02.04	Sacurity / Guards															
16.02.05	Dther Operational Expenditures															
17	AUTHORITIES															
Sum																

Table 10-11: Detailed KCD Decommissioning costs per year (continued)

Container Type	Packed Mass [Mg]	Number of Containers [-]	Container Costs [k€]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal [k€]
90-l Press drums	302,8	6.094		-	-
200-l Container, with a surface dose rate <= 0,2 mSv/h	401,5	2.169		527,1	
KONRAD Type II-Container	727,7	135		624,6	
MOSAIK-Container	5,6	12		16,4	
Total without 90-l Press drums	**1.134,8**	**2.316**		**1.168,1**	[illegible]
Total with 90-l Press drums		**8.410**		**1.168,1**	

Table 10-12: Container data (Best estimate using clearance levels from Kernenergiewet)

Qualification	Number per Year														Total Man-Years per Qualification
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	
GKN-Project Manager	10 1 c [redacted]														21,2
GKN-Engineer															46,9
GKN-Accountant															9,4
GKN-Worker															42,9
Sub-Total - GKN															**120,4**
Project Manager															10,3
Engineer															85,7
Accountant															7,8
Foreman															100,0
Craftsman															148,9
Worker															176,3
Sub-Total - Contractors (nuclear)															**577,3**
C-Planner / Work organizer															3,3
C-Foreman															2,8
C-Craftsman / Crane operator															18,3
C-Worker															31,9
Sub-Total - Contractors (conventional)															**56,3**
Total															**754,0**

Table 10-14: KCD Decommissioning – Number of staff per qualification and year

Description	No. of locations stored in DIS or additional	Hours per location	Percentage surcharge	Total hours	Number of staff	Wages in €/h	Costs per hour in €/h	Total number of additional samples	Costs per sample analysis in €	Total costs in €
Verification of Asbestos locations	40	2		80	2					
Additional investigations			50%							
Analyses of additional samples			50%					20		
Technical specification and tender										
Asbestos removal work	40	16		640	4					
Asbestos removal work (additional: 60% of 20)	12	16		192	4					
Scaffolding, tents, etc.			20%							
Follow-up of work			25%							
Total										

Waste management costs are included in decommissioning costs.

Table 10-13: Estimate of asbestos removal costs

WP No.	Working Package	Radiation exposure [man-mSv]
01	PRE-DECOMMISSIONING ACTIONS	0,7
02	LICENSING PROCEDURE	0,0
03	PREPARATORY WORK	23,3
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1	177,5
05	DISMANTLING RPV INTERNALS	85,4
06	DISMANTLING RPV	41,9
07	DISMANTLING DRYWELL	102,8
08	DISMANTLING BIOLOGICAL SHIELD	43,9
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2	29,8
10	CLEARANCE OF BUILDING STRUCTURES	71,9
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL	733,8
12	CONVENTIONAL DEMOLISHING	0,0
13	SITE RESTORATION, CLEANUP AND LANDSCAPING	0,0
14	ASBESTOS REMOVAL	0,0
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT	0,0
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE	73,4
17	AUTHORITIES	0,0
SUM		**1.384,4**

Table 10-15: Radiation exposure per working package

WP No.	Working Package	Total costs [M€]	Staff costs [M€]	Investment costs / Revenues [M€]	Consumable costs *) [M€]	Other costs [M€]
01	PRE-DECOMMISSIONING ACTIONS					
02	LICENSING PROCEDURE					
03	PREPARATORY WORK					
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1					
05	DISMANTLING RPV INTERNALS					
06	DISMANTLING RPV					
07	DISMANTLING DRYWELL					
08	DISMANTLING BIOLOGICAL SHIELD					
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2					
10	CLEARANCE OF BUILDING STRUCTURES					
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL					
12	CONVENTIONAL DEMOLISHING					
13	SITE RESTORATION, CLEANUP AND LANDSCAPING					
14	ASBESTOS REMOVAL					
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT					
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE					
17	AUTHORITIES					
SUM						

*) "0,0" M€ means that the estimated costs are below 0,05 M€.

Table 10-16: KCD Decommissioning costs per working package and cost type (Best estimate using clearance levels from IAEA RS-G-1.7)

WP No.	Working Package	Total [k€]	2041 [k€]	2042 [k€]	2043 [k€]	2044 [k€]	2045 [k€]	2046 [k€]	2047 [k€]	2048 [k€]	2049 [k€]	2050 [k€]	2051 [k€]	2052 [k€]	2053 [k€]	2054 [k€]
01	PRE-DECOMMISSIONING ACTIONS															
02	LICENSING PROCEDURE															
03	PREPARATORY WORK															
04	DISMANTLING CONTROLLED AREA (CONTAMINATED) - CA-C1															
05	DISMANTLING RPV INTERNALS															
06	DISMANTLING RPV															
07	DISMANTLING DRYWELL															
08	DISMANTLING BIOLOGICAL SHIELD															
09	DISMANTLING REMAINING SYSTEMS AND COMPONENTS (CONTAMINATED) - CA-C2															
10	CLEARANCE OF BUILDING STRUCTURES															
11	WASTE PROCESSING, TRANSPORT, STORAGE AND DISPOSAL															
12	CONVENTIONAL DEMOLISHING															
13	SITE RESTORATION, CLEANUP AND LANDSCAPING															
14	ASBESTOS REMOVAL															
15	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT															
16	SITE SECURITY, SURVEILLANCE AND MAINTENANCE															
17	AUTHORITIES															
Sum																

Table 10-17: KCD Decommissioning costs per working package and per year (Best estimate using clearance levels from IAEA RS-G-1.7)

Container Type	Packed Mass [Mg]	Number of Containers [-]	Container Costs [k€]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal [k€]
90-l Press drums	302,8	6.094		-	-
200-l Container, with a surface dose rate <= 0,2 mSv/h	401,5	2.169		527,1	
KONRAD Type II-Container	937,2	190		879,7	
MOSAIK-Container	5,6	12		16,4	
Total without 90-l Press drums	**1.344,3**	**2.371**		**1.423,2**	
Total with 90-l Press drums		**8.465**		**1.423,2**	

Table 10-18: Container data (Best estimate using clearance levels from IAEA RS-G-1.7)

10.11 Figures

10 1 c

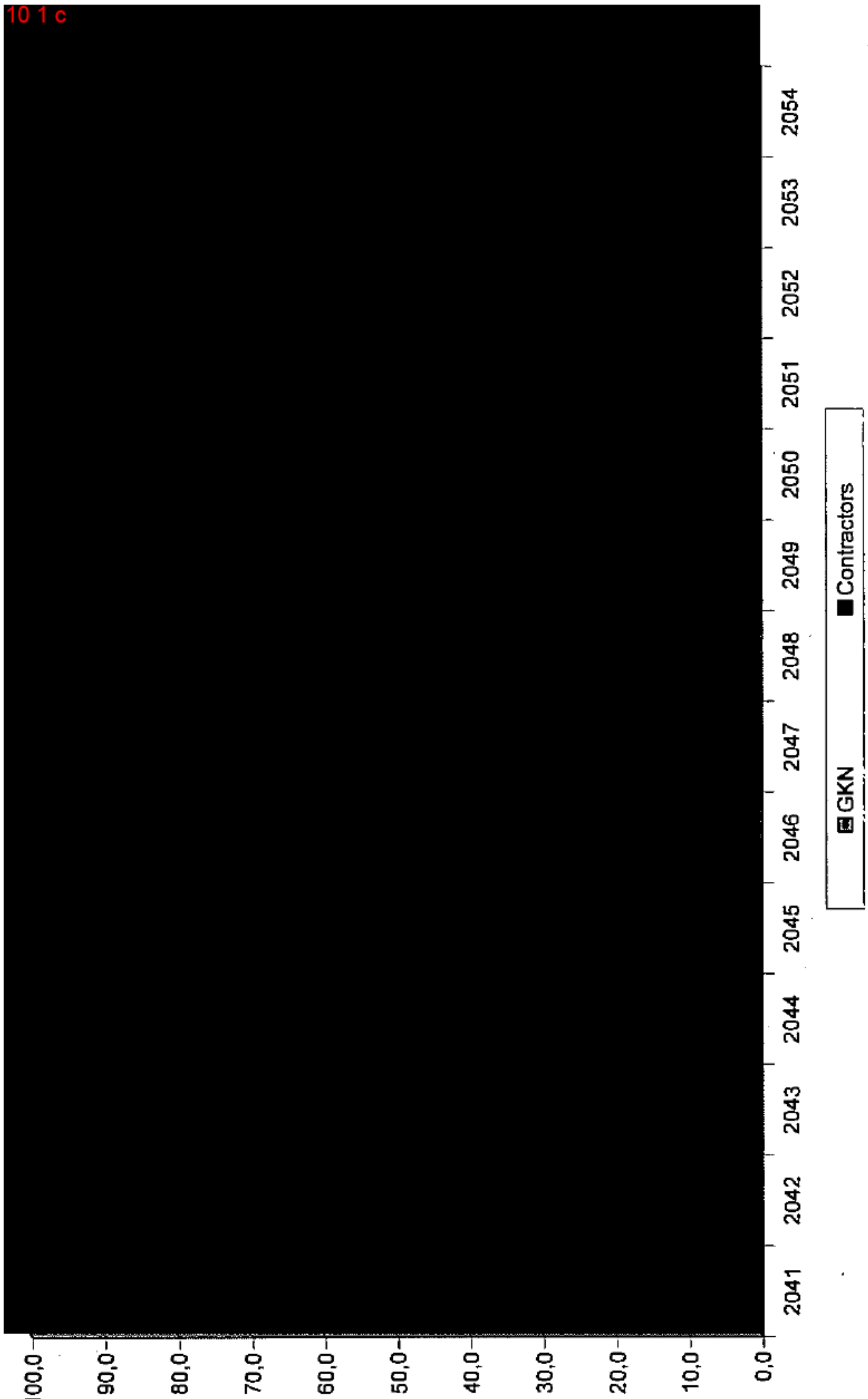
[redacted]

Figure 10-1: Percentage distribution of the total decommissioning cost to cost types

[redacted]

2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054

Figure 10-2: KCD Decommissioning cost per year in [k€]



[redacted]

Figure 10-3: KCD Decommissioning - Total number of staff per year (GKN vs. Contractors)

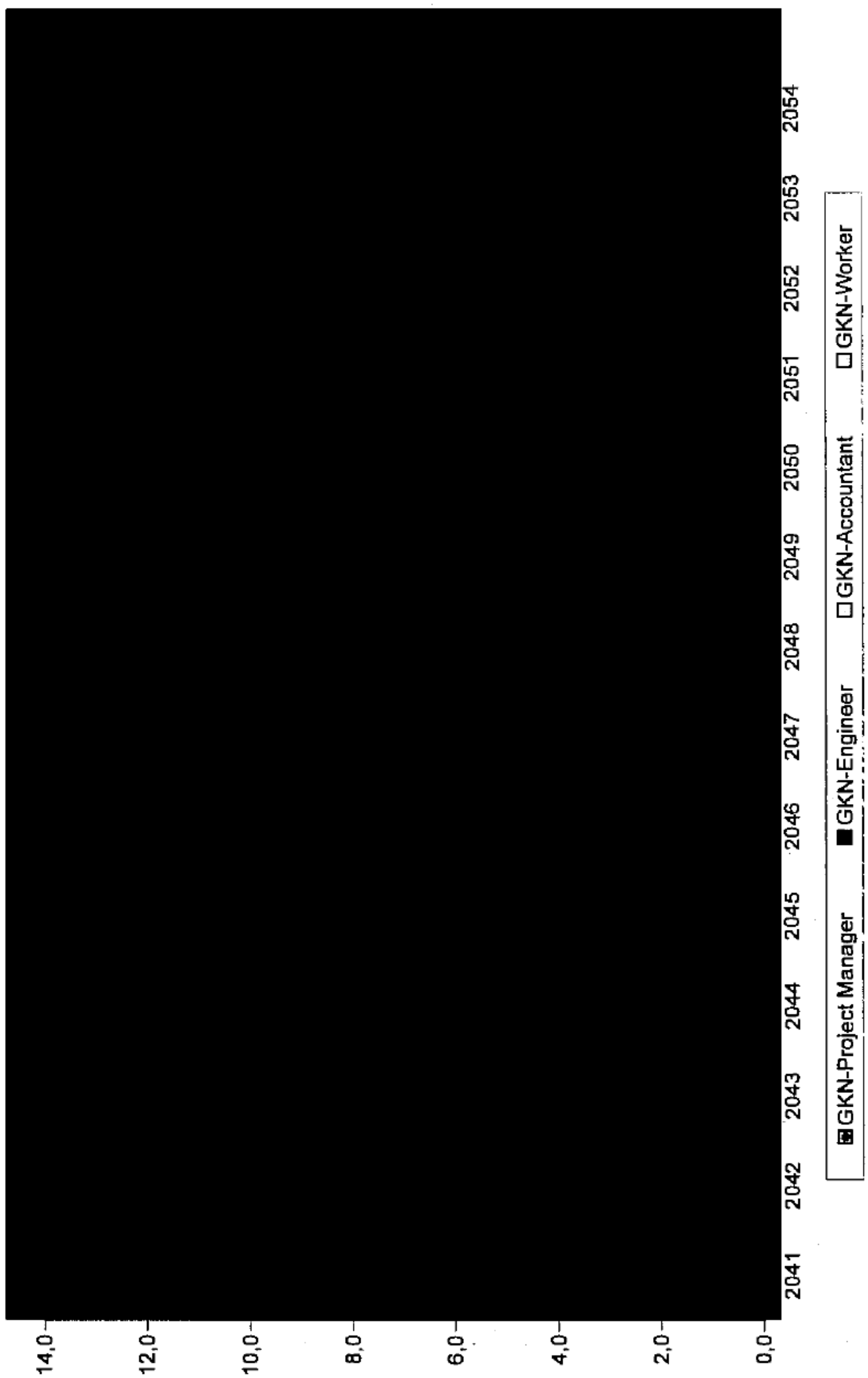


Figure 10-4: KCD Decommissioning - GKN staff per qualification and year

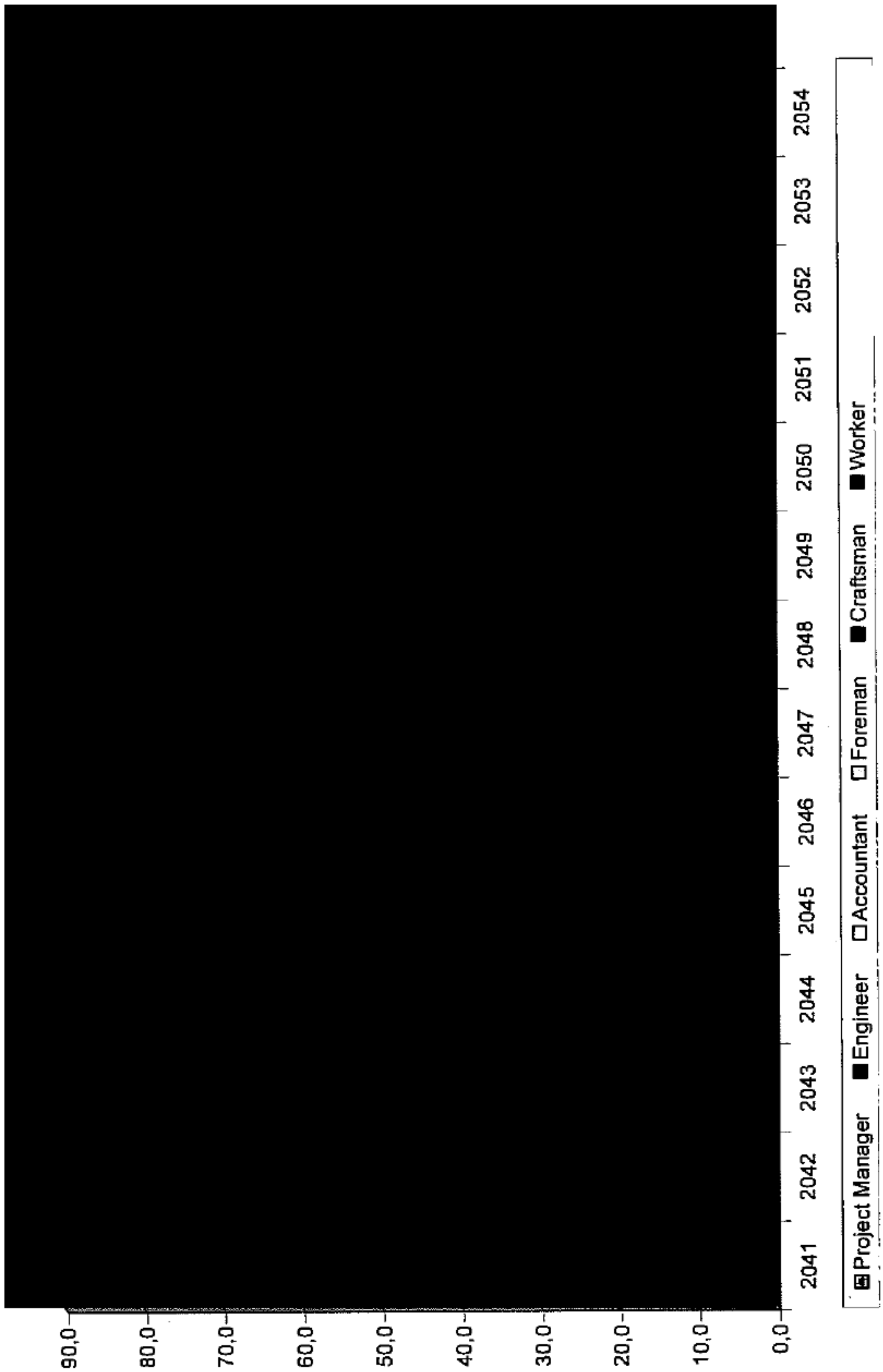


Figure 10-5: Nuclear dismantling - Contractors staff per qualification and year

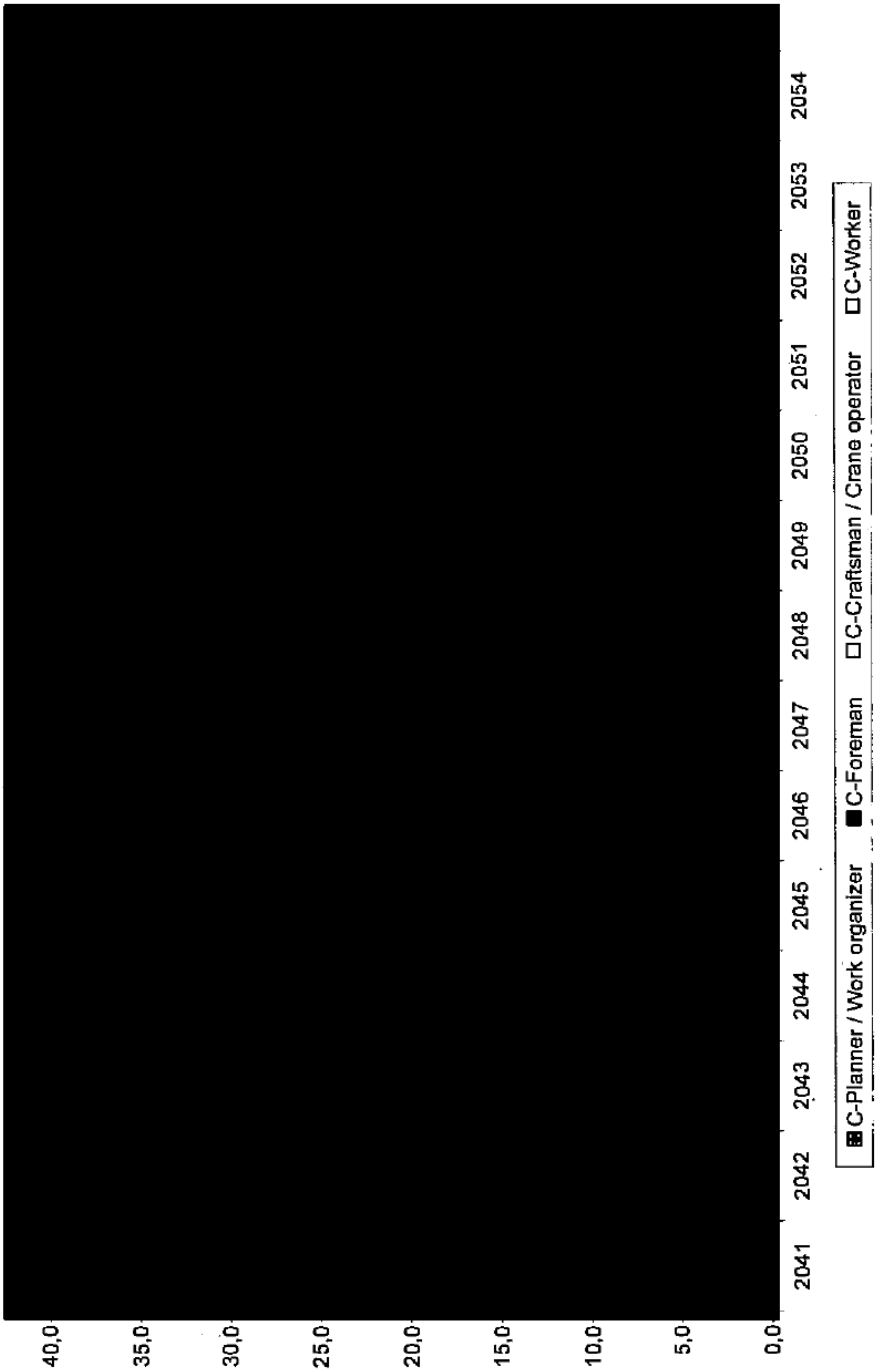


Figure 10-6: Conventional demolishing - Number of staff per qualification and year

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Clearance levels: KEW and IAEA
Document No.: 8229 / CA / F 008157 7 / 00
NIS Ingenieurgesellschaft mbH
Alzenau, March 2010

Appendix 1: List with Distribution Factor Sets (Output from CORA)

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate 2045 - Kernenergiewet

No.	Distribution Factor Set		Portion [%]	Disposal Way / Cask Type	Waste Category	Capacity [kg]	
1	RPV-Internals - A5, A4		100,00	Radioactive Waste + Direct packaging			
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	MOSAIK Type II / 60mm Fe	Steel parts	450,0	☑
2	RPV-Internals - A3, A2		100,00	Radioactive Waste + Direct packaging			
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
3	RPV - A5, A4, A3		100,00	Radioactive Waste + Direct packaging			
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II / 180mm NC	Steel parts	3.200,0	☑
5	RPV - A3, A2		100,00	Radioactive Waste + Direct packaging			
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
6	RK - Internals/vessel (mix material, e.g. concrete/steel)		100,00	Radioactive Waste + Direct packaging			
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II	Steel & concrete mixture (40 %)	4.800,0	☑
7	RK - Internals (steel)		100,00	Radioactive Waste + Direct packaging			
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
9	RK - vessel		100,00	Radioactive Waste + Direct packaging			
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
11	RPV-Insulation		100,00	Radioactive Waste + Super-compaction			
		Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
			100,00	200-l drum (<= 0,2 mSv/h)	5 Pellets 90-l (Insulation)	212,5	☑
			100,00	90-l press drum	Insulation for super-compaction	42,5	☐

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate 2045 - Kernenergiewet

No.	Distribution Factor Set	Portion [%]	Disposal Way
20	BS - NC	100,00	Radioactive Waste + Direct packaging
	Packaging: Portion [%] 100,00; Cask Type: KONRAD Type II; Waste Category: Concrete (NC - 40%); Capacity [kg]: 3.800,0 ☑		
21	BS - HC	100,00	Radioactive Waste + Direct packaging
	Packaging: Portion [%] 100,00; Cask Type: KONRAD Type II; Waste Category: Concrete (HC - 40 %)); Capacity [kg]: 5.600,0 ☑		
30	Unrestricted Release C1	100,00	Unrestricted Release + Direct release
31	Landfill Release C1	100,00	Landfill + Direct release
32	Release after Decontamination	100,00	Unrestricted Release + Dry blasting
33	Concrete Release	50,00	Landfill + Direct release
		50,00	Unrestricted Release + Direct release
34	Electrical equipment Release C1	70,00	Unrestricted Release + Direct release
		30,00	Landfill + Direct release
35	Cable trays with cables C1	35,00	Unrestricted Release + Direct release
		35,00	Reuse of Material + Shredding
		30,00	Landfill + Shredding

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate 2045 - Kernenergiewet

No.	Distribution Factor Set	Portion [%]	Disposal Way
36	Steel contsruction >C1	60,00	Unrestricted Release + Direct release
		35,00	Unrestricted Release + Dry blasting
		5,00	Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

No.	Distribution Factor Set	Portion [%]	Disposal Way
37	Small Pipes (<50 mm)	50,00	Unrestricted Release + Dry blasting
		30,00	Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

Portion [%]	Disposal Way
10,00	Unrestricted Release + Direct release
10,00	Radioactive Waste + Direct packaging

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

No.	Distribution Factor Set	Portion [%]	Disposal Way
38	Medium Pipes (>50 <100 mm)	70,00	Unrestricted Release + Dry blasting
		10,00	Unrestricted Release + Direct release
		10,00	Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

Portion [%]	Disposal Way
10,00	Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

*) 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.

No. Distribution Factor Set
Portion [%] Disposal Way

39 Large Pipes (>100 mm)

80,00 Unrestricted Release + Dry blasting

10,00 Radioactive Waste + Cutting

<u>Packaging:</u>

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

10,00 Unrestricted Release + Direct release

40 Small Vessels (<=100 kg)

70,00 Unrestricted Release + Dry blasting

10,00 Radioactive Waste + Super-compaction

<u>Packaging:</u>

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

10,00 Radioactive Waste + Cutting

<u>Packaging:</u>

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

10,00 Unrestricted Release + Direct release

41 Medium Vessels (>100 <1000 kg)

75,00 Unrestricted Release + Dry blasting

10,00 Unrestricted Release + Direct release

10,00 Radioactive Waste + Cutting

<u>Packaging:</u>

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

5,00 Radioactive Waste + Super-compaction

<u>Packaging:</u>

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate 2045 - Kernenergiewet

No.	Distribution Factor Set	Portion [%]	Disposal Way			
42	Large Vessels (>1000 kg)	80,00	Unrestricted Release + Dry blasting			
		10,00	Radioactive Waste + Cutting			
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
		10,00	Unrestricted Release + Direct release			
43	Small Heat Exchangers (<200 kg)	55,00	Unrestricted Release + Dry blasting			
		30,00	Radioactive Waste + Super-compaction			
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
		100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
		10,00	Radioactive Waste + Cutting			
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
		5,00	Unrestricted Release + Direct release			
44	Medium Heat Exchangers (>=200 <1000 kg)	65,00	Unrestricted Release + Dry blasting			
		20,00	Radioactive Waste + Super-compaction			
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
		100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
		10,00	Unrestricted Release + Direct release			
		5,00	Radioactive Waste + Cutting			
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate 2045 - Kernenergiewet

No.	Distribution Factor Set	Portion [%]	Disposal Way
45	Large Heat Exchangers (>1000 kg)	70,00	Unrestricted Release + Dry blasting
		15,00	Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

Portion [%]	Disposal Way
10,00	Unrestricted Release + Direct release
5,00	Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	KDNRAD Type II	Steel parts (20%)	6.300,0	☑

No.	Distribution Factor Set	Portion [%]	Disposal Way
46	Small Pumps (<=25 kg)	100,00	Radioactive Waste + Direct packaging

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

No.	Distribution Factor Set	Portion [%]	Disposal Way
47	Medium Pumps (>25 <200 kg)	60,00	Unrestricted Release + Dry blasting
		30,00	Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

Portion [%]	Disposal Way
10,00	Unrestricted Release + Direct release

No.	Distribution Factor Set	Portion [%]	Disposal Way
48	Large Pumps (>=200 kg)	70,00	Unrestricted Release + Dry blasting
		15,00	Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	Hook
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

Portion [%]	Disposal Way
15,00	Unrestricted Release + Direct release

*) 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.

No. Distribution Factor Set
Portion [%] Disposal Way

49 Small Valves (<=25 kg)

100,00 Radioactive Waste + Direct packaging

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

50 Medium Valves (>25 <200 kg)

60,00 Unrestricted Release + Dry blasting

30,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

10,00 Unrestricted Release + Direct release

51 Large Valves (>=200 kg)

70,00 Unrestricted Release + Dry blasting

15,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

15,00 Unrestricted Release + Direct release

52 FR - Mixed material with super-compaction (e.g. PE, PVC)

100,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	5 Pellets 90-l (Mix material)	175,0	☑
100,00	90-l press drum	Mixed material for super-compaction (e.g. PE, PVC)	35,0	☐

53 FR - Metal Components with super compaction

100,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

*) 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.

No. Distribution Factor Set
Portion [%] Disposal Way

54 Cable trays with cables C2, C3

35,00 Reuse of Material + Shredding

30,00 Radioactive Waste + Shredding

<u>Packaging:</u>

Portion [%]	*Cask Type*	*Waste Category*	*Capacity [kg]*	
100,00	200-l drum (<= 0,2 mSv/h)	5 Pellets 90-l (Insulation)	212,5	☑
100,00	90-l press drum	Insulation for super-compaction	42,5	☐

20,00 Unrestricted Release + Direct release

10,00 Unrestricted Release + Dry blasting

5,00 Radioactive Waste + Super-compaction

<u>Packaging:</u>

Portion [%]	*Cask Type*	*Waste Category*	*Capacity [kg]*	
100,00	90-l press drum	Steel parts for super-compaction	82,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

55 Concrete blocks contaminated

97,00 Landfill + Dry blasting

3,00 Radioactive Waste + Dry blasting

<u>Packaging:</u>

Portion [%]	*Cask Type*	*Waste Category*	*Capacity [kg]*	
100,00	200-l drum (<= 0,2 mSv/h)	Concrete rubble	200,0	☑

56 Electrical Equipment > C1

60,00 Unrestricted Release + Direct release

20,00 Landfill + Direct release

10,00 Unrestricted Release + Dry blasting

10,00 Radioactive Waste + Super-compaction

<u>Packaging:</u>

Portion [%]	*Cask Type*	*Waste Category*	*Capacity [kg]*	
100,00	200-l drum (<= 0,2 mSv/h)	5 Pellets 90-l (Mix material)	175,0	☑
100,00	90-l press drum	Mixed material for super-compaction (e.g. PE, PVC)	35,0	☐

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

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No.	Distribution Factor Set	Portion [%]	Disposal Way					
57	FR - Mixed material (e.g. PE, PVC, wood)	100,00	Radioactive Waste + Cutting					
			Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
				100,00	KONRAD Type II	Mixed material (e.g. PE, PVC, wood - 40 %)	2.400,0	☑
58	FR - Contaminated conrete rubble	100,00	Radioactive Waste + Direct packaging					
			Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
				100,00	200-l drum (<= 0,2 mSv/h)	Concrete rubble	200,0	☑
59	FR - Metal Components directly	50,00	Radioactive Waste + Direct packaging					
			Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
				100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
		50,00	Radioactive Waste + Cutting					
			Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
				100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
60	Turbine	80,00	Unrestricted Release + Dry blasting					
		10,00	Unrestricted Release + Direct release					
		10,00	Radioactive Waste + Cutting					
			Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
				100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
61	FR - Special material (e.g. crud)	100,00	Radioactive Waste + Direct packaging					
			Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
				100,00	200-l drum (<= 0,2 mSv/h)	Steel parts (20%)	320,0	☑

*) 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.

No.	Distribution Factor Set	Portion [%]	Disposal Way			
62	Devices (e.g. Manipulator)	50,00	Unrestricted Release + Dry blasting			
		30,00	Unrestricted Release + Direct release			
		15,00	Landfill + Direct release			
		5,00	Radioactive Waste + Cutting			
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
63	Ventilation ducts	60,00	Unrestricted Release + Dry blasting			
		25,00	Radioactive Waste + Super-compaction			
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
		100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
		10,00	Unrestricted Release + Direct release			
		5,00	Radioactive Waste + Cutting			
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

*) 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.

No.	Distribution Factor Set / Portion [%] Disposal Way					
64	Ventilator	50,00 Unrestricted Release + Dry blasting				
		25,00 Radioactive Waste + Super-compaction				
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
		100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
		10,00 Unrestricted Release + Direct release				
		10,00 Landfill + Direct release				
		5,00 Radioactive Waste + Direct packaging				
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑
65	Insulation (Mineral wool)	80,00 Radioactive Waste + Super-compaction				
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	200-l drum (<= 0,2 mSv/h)	5 Pellets 90-l (Insulation - mineral wool)	100,0	☑
		100,00	90-l press drum	Insulation for super-compaction (minearal wool)	20,0	☐
		20,00 Unrestricted Release + Direct release				
66	FR - Metal Components with super compaction (higher dose rate,	100,00 Radioactive Waste + Super-compaction				
	Packaging:	*Portion [%]*	*Cask Type*	*Waste Category*	*Capacity [kg]*	
		100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
		100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

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No. Distribution Factor Set
Portion [%] Disposal Way

67 Medium Pipes (>50 <100 mm), higer dose rate (C5)

70,00 Unrestricted Release + Dry blasting

20,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

10,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

68 Small&Medium Vessels (<=1000 kg), higer dose rate (C5)

70,00 Unrestricted Release + Dry blasting

20,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

10,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

69 Medium Heat Exchangers (>=200 <1000 kg), higer dose rate (C5)

65,00 Unrestricted Release + Dry blasting

20,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

10,00 Unrestricted Release + Direct release

5,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

*) Tha report only includas tha Distribution Factor Sets assigned to the Components or tha Sacondary 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.

No. Distribution Factor Set
Portion [%] Disposal Way

70 Large Heat Exchangers (>1000 kg), higer dose rate (C5)

70,00 Unrestricted Release + Dry blasting

15,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐

10,00 Unrestricted Release + Direct release

5,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel parts (20%)	6.300,0	☑

71 New Equipment

50,00 Unrestricted Release + Dry blasting

20,00 Unrestricted Release + Direct release

10,00 Radioactive Waste + Cutting

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KDNRAD Type II	Steel parts (20%)	6.300,0	☑

10,00 Landfill + Direct release

10,00 Radioactive Waste + Super-compaction

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	90-l press drum	Steel parts for super-compaction	62,5	☐
100,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Steel parts)	250,0	☑

72 Concrete rubble (Building Decontamination)

45,00 Landfill + Direct release

35,00 Radioactive Waste + Direct packaging

Packaging:

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	Concrete rubble	200,0	☑

20,00 Unrestricted Release + Direct release

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

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No.	Distribution Factor Set	Portion [%]	Disposal Way
73	Masses SE	50,00	Unrestricted Release + Direct release
		30,00	Radioactive Waste + Direct packaging
		20,00	Unrestricted Release + Dry blasting
80	Reuse C1 - Copper	100,00	Reuse of Material + Direct release
81	Reuse A0, C1 - Lead	100,00	Reuse of Material + Direct release
82	Reuse C1 - Aluminium	100,00	Reuse of Material + Direct release
83	Reuse C2 - Copper	100,00	Reuse of Material + Dry blasting
84	Reuse >C1 - Lead	90,00	Landfill + Direct release
		10,00	Landfill + Dry blasting
85	Reuse & FR >C1 - Lead	88,00	Landfill + Direct release
		10,00	Landfill + Dry blasting
		2,00	Radioactive Waste + Direct packaging

Packaging for 73 (30,00 Radioactive Waste + Direct packaging):

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	KONRAD Type II	Steel & concrete mixture (40 %)	4.800,0	☑

Packaging for 85 (2,00 Radioactive Waste + Direct packaging):

Portion [%]	Cask Type	Waste Category	Capacity [kg]	
100,00	200-l drum (<= 0,2 mSv/h)	Lead	450,0	☑

*) 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.

Distribution/Packaging - Distribution Factor Sets Used *)

Best Estimate 2045 - Kernenergiewet

No.	Distribution Factor Set	Portion [%]	Disposal Way
100	Incineration	100,00	Radioactive Waste + Super-compaction

Packaging:

Portion [%]	*Cask Type*	*Waste Category*	*Capacity [kg]*	
10,00	200-l drum (<= 0,2 mSv/h)	4 Pellets 90-l (Secondary Waste)	100,0	☑
10,00	90-l press drum	Secondary waste for super-compaction	25,0	☐

*) 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.

20100527-1 - NIS

6 Maintenance Description

6.1 Inleiding Stralingsveiligheid (Introduction to Radiation Safety)

Hoofduitgangspunt van de stralingsveiligheid is dat zowel onder normale bedrijfsomstandigheden als bij storingen en ongevallen nooit een toestand mag ontstaan, waarbij het personeel, derden, de omwonende bevolking en de medewerkers van omliggende bedrijven ontoelaatbaar geachte schade zal kunnen worden toegebracht. In de afgelopen jaren is, in het kader van het milieubeleid van de overheid, de risicobenadering ontwikkeld. Dit is voor de bescherming tegen de aan ioniserende straling verbonden gevaren vastgelegd in het Besluit stralenbescherming Kernenergiewet (BsK). In overeenstemming met dit besluit wordt als uitgangspunt gehanteerd dat de dosis voor leden van de bevolking in de omgeving van de inrichting niet groter mag zijn dan 0,1 mSv per jaar bij normale bedrijfssituaties.

Conform het desbetreffende overheidsbeleid geldt daarnaast dat gestreefd wordt naar een individueel risico dat kleiner is dan 1 E-8 per jaar, het zogenoemde secundair niveau, overeenkomend met 4 E-4 mSv per jaar.

Voor ongevalsituaties tijdens de Eindontmanteling wordt gestreefd naar een veiligheidsniveau resulterend in een individueel risico dat kleiner is dan het secundair niveau van 1 E-8 per jaar.

Daarnaast is er een criterium voor het groepsrisico, dat bedoeld is om maatschappelijke ontwrichting te voorkomen. Aangezien er geen realistische ongevalscenario's denkbaar zijn waarbij acute slachtoffers in de omgeving kunnen vallen is dit criterium niet relevant voor de Eindontmanteling.

Voor mogelijke storingen en ongevallen in de installatie tijdens de Eindontmanteling zullen in het Veiligheidsrapport Eindontmanteling diverse veiligheidsanalyses worden gemaakt. Daarbij is voor ongevallen met mogelijke consequenties voor de omgeving nagegaan of het individueel risico voldoet aan bovengenoemd uitgangspunt.

Bij de uitwerking van bovenstaand uitgangspunt zal gebruik worden gemaakt van een aantal belangrijke erkende veiligheidsbeginselen (principes), waarvan de belangrijkste het ALARA-, het "defence-in-depth"- en het IBC-principe zijn.

6.2 Basis uitgangspunten voor de stralingsveiligheid (Assumptions for Radiation Safety)

6.2.1 Het ALARA-principe (ALARA principle)

Uitgangspunt van het beleid ten aanzien van de stralingsbescherming van het personeel en de omgeving is een vermijdbare blootstelling aan straling te voorkomen en onvermijdelijke blootstelling zo veel mogelijk te beperken.

Dit beleid is erop gericht dat de blootstelling zo laag als redelijkerwijs mogelijk is: "As Low As Reasonably Achievable" (ALARA). Daarnaast geldt als randvoorwaarde dat de wettelijke vastgelegde dosislimieten niet worden overschreden.

De praktische uitwerking van het ALARA-principe in het ontwerp en de bedrijfsvoering van de Veilige Insluiting betekent dat onderzocht wordt welke technieken en procedures kunnen leiden tot een beperking van de stralingsdoses voor medewerkers, derden en de omwonende bevolking. Hierbij vindt een afweging plaats tussen de te bereiken reductie van de stralingsdosis en de kosten van de maatregelen die deze reductie mogelijk maken.

6.2.2 Het "defence-in-depth"-principe (Defence in depth principle)

Het "defence-in-depth"-principe is het beginsel dat mogelijk menselijk falen of falen van (delen van de) installaties gecompenseerd dient te worden door meerdere beveiligingsniveaus, die aanwezig dienen te zijn ter voorkoming van het vrijkomen van radioactieve stoffen in de omgeving.

Deze beveiligingsniveaus zijn:

- Niveau 1
  Het voorkomen van storingen door de kwaliteit van het ontwerp, de bouw en de bedrijfsvoering van de installatie door middel van kwaliteitsborging en het handhaven van een adequate veiligheidscultuur.
- Niveau 2
  Het voorkomen dat storingen tot ongevallen kunnen leiden door middel van het detecteren van abnormale situaties en het adequaat reageren hierop.
- Niveau 3
  Het beperken van de gevolgen van ongevallen door middel van de toepassing van actieve en/of passieve veiligheidsvoorzieningen.
- Niveau 4
  Het nemen van maatregelen om de gevolgen van ongevallen voor het personeel, de bevolking en medewerkers van omliggende bedrijven en de omgeving verder te beperken.

6.2.3 Het IBC-principe (The IBC principle)

Het "defence-in-depth"- principe sluit nauw aan bij het IBC-principe, dat voor de insluiting van de radioactieve stoffen wordt toegepast en bestaat uit:

- isoleren;
- beheersen;
- controleren.

Isoleren

Dit principe leidt ertoe dat radioactieve stoffen worden ingesloten binnen een of meerdere barrières die kunnen bestaan uit het materiaal zelf, de verpakking, de ruimte waarin het materiaal zich bevindt en/of de filters in het ventilatiesysteem van de Veilige Insluiting. Het is verder uitgewerkt in de volgende voorzieningen:

- potentieel besmette gebieden worden op onderdruk gehouden;

- er wordt een gerichte luchtstroming in stand gehouden die loopt vanaf een gebied zonder radioactieve besmetting naar gebieden met een hogere potentiële besmetting.

Daartoe zijn binnen de installatie gescheiden zones ingesteld en wordt ventilatielucht uitsluitend via filters geloosd naar de omgeving.

Beheersen

Dit principe leidt ertoe dat de insluiting van radioactief materiaal zeker gesteld dient te worden. Dit wil zeggen dat de barrières, die het vrijkomen van radioactieve stoffen verhinderen, in stand worden gehouden gedurende de Eindontmanteling.

Dit heeft niet alleen betrekking op de bouwkundige en systeemtechnische voorzieningen die zijn aangebracht, maar ook op het onderhoud- en inspectieprogramma en het kwaliteitsborgingsysteem dat gedurende de Eindontmanteling zal worden onderhouden.

Controleren

Dit principe leidt ertoe dat geen radioactieve materialen onopgemerkt de installatie verlaten. Dit wordt gerealiseerd doordat:

- gasvormige producten en aërosolen uitsluitend gefilterd geloosd kunnen worden en de hoeveelheid radioactiviteit na een filter wordt gemeten en geregistreerd;
- essentiële procesparameters worden gemeten en geregistreerd;
- er geen radioactief afvalwaterlozingen kunnen plaatsvinden anders dan door aftappen van de verzameltank van besmet water;
- eventueel transport van aanwezig niet geconditioneerd radioactief materiaal door de materiaalmonitor bij de uitgang van het terrein wordt gedetecteerd.

6.3 Interne en externe invloeden op de veiligheid (Internal and external influences to Safety)

6.3.1 Interne invloeden op de veiligheid (Internal influences to Safety)

De veiligheidscriteria die gesteld worden aan het ontwerp van de installatie tijdens de Eindontmanteling worden gerelateerd aan de zogenaamde ontwerpgebeurtenissen, waarbij rekening wordt gehouden met de ernst van de gevolgen en de kans van optreden. De indeling in categorieën ontwerpgebeurtenissen is ontleend aan de voor dit doel goed bruikbare Amerikaanse standaard voor installaties voor de droge opslag van splijtstofelementen. Hierbij wordt onderscheid gemaakt tussen:

- Categorie 1: Normaal bedrijf
  Hieronder worden alle handelingen verstaan die continu of regelmatig optreden gedurende de Eindontmanteling, zoals het bedrijf van het ventilatiesysteem, onderhoud en inspectie, evenals het verkleinen en verpakken van radioactief afval. Het normale bedrijf van de installatie heeft geen schadelijke gevolgen voor de omgeving. Het individueel risico bij normaal bedrijf is kleiner dan het secundair niveau.

- Categorie 2: Storingen
  Hieronder worden alle gebeurtenissen verstaan die niet regelmatig optreden, maar waarvan verwacht kan worden dat deze ten minste eenmaal per jaar kunnen voorkomen, bijvoorbeeld het uitvallen van de externe elektriciteitsvoorziening en het uitvallen van het ventilatiesysteem. Tot de storingen worden ook fouten tengevolge van foutief menselijk handelen gerekend. De kans van optreden van deze gebeurtenissen is van de orde van 1 maal per jaar. Het individueel risico tengevolge van storingen is kleiner dan het secundair niveau.

- Categorie 3: Ongevallen
  Hieronder worden alle gebeurtenissen verstaan waarvan verwacht kan worden dat deze een beperkt aantal malen gedurende de Eindontmanteling zouden kunnen optreden, bijvoorbeeld het uitvallen van de externe elektriciteitsvoorziening gedurende een lange periode, of een interne brand. De kans van optreden van deze gebeurtenissen is van de orde van 1 maal per 10 tot 100 jaar. In het ontwerp van de installatie is met ongevallen van deze categorie rekening gehouden. Het individueel risico tengevolge van ongevallen is kleiner dan het secundair niveau.

- Categorie 4: Extreme ongevallen
  Hieronder worden alle gepostuleerde gebeurtenissen verstaan die, gezien hun ernst, gevolgen zouden kunnen hebben voor de omgeving van de installatie. Tot deze gebeurtenissen dienen ook externe invloeden van natuurlijke of niet-natuurlijke oorsprong gerekend te worden. De kans van optreden van deze gebeurtenissen is kleiner dan 1 maal per 100 jaar.

Naast bovengenoemde categorieën kan onderscheid worden gemaakt tussen "ontwerpongevallen" (ter beheersing waarvan in het ontwerp voorzieningen zijn getroffen) en "buiten-ontwerpongevallen" (ongevallen die niet in het ontwerp zijn betrokken). Voor interne ongevallen met ernstiger gevolgen dan die onder categorie 3 genoemd, komen alleen die scenario's in aanmerking waarbij de radioactieve inventaris van het reactorvat en/of het biologisch schild vrij komt. Hiervoor is echter geen realistisch scenario denkbaar. Ongevallen van categorie 4 zijn derhalve uitsluitend die met een externe oorsprong.

Analyse van de gevolgen van interne ongevallen:
De mogelijke gevolgen van de storingen en ongevallen zullen in het Veiligheidsrapport “Eindontmanteling”verder worden uitgewerkt.

6.3.2 Externe invloeden op de veiligheid (External influences to Safety)

Externe gebeurtenissen, die invloed kunnen hebben op de veiligheid van de installatie tijdens de Eindontmanteling behoren voor wat betreft de kans van optreden tot de categorie 4. Deze externe invloeden zijn naar oorzaak te onderscheiden in:

- invloeden met een natuurlijke oorsprong:
  - overstroming;
  - aardbeving;
  - harde wind en windhoos;
- invloeden met een niet-natuurlijke oorsprong:

- transportongeval op de Waal (gaswolkexplosie);
- neerstortend vliegtuig.

Analyse van de gevolgen van externe gebeurtenissen:
De mogelijke gevolgen van externe gebeurtenissen zullen in het Veiligheidsrapport Eindontmanteling verder worden uitgewerkt.

6.4 Beveiliging (Security)

Beveiliging van de installatie is noodzakelijk om te voorkomen dat personen onbevoegd het gebied zouden kunnen betreden en zichzelf daarmee aan straling of besmetting met radioactieve stoffen bloot zouden kunnen stellen. Daarnaast is beveiliging van de insluiting noodzakelijk om te voorkomen dat al dan niet kwaadwillende derden een voor de omgeving gevaarlijke situatie kunnen creëren.

De volgende beveiligingsmaatregelen zullen worden getroffen.

- Organisatorische maatregelen
  Hieronder vallen de organisatie, het personeel en de middelen die ingezet worden om de beveiliging gestalte te geven. Onder middelen worden de noodzakelijke beleidsstukken, procedures, richtlijnen, voorschriften, instructies en dergelijke verstaan.
- Bouwkundige maatregelen
  Hieronder vallen alle materiële voorzieningen die tot doel hebben weerstand te bieden tegen het middelenarsenaal waarmee binnendringing van een beveiligd object redelijkerwijs kan plaatsvinden. Hiertoe behoren wanden, daken, deuren, ramen, plafonds en dergelijke.
- Elektronische maatregelen
  Hieronder vallen alle materiële elektronische, elektrotechnische en optische voorzieningen die een observerende, signalerende of alarmerende functie hebben.

Naast de actief getroffen beveiligingsmaatregelen wordt de vorm waarin het radioactieve materiaal aanwezig is gekenmerkt door een hoge mate van passieve veiligheid (voornamelijk chemisch gebonden en geactiveerd materiaal) die onafhankelijk is van de permanente werking van mechanische en elektrotechnische systemen die door moedwillige beschadiging buiten werking zouden kunnen worden gesteld. De aard en de vorm waarin de radioactieve producten zich bevinden, beperken het risico van het vrijkomen van radioactiviteit tengevolge van sabotage of terroristische acties.

6.5 Industriële veiligheid (Industrial Safety)

De zorg voor de industriële veiligheid is geïntegreerd in de zorg voor de arbeidsomstandigheden (veiligheid, gezondheid en welzijn) en heeft tot doel de veiligheid van de eigen werknemers en die van derden te waarborgen, in overeenstemming met de bepalingen van de Arbo-wet.

7 Decontamination and Dismantling Techniques

7.1 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 experience is available with a wide variety of dismantling and decontamination techniques. The needed techniques are available and known. Published descriptions of these techniques can be found in the literature, e.g. /13/.

Not all techniques that were developed in the past could achieve acceptance in practice. In the course of the last ten years there has been a process of consolidation.

The techniques mentioned hereafter should give a short overview and they are commonly used today, but not all are taken into account in the present study. The selected decontamination and dismantling techniques are presented in section 7.3 and section 7.7 respectively.

7.1.1 Non-contaminated and Non-activated Objects

Non-activated and non-contaminated objects from the controlled area will be regarded as potentially contaminated. They will be removed from the plant and transferred to free release measurements before being free released when found in compliance with the free release limits.

Further treatment is carried out if this is required for the release measurements, for example if the geometry of the components makes release measurements too difficult or impossible.

7.1.2 Contaminated Objects

Contaminated objects will be removed from the plant and treated for free release or disposal as radioactive waste.

The components are cut in situ to suitable dimensions for internal transfer to the treatment areas. There a further cutting is carried out so that the parts can be free released after decontamination or they are packed and conditioned as radioactive waste.

7.1.3 Activated Objects

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

The aim of the dismantling is:

– to cut the activated parts to suitable dimensions for packaging

– to put them in the repository package

as effectively as possible.

7.2 Decontamination Techniques

Decontamination is an important issue in the Decommissioning & Dismantling (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:

- 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 clearance level.

7.2.1 Mechanical Decontamination

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

The procedures range from simple washing off and brushing off, mostly in combination with decontamination cleansers, to abrasion and mechanical removal of the surfaces for example by steel or sand blasting. The procedures are applied on well accessible surfaces (outer surface or inner surface after cutting) of almost all materials. The contamination can be loose or firmly clinging at the surface or even slightly penetrated into the surface. The volume of secondary waste is relatively small, as the abrasive media, for instance, may be applied several times. A partial decontamination of surfaces is possible in order to remove so-called hot spots. Mechanical decontamination can be used as a stand alone technique or in sequence with chemical decontamination.

The personnel needs might be high and the required protection measures against spreading of the dust are significant (depending on the technique).

7.2.1.1 High Pressure Water Decontamination

This technique is well known from non-nuclear applications. It is used for superficial contaminations. Water at high pressure is used to spray the surface (see Figure 7-1). Complicated surfaces can be cleaned. The consumption of additives is low.

This technique meets its limits if the contamination is chemically bound to the surface, or if it has penetrated into the surface. In such a case, one of the techniques that remove the surface must be applied.

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

7.2.1.2 Dry Blasting Decontamination (Grit Blasting)

The grit blasting technique is commonly called steel/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 (see Figure 7-2 and Figure 7-3).

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).

7.2.1.3 Scarification Techniques

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.

7.2.2 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 the duration, and on the 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 (see Figure 7-4).

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.

7.2.3 Decontamination by Melting

The D&D melting process 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 Caesium-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;
- Duratek Melting Facility, USA;
- 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.

7.3 Selection of an appropriate Decontamination Technique

The decision for the use of the above mentioned decontamination techniques depend on different technical or economic factors. The possible decontamination treatments are not applicable to every component. The decision for the decontamination starts with the evaluation and analysis of the existing components and materials. The analysis will be figured out by the NIS software Cora and the Dodewaard specific component data base (DIS).

When selecting a specific technique for component decontamination, the following main requirements has been considered:

- Safety;
- Cost-effectiveness;
- Waste minimisation;
- Feasibility of industrialisation.

To achieve a good decontamination factor, a decontamination process must be designed for site-specific application taking into account a wide variety of parameters. Some of them are listed below:

- Type of plant and plant process: reactor type, reprocessing plant, etc.;
- Operating history of the plant;

- Type of material: steel, concrete, etc.;
- Type of surface: rough, porous, coated, etc.;
- Type of contaminant: oxide, crud, sludge, loose, etc.;
- Composition of the contaminant (i.e. activation products, fission products, actinides, etc.) and the specific radionuclides involved;
- Regulatory requirements and required decontamination factor;
- Destination of the decontaminated components: disposal, reuse, etc.;
- Time required for application;
- Proven efficiency of the process for the type of contamination in the facility;
- Type of component: pipe, tank, etc.

Other factors which are important in selecting the method, but do not affect the decontamination factor, are:

- Availability, cost and complexity of the decontamination equipment and consumables;
- Need and capability of treatment and conditioning of the generated secondary waste;
- Potential exposure to hazardous materials and/or chemicals used in the decontamination process;
- Occupational and public doses resulting from decontamination (justification of the practice);
- Other safety, environmental and social issues;
- Extent to which the plant needs to be decontaminated to achieve acceptable conditions for decommissioning;
- Salvage value of materials which would otherwise be disposed of;
- Extent to which the facility must be modified to do the decontamination: isolate systems, enclosed and ventilated spaces, etc.

In addition, the choice of a process finally depend on several other factors such as:

- The specific nature of the application, the complexity of the system;
- The feasibility of industrialisation;
- The cost/benefit analysis taking into account all aspects of the decontamination operation, i.e. until disposal of remaining radioactive waste.

Due to the situation at KCD (dismantling after SE and no operable waste water system available) the intention is to avoid water. Therefore only dry decontamination techniques are selected.

Three decontamination areas are installed in the new treatment area in the Turbine building (investments see No. 14 of Table 10-8):

- Caisson for dry blasting;
- Grinding / Scarifying area;
- Decontamination place for hands on decontamination like scrubbing or wiping incl. the possibility of using decontamination cleansers.

The gathered experience in the field of decontamination shows that the necessary decontamination work can be done by dry decontamination techniques.

The selection of dry blasting technique is based on the following aspects:

- Very flexible technique;
- Recirculation and/or recycling of abrasives;
- Comparably low priced technique;
- Large and small pieces can be decontaminated;
- Treatment of large tanks in situ;
- Metal removal on demand;
- Technique gives result in a relative short time;
- Equipment is well developed and commercially available;
- High practical experience.

Nevertheless the entire treatment process (cutting, treatment, disposal etc.) leaves scope for future optimization, especially since there are no finalized findings about the radiological plant conditions (i.e. kind and level of contamination) at the actual time of dismantling and treatment yet.

Melting might be also an alternative, but all available facilities are outside of the Netherlands, what necessitate a lot of transports abroad. In addition there might be also a problem with the probably still contaminated ingots which has to be disposed of as radioactive waste.

7.4 Dismantling Techniques

7.4.1 General

Today a great experience on dismantling of components in nuclear installations is available. New developments are needed only in some specific cases where the local situation is very special. 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 decommissioning project, as described in the following.

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

- Internal transfer;
- Decontamination;
- Measuring for release;
- 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. large components which will be radioactive waste and which can be put directly into a container.

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

So dismantling techniques are needed for the following:

- Dismantling in situ: The components and equipment have to be removed from the plant and in most cases they will be transported to the treatment area for further handling and conditioning. Components that are a part of a system must be cut out of the system. Components with a size that can be handled and transported without cutting will be removed in one piece. Pipes will be cut to pieces that are suitable for internal transportation. The in situ cutting techniques must be flexible.
- Remote dismantling: The RPV internals, the RPV itself, the RPV insulation, the drywell with its installations and the biological shield will be dismantled in situ, but under remote control. All these dismantling activities are processed under dry conditions. Cut pieces are directly put in storage packages.
- Dismantling in treatment areas: A lot of the dismantled equipment (except activated parts like RPV, RPV internals, etc.) are treated in special treatment areas, e.g. in the turbine building. Further cutting is needed either to facilitate decontamination, to achieve a better filling rate of the packages, or to facilitate clearance measurements.

The following chapters give some information on dismantling techniques which were preferred in real decommissioning projects of today.

7.4.2 Mechanical Cutting

Mechanical cutting is the name for techniques such as sawing, cutting, milling, planning, abrasive cutting etc. These separation processes are possible under dry conditions 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, kerfs, 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.

7.4.2.1 Band Saw Cutting

Band saw cutting (see Figure 7-5) 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).

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 substructure 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.

7.4.2.2 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.

7.4.2.3 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 and has a diameter of 2.5 m and can cut a 1 m 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 tonnes 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 30 cm, the weight and bulk of the machines then require special adaptations to the manipulation and guidance equipment.

7.4.2.4 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 kerfs (the width being a constant).

Wire saw cutting is suitable for reinforced concrete but also for simple thick steel structures.

The wires are provided with small blades (see Figure 7-6).

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.

The technique of cable cutting is well known 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.

7.4.2.5 Hydraulic Shear

A hydraulic shear (see Figure 7-7) 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.

In case of remote controlled operation the cutting forces and the resulting moments must be observed to prevent damages to the remote control handling tools.

7.4.2.6 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.

7.4.3 Thermal Cutting

Thermal cutting processes (see Figure 7-8) include, for example, oxyacetylene 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.

7.4.3.1 Acetylene Cutting Technique

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 combustion 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 1150°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 200 mm can be achieved for mild steel.

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

7.4.3.2 Plasma Arc Cutting technique

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 electric 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.

7.5 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 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).

7.6 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.

7.7 Application and Selection of Dismantling Techniques

The selection criteria for the dismantling techniques are comparable to the criteria for the selection of decontamination techniques, like:

- Safety;
- Cost-effectiveness;
- Component type, material, geometry;
- Flexibility;
- Remote controlled handling;

- Practical experience;
- Feasibility of industrialisation.

The above mentioned techniques fulfil these requirements. The wide variety of components and materials require also a variety in dismantling techniques and therefore, more or less all described techniques are chosen for the dismantling of KCD (see next sections). Only the WAS Technique is not selected, because this would demand costly new waste water systems, which are not considered in the present study.

7.7.1 Contaminated and Non-Contaminated Components

The dismantling process is carried out system by system and/or room by room and/or component by component. The sequence of work will be decided during the detailed planning work depending on the needs of keeping some systems in operation, on the needs of working space and the improvement of the infrastructural matters. Mechanical and thermal cutting processes will be applied.

Applied mechanical separation processes are such as sawing, milling, grinding, etc.; in the field of thermal separation processes the acetylene cutting and plasma cutting are used.

The thermal cutting process is associated with the generation of dust and aerosols. To avoid the contamination on the surrounding surfaces additional ventilation systems and/or caissons are necessary.

The investments for the selected tools are given in Table 10-8 under No. 20 to 22.

A lot of the dismantled components have to be cut further to allow their decontamination and/or to fit into the storage containers. These further cutting activities are carried out in a special treatment area in the Turbine building. The cutting is done by mechanical (e.g. band saw, hydraulic shear) and by thermal techniques (e.g. cutting torch). The planned investments for these cutting tools are listed in Table 10-8 under No. 15.

7.7.2 Dismantling RPV-internals, RPV and Drywell with internals

The most important dismantling activities are the dismantling of the RPV-internals and the RPV itself. The internals will be dismantled in an in situ action and packaged directly in storage container like MOSAIK cast iron containers.

The packaging concept affects the dismantling procedures and the sequence of work very strongly, but not the dismantling techniques useable for the RPV internals.

For the disassembling and the cutting action of all activated components (RPV internals, RPV, Internals of Drywell and Drywell itself) the following techniques are used:

- Acetylene burning;
- Plasma burning;
- Mechanical cutting such as sawing, milling, grinders, nibblers.

Taking into account the present situation at KCD, no active waste water system is available, so only dry dismantling techniques (e.g. Plasma burning) are used to dismantle the activated RPV internals. Such a dry dismantling was carried out in the German dismantling project Niederaichbach where NIS was involved and experiences are available.

The dismantling of the RPV itself will be performed in air without water and under remote control. The techniques used are sawing (blade saw) and Plasma burning. This is common practice in other decommissioning projects. In 2010, the RPV of the NPP Stade is for example dismantled under dry conditions by NIS.

The cutting of the RPV is carried out from the top to the bottom by segmenting it into pieces which fit in KONRAD Type II-Containers. Before cutting the RPV segments, the surrounding internals of the Drywell are cut and packaged also into KONRAD Type II-Containers. After dismantling the Drywell internals and the RPV, the Drywell itself is cut into pieces and packaged, starting from the top and ending with the bottom part.

At the beginning of the dismantling work substantial installations and preparatory works are necessary on the reactor building operating deck (level F) and in the reactor vessel pit itself; e.g.:

- Erection of a caisson (shielding and separate ventilation system);
- Installation of remote-controlled equipment and cutting tools comprising control panels;
- Installation of cameras;
- Improvement of the fuel loading bridge.

The investments for dismantling of the activated parts (RPV internals, RPV, Drywell internals and Drywell) are given in Table 10-8 under No. 17 to 19.

7.7.3 Biological Shield

The radioactive part of the biological shield is dismantled by means of the rope sawing method together with a blade saw. With this technique a rope is pulled through holes drilled in the concrete. On the surface of the rope there are very hard materials placed in defined distances. Diamonds, very hard metals or ceramics have been applied up to now. This rope is led through deflection pulleys to a drive unit. There is the possibility to detach square meter large pieces which may then be demolished in a work shop using appropriate cutting tools. See No.19 in Table 10-8 for all necessary investments to remove the biological shield.

7.7.4 Dismantling of Non-Nuclear Equipment and Buildings

The building structures will be dismantled with conventional techniques and procedures under consideration of the relevant technical rules and prescriptions. As far as possible the different waste categories will be separated (concrete, masonry, etc.).

The present section describes the procedures to be followed in the non-nuclear buildings and in the nuclear buildings after nuclear clearance.

The conventional dismantling includes:

- Preparation of a report on toxic substances;
- Preparation of the dismantling and demolishing;
- Removal of toxic substances such as asbestos and other mineral fibres;
- Removal of toxic substances from operation such as spilled oil;
- Dismantling and demolishing of the buildings;
- Separation of the material fractions;
- Site Recovery.

7.8 Summary of selected Decontamination and Dismantling Techniques

To give a short overview, a list summarizing the selected main decontamination and dismantling techniques is following:

Decontamination Techniques:

- Dry blasting in a special caisson;
- Grinding / Scarifying;
- Hands on decontamination like scrubbing or wiping incl. the possibility of using decontamination cleansers.

Dismantling Techniques:

- Blade saw;
- Band saw / circular diamond saw;
- Diamond rope saw
- Angle grinder
- Hydraulic shear
- Shredder (cables)
- Acetylene cutting technique
- Plasma arc cutting technique

7.9 Figures

Figure 7-1: Decontamination by high pressure water (Picture by courtesy of EWN)

Figure 7-2: Dry blasting decontamination (Picture by courtesy of EWN)

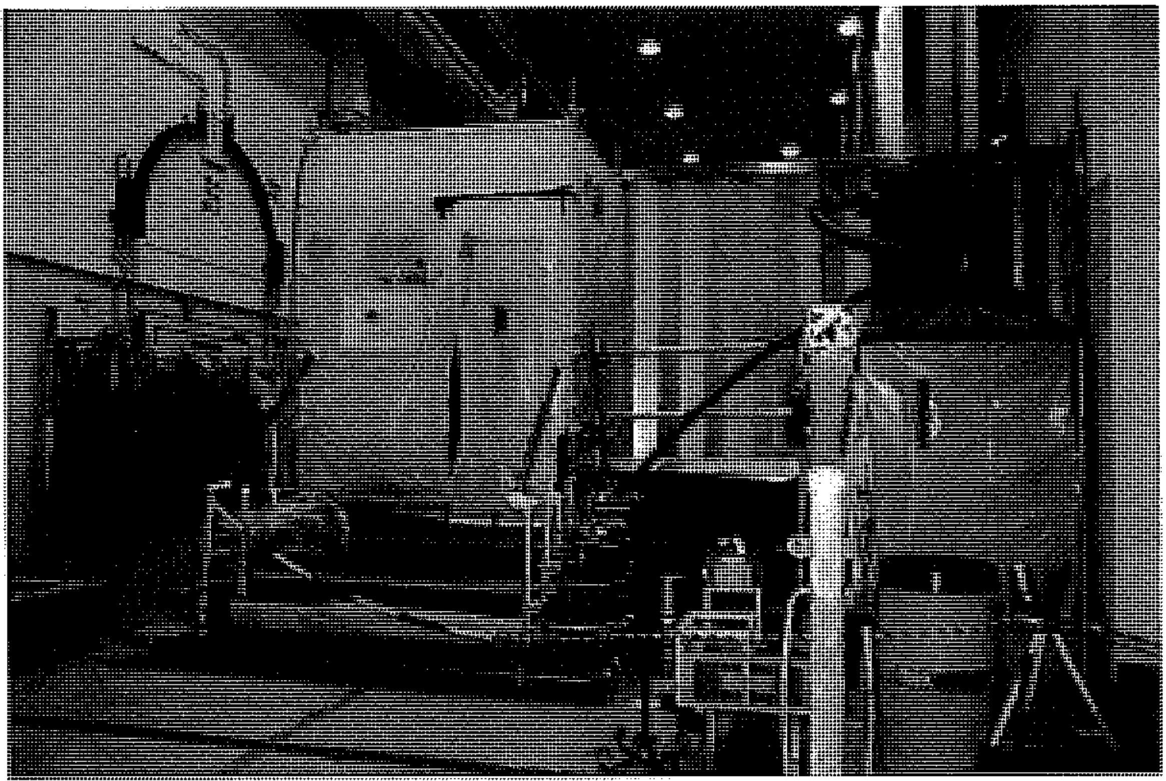

Figure 7-3: Blasting caisson at NPP Kahl

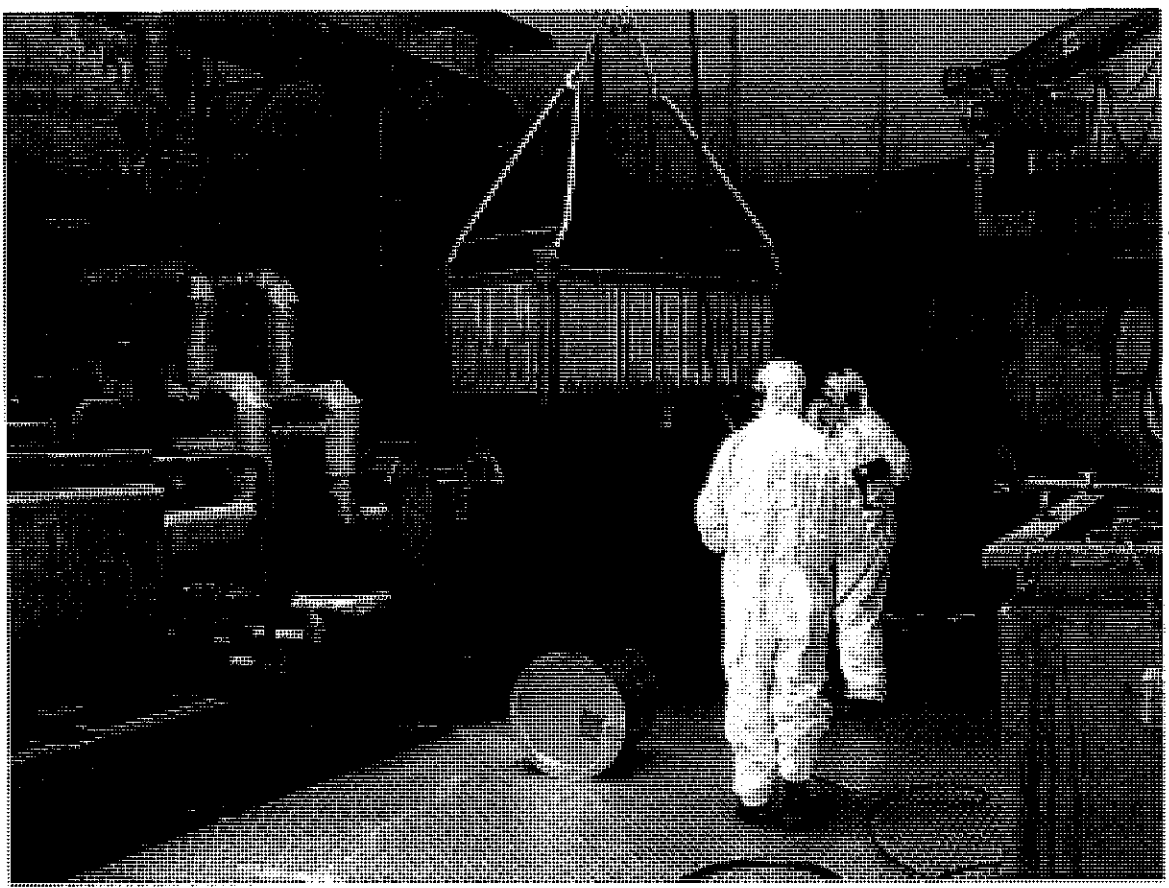

Figure 7-4: Chemical decontamination (Picture by courtesy of EWN)

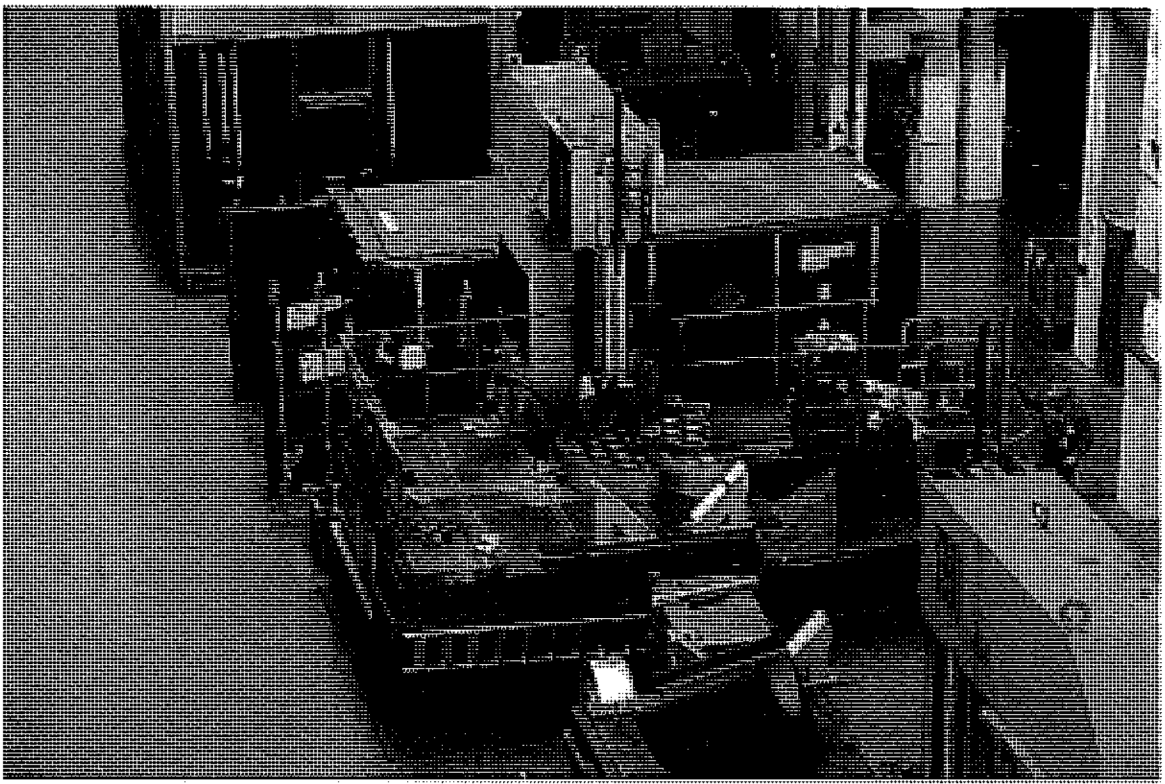

Figure 7-5: Band saw (Picture by courtesy of EWN)

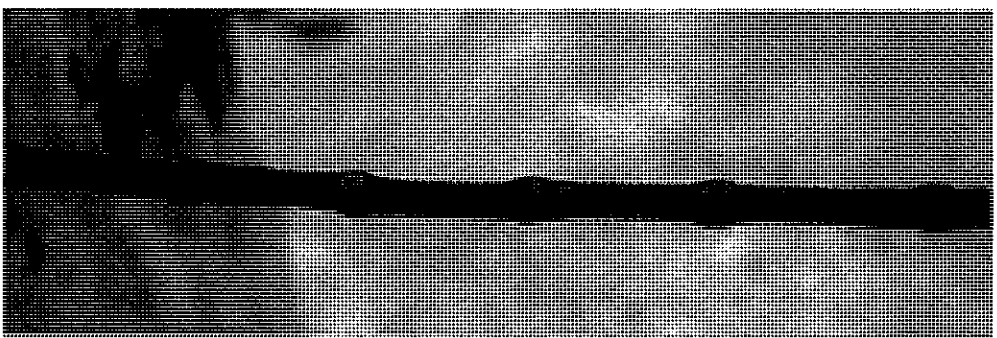

Figure 7-6: Cutting wire with diamond "Pearls" and distance springs

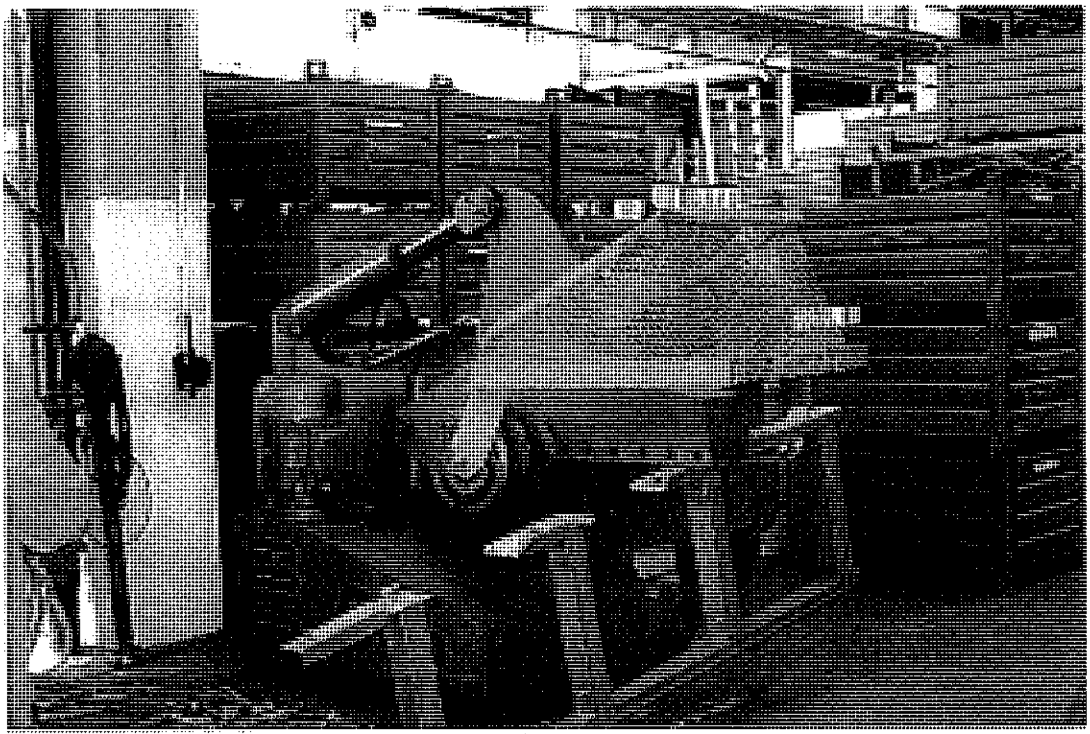

Figure 7-7: Hydraulic shear (Picture by courtesy of EWN)

Figure 7-8: Thermal cutting (Picture by courtesy of EWN)

8 Waste Management

8.1 Basic Considerations

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

- Release of non-radioactive material for industrial recycling, if necessary a decontamination treatment can be applied before;
- Preparation for final repository of radioactive waste, so called conditioning and packaging;
- Preparation for conventional repository of non-radioactive waste.

Also several groups of material will be generated. The main groups, entitled by the origin, are:

- Primary masses:
  Components and structures contained in the NPP at the final shutdown (this group contains all masses stored in DIS and transferred to CORA).
- Secondary masses:
  All material which are generated during the D&D work, i.e. consumables, plastic foils, clothes, air filters, worn tools, solids from decontamination, etc.
- Tertiary/additional masses:
  New buildings, tools and equipment used for the D&D work, but possibly reusable for other D&D projects (e.g. super-compactor)

8.2 Qualitative and Quantitative Estimate of Dismantling Masses

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 can not be released from nuclear constraints.
- Conventional waste:
  Material that is free from nuclear constraints, but there are other (non-nuclear) reasons why this material must be treated as waste.

8.2.1 Mass distribution factor sets

Thousands of different components have to be considered for the D&D planning. For the calculation of the D&D costs one must decide what will be done with these components: 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. In CORA / CALCOM this is done via the so called mass distribution factor sets (DF sets). The concept of the DF sets is explained in the following.

A DF set indicates what will be done with the component and how the resulting waste will be packed. If needed, a separate DF set can be defined for each individual component, but in most cases a DF set serves for several components.

As an example the DF for "contaminated cable trays with cables" gives:

- 35% are reused after treatment (shredding), this is the copper part of the cables;
- 30% are packaged after shredding and super-compaction (e.g. insulation of cables);
- 20% are released after measuring without a special decontamination (steel from cable trays);
- 10% are released after mechanical decontamination (steel from cable trays);
- 5% are packaged after super-compaction (e.g. parts of cable trays).

For a first evaluation each component listed in CORA (about 5750 different items) has been allocated with a DF set. All DF sets which are used are given in Appendix 1 as a printout of CORA.

Three possible destinations of the dismantled materials have been considered:

- Unrestricted release / landfill (cleared material);
- Reuse, as non-radioactive (cleared) material;
- Final repository.

Taking into account the DF sets Table 8-1 (KEW) and Table 8-2 (IAEA) give an overview about the masses for the different destinations.

The tables show that about 14 % (KEW) or 17 % (IAEA) of the plant inventory (incl. the new installations) has to be stored as radioactive waste. Considering the total plant masses (incl. building structures, see Table 2-6) less than **2 %** will be radioactive waste.

8.2.2 Size specific classification of physical input data

An effort is made to consider the influence of the component size on the dismantling work and on the decision on what will be done with the dismantling components.

Therefore the system components are classified in three groups:

- Small;
- Medium;

- Large.

The assumed criteria used for the classification of pipes, valves, pumps, vessels and heat exchangers are listed in Table 8-3.

8.3 Waste Management Strategy

8.3.1 Dismantled components

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, Drywell and Biological Shield) all other dismantled parts are pre-sorted (e.g. materials) and transported to the treatment area in the Turbine building. The selected transport routes are shown in Figure 8-1 to Figure 8-7. 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.

The treatment area is prepared in the Turbine building. The considered area is shown in Figure 8-8. Before the installation of the treatment equipment and facilities the present equipment is dismantled and the area is prepared for the new installations. By thoroughly checking building drawings and scrutinising the situation on site it has been verified that there is enough available room to buffer store the materials which had to be removed for the preparation of the treatment area (e.g. 22,2 m floor of the Turbine building). Treatment methods and techniques are combined to the actual needs. It includes:

- 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 can not be removed. Then one will try to separate the contaminated portion from the rest, to minimise the amount of radioactive waste.

- Super-Compaction:
  Super-compaction is done to reduce the size (in m^3) 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 on-site. Therefore a mobile super-compactor is installed in the Turbine building (see section 8.7). An alternative to the treatment on-site is to carry out the super-compaction at COVRA, but this is depending on the amount of material for super-compaction and the available duration for the performance of the work. The buffer storage capacities at COVRA are limited. Due to the extended decommissioning period (compared to the previous studies /1/, /2/) there might be a cost benefit in transporting the waste to COVRA for treatment (potential savings might be possible). This issue has to be revisited very carefully at the time of the execution of the decommissioning project as soon as the real amount and duration for treatment are better known.

- 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.

- 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:
  Combustible waste will be sent to an incineration facility. Incineration leads to a reduction in mass and in volume of the waste. After incineration the radioactive particles will be concentrated in the ashes and in the air filters. About 35,1 Mg of combustible waste have been taken into account in the present study.

- Liquid waste treatment:
  The liquid waste is collected in a storage tank. Batch wise the contaminated liquids are transported to COVRA (using 60-l drums) for further treatment. In the present study is assumed that in average about 6.500 litres of radioactive liquids per year have to be transported and treated. No liquid treatment on site is foreseen. Non-contaminated liquids are measured and discharged to the river.

Depending on the origin of the dismantled parts and what is known about their physical, chemical and radiological properties, the operators of the treatment area will decide how to treat and condition the parts. For example:

- A specific component may be cut to smaller pieces, some of its parts may be decontaminated, another portion may be packed as radioactive waste and a third part may be super-compacted and then packed;

- Some other equipment may be cleared after clearance measurements;

– Some other structures may never have been in the controlled area, and they require no treatment at all. If they are not to be treated as conventional waste, they can be cleared for reuse.

The above said is reality in D&D projects, and – with few exceptions – it appears to be impossible to decide in advance what's to be done exactly with a specific component. But there are experiences which can be used to predict what will be needed for specific types of components. The NIS software uses the concept of so-called "Distribution Factor Sets" (DF-Sets) which describe what, as an average, will happen to the components they are assigned to (see section 8.2.1 and Appendix 1).

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 (see section 8.5). Otherwise it has been packed into the containers for transport, interim storage at COVRA and later disposal.

8.3.2 Decontamination of Building Structures

Decontamination of building structures is completely different from decontamination of components and equipment that was treated in the previous section.

The surfaces of the building structures inside the controlled area are decontaminated by removing the surface layer where contamination is suspected.

Regarding the removal of surface layers following assumptions have been taken into account (derived from NIS experience with real D&D projects):

– Floors – contamination > 0,4 Bq/cm²: 100 % of the surface are removed (20 mm);

– Floors – contamination <= 0,4 Bq/cm²: 25 % of the surface are removed (20 mm);

– Walls – contamination > 0,4 Bq/cm²: 20 % of the surface are removed (2 mm);

– Walls – contamination <= 0,4 Bq/cm²: 10 % of the surface are removed (2 mm);

– Ceilings: no surface removal assumed.

The building structures are then measured for clearance as a whole, in situ (see section 8.6.2).

After clearance from nuclear regulations, the building structures are dismantled under conventional conditions.

8.4 Packaging Concept / Containers

Radioactive waste is packaged regarding the acceptance requirements of COVRA. Main boundary conditions are:

– The maximum total weight of a filled storage container is below 15 Mg.

– The contents of the storage containers and 200-l drums are immobilized with cement. Only the MOSAIK containers are not filled with cement.

- The dose rate for transportation are below the limits of the international transport regulations, i.e.:
  - 2 mSv/h at surface of the transport package;
  - 0,1 mSv/h a 2 m distance from the transport package.
- The 200-l drums and the 1000-l containers themselves can have higher surface dose rates, but the transport, interim storage and disposal fees are depending on the surface dose rates. In the present study following dose rates have been considered:
  - 200-l drum with a surface dose rate <= 0,2 mSv/h
- 90-l drums for super-compaction are used to ensure the stackability of the immobilized 200-l drums (eightfold stacking must be possible).
- Standard 60-l drums are used for the transportation of radioactive liquid waste.
- Lead as an additional internal shielding should not be used (in the present study only concrete or steel have been used as additional shielding).

Except the activated parts (e.g. RPV-internals, RPV), which are packaged directly at the dismantling place, all other radioactive waste is packaged and immobilized with concrete in the treatment area of the Turbine building. Mainly 200-l drums and KONRAD containers are used. The filling rate of the drums and containers is considered with 20 % for metallic and mixed materials and with 40 % for concrete rubble. The loaded masses, that means which mass of the dismantled materials are loaded into the different packages, can be taken from Appendix 1.

Containers used for the packaging of the radioactive waste are:

- 90-l drum (press drum for super-compaction);
- 60-l drum (for transport of liquid waste to COVRA);
- 200-l drum;
- MOSAIK Type II container;
- KONRAD Type II container.

Examples of the different drums and container types are shown in Figure 8-9 to Figure 8-15. The main dimensions are given in Table 8-4.

KONRAD Type II containers are currently not licensed in the Netherlands. It was agreed by VROM these packages can be brought forward for licensing as long as these packages are licensed in Germany. COVRA agreed to accept these packages.

Table 8-5 to Table 8-7 show the results of an estimation of the maximum specific activity [Bq/g] of Co-60 which can be packaged in a MOSAIK Type II-, in a KONRAD Type II-Container or in a 1000-l Container to comply with the transport regulations. The results are given for different shielding thicknesses and materials. The highlighted types in the different tables are used for the present study.

Table 8-8 gives the maximum specific activity [Bq/g] of Co-60 for a 200-l drum to comply with the different COVRA limits for transportation, interim storage and disposal.

As mentioned above also the type and number of packages have been evaluated by using these DF. The results of the evaluation for the primary masses are shown in Table 8-9 for Task 1.1 (Best estimate using clearance levels from the Dutch Kernenergiewet) and in Table 8-10 for Task1.2 (Best estimate using clearance levels from IAEA RS-G-1.7).

8.5 Clearance Measurements

8.5.1 Measurement Equipment

8.5.1.1 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 smooth, then samples can be taken from representative surfaces.

8.5.1.2 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 radiating nuclides (alpha, or pure beta radiators).

8.5.1.3 Total Gamma Measurement

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

8.5.1.4 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.

8.5.1.5 In-Situ Gamma Measurements

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.

8.5.1.6 Nuclide Specific Gamma Measurements (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.

8.5.1.7 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 radio nuclides, 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.

8.5.1.8 Germanium Detectors for Clearance of Material

Germanium detectors are semiconductor diodes having a P-I-N structure in which the Intrinsic (I) region is sensitive to ionizing radiation, particularly X-rays and gamma rays. Under reverse bias, an electrical field extends across the intrinsic or depleted region.

When photons interact with the material within the depleted volume of a detector, charge carriers (holes and electrons) are produced and are swept by the electrical field to the P and N electrodes. This charge, which is in proportion to the energy deposited in the detector by the incoming photon, is converted into a voltage pulse by an integral charge sensitive preamplifier. Because germanium has a relatively low band gap, these detectors must be cooled in order to reduce the thermal generation of charge carriers (thus reverse leakage current) to an acceptable level. Otherwise, leakage current induced noise destroys the energy resolution of the detector. Liquid nitrogen, which has a temperature of 77 K is the common cooling medium for such detectors.

The detector is mounted in a vacuum chamber which is attached to or inserted into a liquid nitrogen Dewar or an electrically powered cooler. The sensitive detector surfaces are thus protected from moisture and condensable contaminants.

8.5.1.9 Preamplifiers for Germanium Detectors

There are only two basic types of preamplifiers in use on Ge detectors. These are charge sensitive preamplifiers that employ either dynamic charge restoration (RC feedback) or pulsed charge restoration (Pulsed optical or Transistor reset) methods to discharge the integrator.

Pulsed Optical Reset preamplifiers are widely used on low energy detectors where resolution is of utmost consideration. Eliminating the feedback resistor decreases noise without a serious impact on dead-time, as long as the average energy per event is low to moderate.

At 5.9 keV per event, a preamplifier may process almost 1000 pulses between resets. Since the reset recovery time is 2-3 amplifier pulse widths, little data is lost in this situation. Optical feedback systems can, however, exhibit long recovery times due to light activated surface states in the FET.

Proper selection and treatment of components can minimize the problem, but it is generally present to some degree in pulsed optical systems. With high energies, where resets necessarily occur very often, perhaps after as few as 10 events, this spurious response can be a serious problem. As a consequence, pulsed optical feedback systems are not in general used with coaxial detectors.

The Transistor Reset Preamplifier was developed in an attempt to overcome the problems associated with pulsed optical reset preamplifiers in high energy, high rate systems. The feedback capacitor is discharged by means of a transistor switch connected to the FET gate. This transistor adds some capacitance and noise to the input circuit but this is tolerable in most applications involving high count or energy rates. Compared to an RC preamplifier with selected feedback resistor for high rate performance, the transistor reset preamplifier will exhibit less noise but will sacrifice dead time because the amplifier will require 2-3 pulse widths to recover from the periodic reset of the preamplifier.

8.5.2 Clearance Concept

A site specific clearance concept will be prepared as a basis for the clearance of material from the controlled area. The clearance concept will cover the specification of the clearance measurement equipment, the agreements with the authorities, the description of the measurement and clearance procedures and the documentation of the results and decisions.

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.

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.

8.5.3 Clearance for Transportation

A special type of clearance is the clearance for the transportation of radioactive material. Measurements will be made to demonstrate that the individual packages are below the limits for transportation, and also the complete batch (for example a truck with several waste packages) will be measured. The procedures to be followed and the limits to be complied with will be described in a working directive.

8.6 Clearance of Components, Equipment, Buildings and Site from Nuclear Regulations

8.6.1 Clearance of Components and Equipment

Components and equipment to be cleared are cut and decontaminated, if needed, and then sent to the decision measurement station. The decision measurements will be performed per batch. The clearance directives will be complied with, and all measurements will be documented. Portions that can not be cleared will be removed from the batch and sent back to the waste conditioning station.

The documentation for the batch will be presented to the authority or its representation. They can check the documentation and can perform independent measurements. After clearance by the authority the batch is free from nuclear regulations and is handed over to a qualified recycling company.

8.6.2 Clearance of Nuclear Buildings (Removal of Controlled Area)

Building structures will be decontaminated, if needed, and cleared in situ. The dismantling can then be done under conventional conditions.

When all components and equipment are removed from a specific area, and the modified ventilation and media supply systems are in operation (pressurised air, electrical energy, and illumination), this area is separated from the rest of the controlled area. Pre-measurements are performed to decide about the decontamination techniques for the building. The relevant directives will be complied with.

After the decontamination of the area (bottoms, walls, ceilings as decided on the basis of the pre-measurements) the plant operator will measure the complete area and prepare a detailed report with the measuring results. The authority can check the documentation and can perform independent measurements. When all rooms of a separated area are measured and the authorities have confirmed their agreement, the area can be released from controlled area constraints. The controlled area specific measures such as access control and ventilation with under-pressure are not required anymore in this area.

Measurements will also be performed on the removed material (concrete rubble). The authority can check the documentation and can perform independent measurements. Cleared material is handed over to a qualified recycling company.

8.6.3 Clearance of Non Nuclear Buildings and Site

Spot tests will be performed to prove that the non nuclear buildings and the surroundings (streets, free areas) are free from nuclear contamination. The techniques to be used and the samples to be taken (location, specification and number) will be described in a technical report that will be agreed upon with the authority.

Individual rooms in non nuclear buildings which are suspected of possible contamination will be checked carefully and samples will be taken as if they belonged to the controlled area. If necessary they will be decontaminated.

The present study is based on the assumption that outside the controlled area no contamination will be found that could have a significant impact on the D&D plan, on the time schedule or on the costs.

8.6.4 Clearance of Site from Nuclear Regulations

When all the aforementioned steps are performed for the site, it can be cleared from nuclear regulations. A report will be prepared describing the actual status of the site. The authorities will check the report and confirm the clearance from nuclear regulations.

The area and the activities on it are then ruled by the conventional regulations for industrial sites under dismantling.

8.7 Needed Installation and Equipment

New offices are installed in the existing control room and the former visitor room. Also a small canteen/cafeteria is planned in this area. Therefore the closed windows have to be reopened again (see No. 11 of Table 10-8).

The personnel access (e.g. sanitary area) and the radiation protection surveillance must be modified and adapted to the changing needs because of the higher number of working people on site. The area of the former switch yard is used for it. The area is modified and connected with the current main entrance point (see No. 4, 6, 7 and 12 of Table 10-8).

Ventilation, heating, energy supply and safety equipment must be adapted to the changing conditions during decommissioning and dismantling (see No.5 and 9 of Table 10-8).

A mechanical and electrical work shop is installed in the former Waste building. Also the buffer store for conditioned drums and containers is placed in the Waste building. The foreseen area was used as buffer store also during operation of the plant. A new door and handling devices have to be installed. A large forklift which can handle containers up to a weight of 20 Mg is used for transportation of the containers (see No. 3 and 10 of Table 10-8).

The treatment area is located in the Turbine building (see Figure 8-8). After removal of the present installation and after modification of the area new equipment is installed. The main equipments foreseen to treat the dismantled parts are as follows:

- Caisson for Dry blasting (see section 7.3 and No. 14 of Table 10-8);
- Grinding / Scarifying area (see section 7.3 and No. 14 of Table 10-8);
- Decontamination place for hands on decontamination like scrubbing or wiping incl. the possibility of using decontamination cleansers (see section 7.3 and No. 14 of Table 10-8);
- Band saw / Frame saw (see No.15 of Table 10-8);
- Hydraulic shear (see No.15 of Table 10-8);
- Cutting torch (see No.15 of Table 10-8);

- Disassembling place (see No.15 of Table 10-8);
- Cable granulating plant (see No.15 of Table 10-8);
- Super-compactor (see No.16 of Table 10-8);
- Cementation plant (see No. 13 of Table 10-8);
- New building for free release measurements with measurement facility (see No. 1 and 2 of Table 10-8 and Figure 2-5);
- Entrance buffer storage (see No. 1 of Table 10-8 and Figure 2-5).

8.8 Tables

Destination	Mass [Mg] *)		Percentage
Cleared Material (e.g. Unrestricted release / Reuse / Landfill)		5.360	86%
thereof after decontamination	961		
Final repository		873	14%
Total		**6.233**	**100%**

*) Without building structures (see Table 2-6)

Table 8-1: Mass distribution according to the planned destination (Best estimate with Dutch (KEW) clearance levels)

Destination	Mass [Mg] *)		Percentage
Cleared Material (e.g. Unrestricted release / Reuse / Landfill)		5.150	83%
thereof after decontamination	961		
Final repository		1.083	17%
Total		**6.233**	**100%**

*) Without building structures (see Table 2-6)

Table 8-2: Mass distribution according to the planned destination (Best estimate with IAEA clearance levels)

Component type	Classification		
	Small	Medium	Large
Pipes	Dia <= 50 mm	Dia > 50 mm < 100 mm	Dia >= 100 mm
Valves	Mass <= 25 kg	Mass > 25 kg < 200 kg	Mass >= 200 kg
Pumps	Mass <= 25 kg	Mass > 25 kg < 200 kg	Mass >= 200 kg
Vessels	Mass <= 100 kg	Mass > 100 kg < 1000 kg	Mass >= 1000 kg
Heat exchangers	Mass <= 200 kg	Mass > 200 kg < 1000 kg	Mass >= 1000 kg

Table 8-3: Size classification of system components

Container type	Height [m]	Width [m]	Length [m]	Diameter [m]	Outer volume [m³]	Wall tickness [mm]	Material	Mass of empty drum or container [kg]
90-l drum	0,64			0,45	0,1	1,5	steel	10
200-l drum	0,93			0,58	0,2	1,0	steel	75
KONRAD Type II	1,70	1,70	1,60		4,6	10	steel	1.500
KONRAD Type II / 180mm NC	1,70	1,70	1,60		4,6	10 / 180 / 10	steel / concrete /steel	6.300
MOSAIK Type II / 60mm Fe	1,50			1,06	1,3	160 / 60	cast iron /steel	7.070

Table 8-4: Main dimensions of the drums and containers used

No.	Shielding Cast iron	Steel	Lead	Inner Volume	Mass Waste	Specific Actvity (Co-60) 0,1 mSv/h 1 m distance	2,0 mSv/h Surface
	[cm]			[m³]	[kg]	[Bq/g]	
1	16			0,490	770	3,47E+05	2,09E+06
2	16	3		0,372	580	1,26E+06	7,52E+06
3	16	6		0,291	450	4,47E+06	2,69E+07
4	16	10		0,203	320	2,45E+07	1,45E+08
5	16	14		0,134	210	1,43E+08	8,25E+08
6	16		3	0,372	580	2,41E+06	1,48E+07
7	16		6	0,291	450	1,64E+07	1,03E+08
8	16		10	0,203	320	2,16E+08	1,36E+09
9	16		12	0,166	260	7,95E+08	4,97E+09
10	16		14	0,134	210	2,95E+09	1,82E+10

(shaded) = Used for the present study

Table 8-5: Specific activity for Co-60 in Bq/g for MOSAIK Type II-Container to comply with the transport regulations

No.	Shielding Steel 7,86 g/cm³	Concrete 2,35 g/cm³	Concrete 3,5 g/cm³	Concrete 4,2 g/cm³	Steel *) 7,86 g/cm³	Inner Volume	Mass Waste Concrete	Mass Waste Steel	Specific Actvity (Co-60) 0,1 mSv/h 1 m distance	2,0 mSv/h Surface
	[cm]					[m³]	[kg]	[kg]	[Bq/g]	
1	1					4,0		6300	1,52E+03	9,99E+03
2	1	18			1	2,0		3200	1,86E+04	1,66E+05
3	1	16			4	1,8		2800	5,71E+04	5,52E+05
4	1	18			11	1,2		1900	9,19E+05	9,46E+06
5	1		18		1	2,0		3200	4,93E+04	5,16E+05
6	1		18		4	1,8		2800	1,56E+05	1,71E+06
7	1		18		11	1,2		1900	2,62E+06	2,93E+07
8	1					4,0	3800		1,84E+03	1,17E+04
9	1					4,0	5600		1,55E+03	1,01E+04
10	0,5			18	1	2,0		3200	7,68E+04	8,62E+05
11	0,5			18	4	1,8		2800	2,46E+05	2,88E+06
12	0,5			18	6	1,5		2300	1,21E+06	1,42E+07

(shaded) = Used for the present study

*) In eny case 1 cm is inner steel liner of concrete shielding, the other "cm" are additionel shielding (i.e. 3 cm, 10 cm or 7 cm)

Table 8-6: Specific activity for Co-60 in Bq/g for KONRAD Type II-Container to comply with the transport regulations

No.	Shielding Concrete 2,35 g/cm³ [cm]	Shielding Concrete 3,30 g/cm³ [cm]	Shielding Steel [cm]	Inner Volume [m³]	Mass Waste [kg]	Specific Actvity (Co-60) 0,1 mSv/h 1 m distance [Bq/g]	Specific Actvity (Co-60) 2,0 mSv/h Surface [Bq/g]
1	18			0,286	450	3,25E+04	1,30E+05
2	18		3	0,219	340	1,15E+05	4,84E+05
3	18		6	0,164	260	3,96E+05	1,70E+06
4	18		9	0,118	190	1,41E+06	6,10E+06
5		18		0,286	450	7,35E+04	3,18E+05
6		18	3	0,219	340	2,64E+05	1,18E+06
7		18	6	0,164	260	9,18E+05	4,14E+06
8		18	9	0,118	190	3,31E+06	1,48E+07
9	18		0,15	0,207	320	4,02E+04	1,55E+05
10		18	0,15	0,207	320	8,92E+04	3,70E+05

Table 8-7: Specific activity for Co-60 in Bq/g for 1000-l container to comply with the transport regulations (not used in the present study)

No.	Shielding Steel	Inner Volume [m³]	Mass Waste [kg]	Specific Actvity (Co-60) 0,1 mSv/h 1 m distance [Bq/g]	0,2 mSv/h Surface [Bq/g]	2,0 mSv/h Surface [Bq/g]	4 mSv/h Surface [Bq/g]	10 mSv/h Surface [Bq/g]
1	0,15	0,20	320	5,73E+03		1,12E+04		
2	0,15	0,20	320		1,12E+03			
3	0,15	0,20	320				2,25E+04	
4	0,15	0,20	320					5,62E+04

Table 8-8: Specific activity for Co-60 in Bq/g for 200-l drums to comply with COVRA limits

Container Type	Packed Mass [Mg]	Number of Container [-]	Storage Volume [m³]
200-l Drum	401,5	2169	527,1
KONRAD Type II	696,3	125	579,2
KONRAD Type II / 180mm NC	31,4	10	45,4
MOSAIK Type II / 60mm Fe	5,6	12	16,4
Total:	**1134,8**	**2316**	**1168,1**

Table 8-9: Container type, packed mass, number of containers and storage volume (Best estimate: Kernenergiewet)

Container Type	Packed Mass [Mg]	Number of Container [-]	Storage Volume [m³]
200-l Drum	401,5	2169	527,1
KONRAD Type II	905,8	180	834,3
KONRAD Type II / 180mm NC	31,4	10	45,4
MOSAIK Type II / 60mm Fe	5,6	12	16,4
Total:	**1344,3**	**2371**	**1423,2**

Table 8-10: Container type, packed mass, number of container and storage volume (Best estimate: IAEA)

8.9 Figures

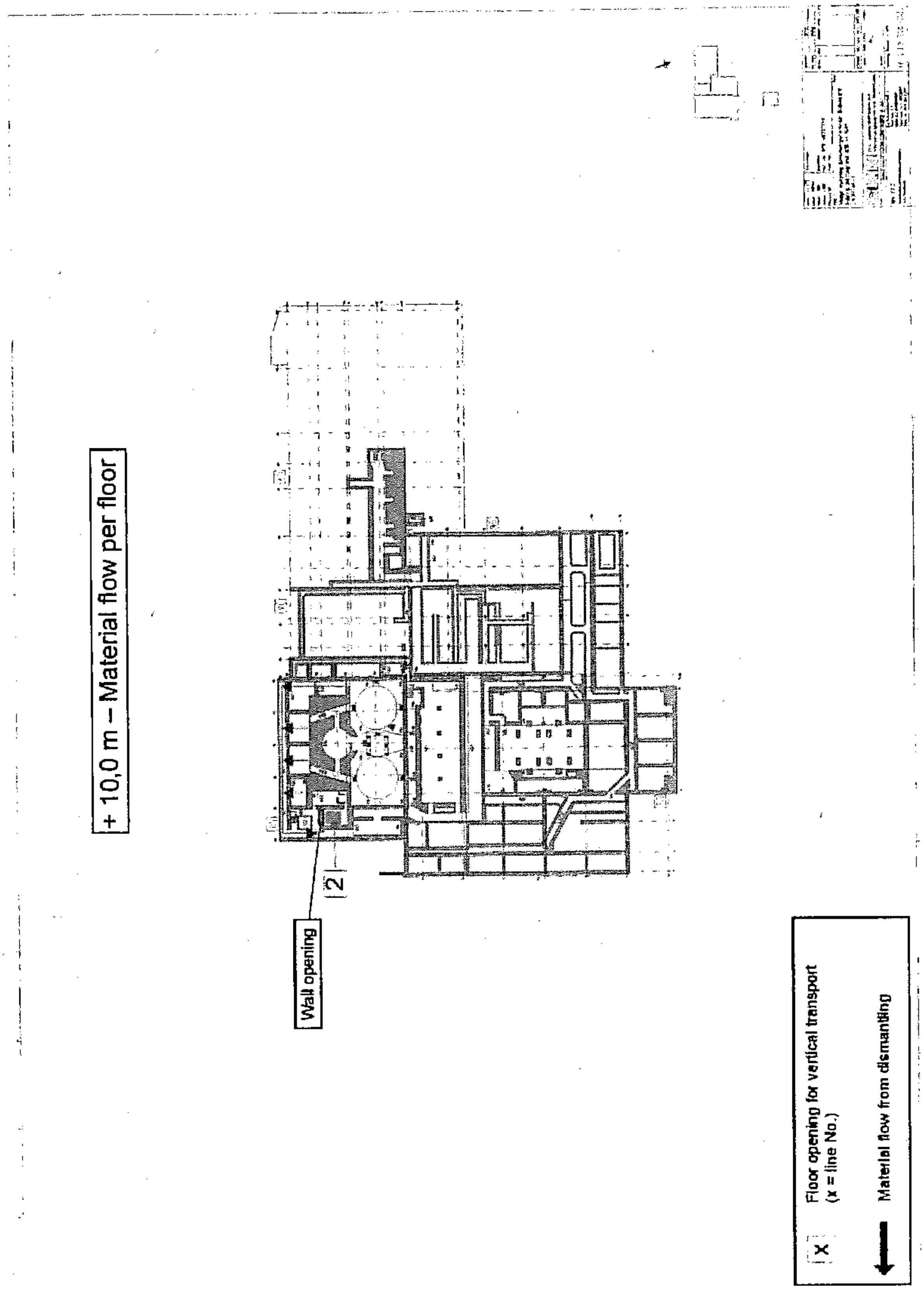

Figure 8-1: Transport routes (level A - 10,0 m)

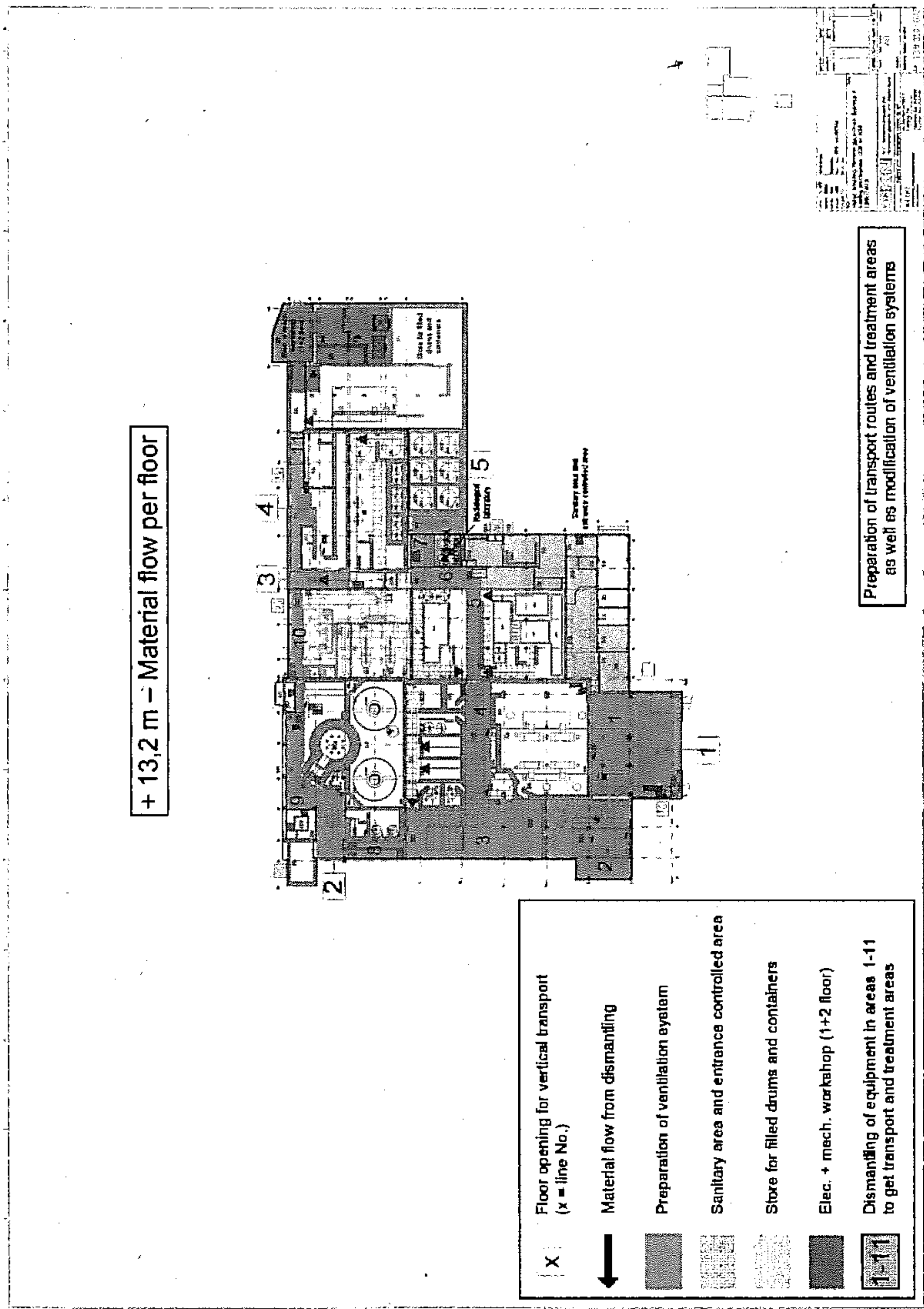

Figure 8-2: Transport routes (level B - 13,2 m)

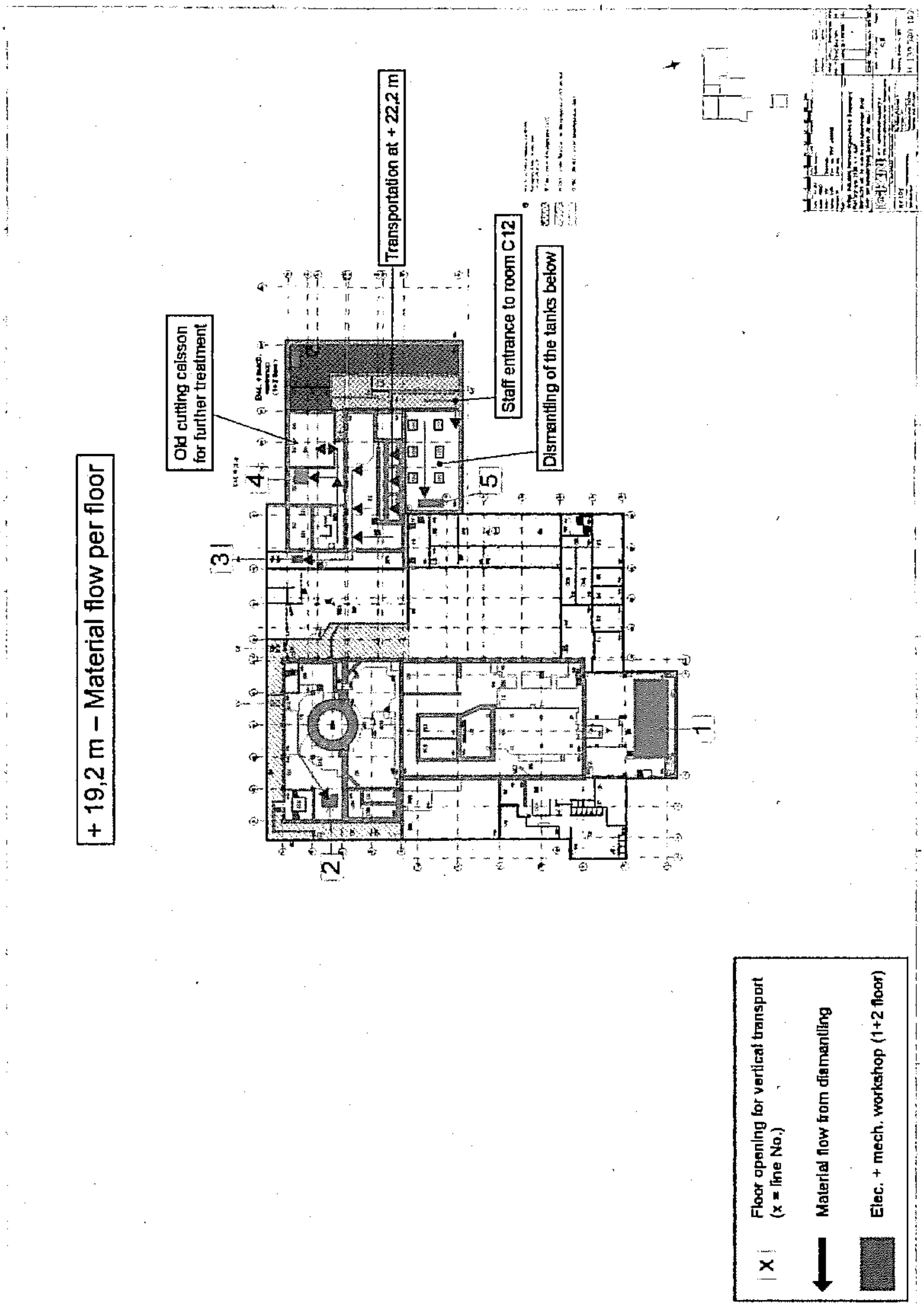

Figure 8-3: Transport routes (level C - 19,2 m)

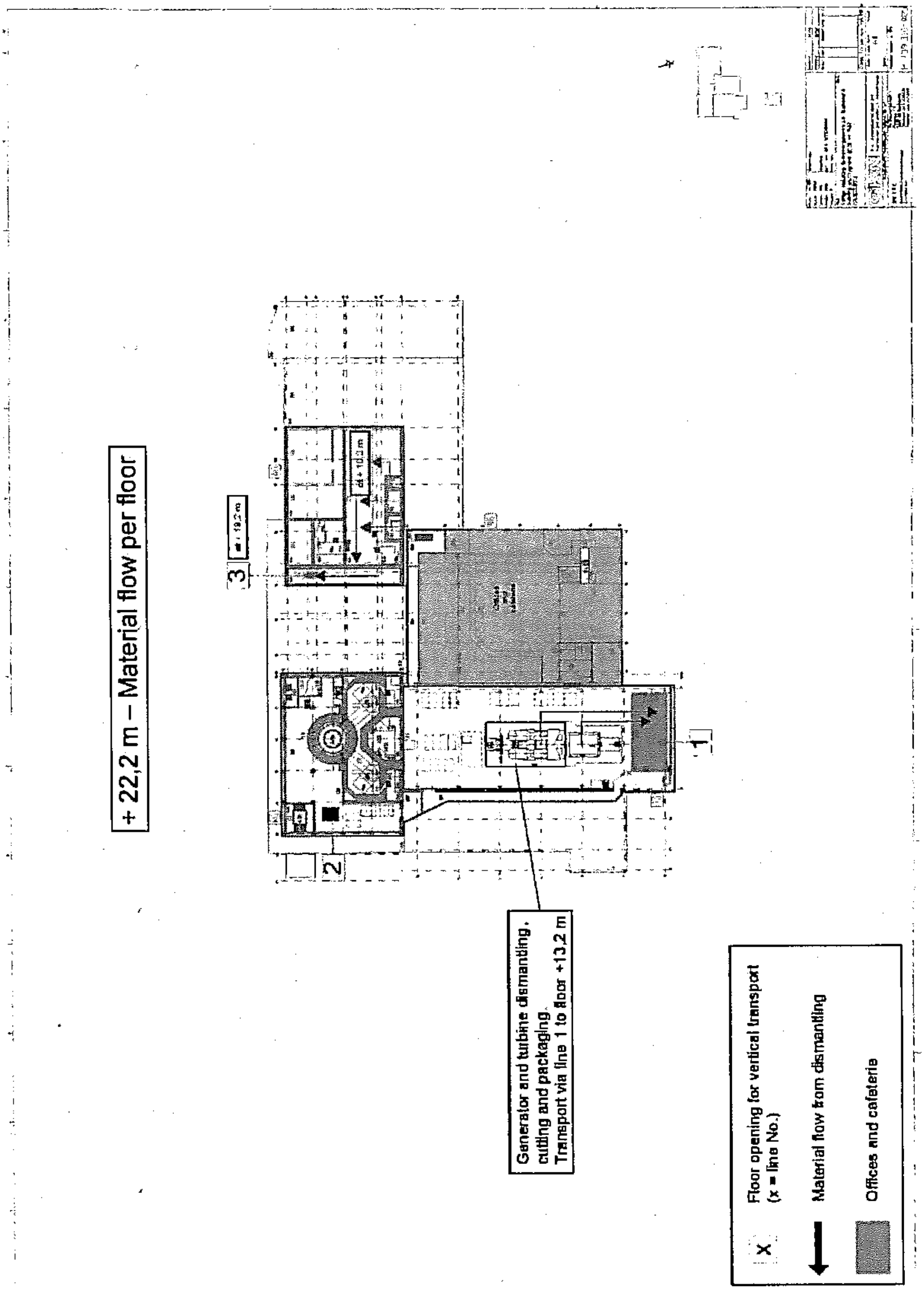

Figure 8-4: Transport routes (level D - 22,2 m)

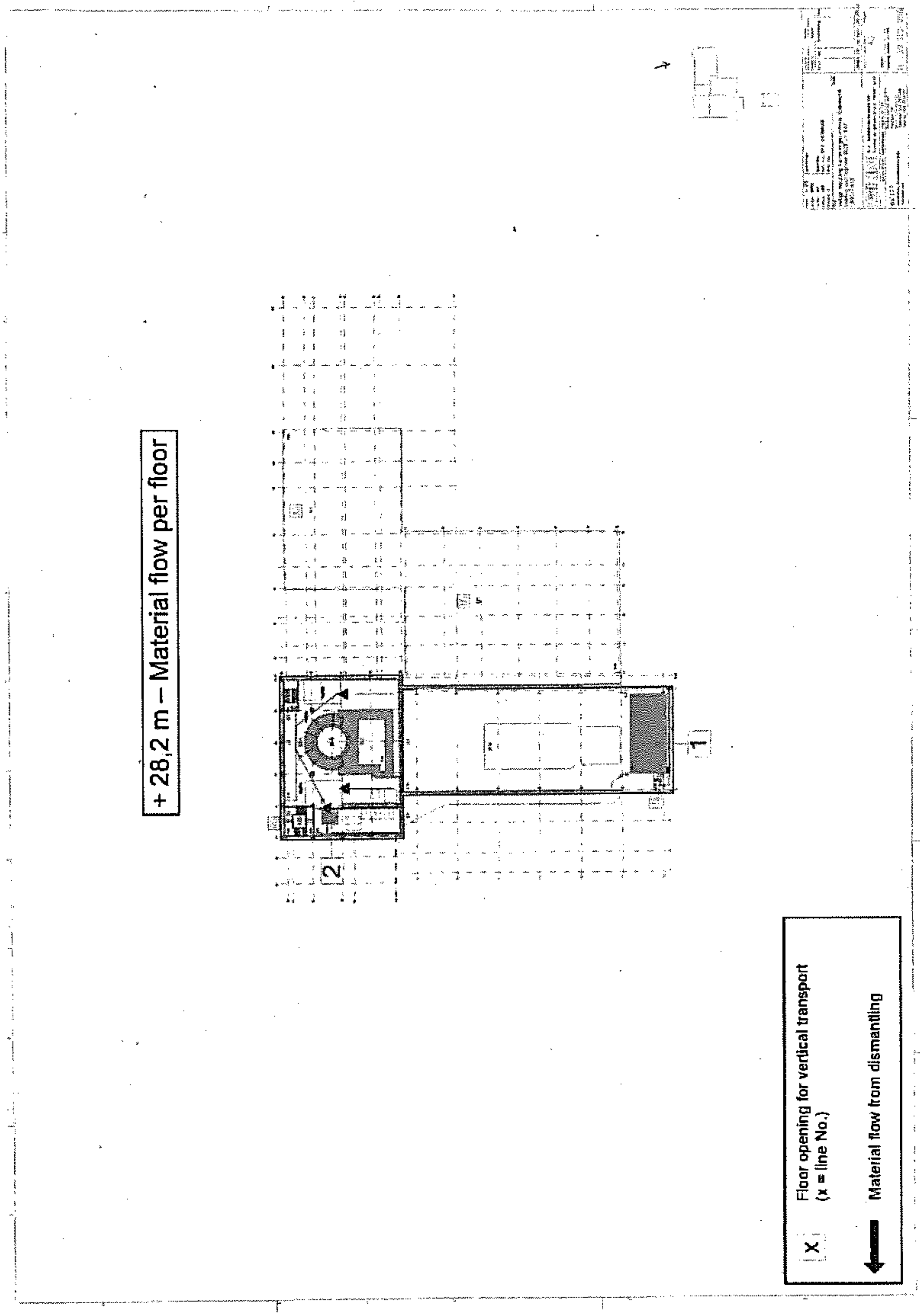

Figure 8-5: Transport routes (level D - 28,2 m)

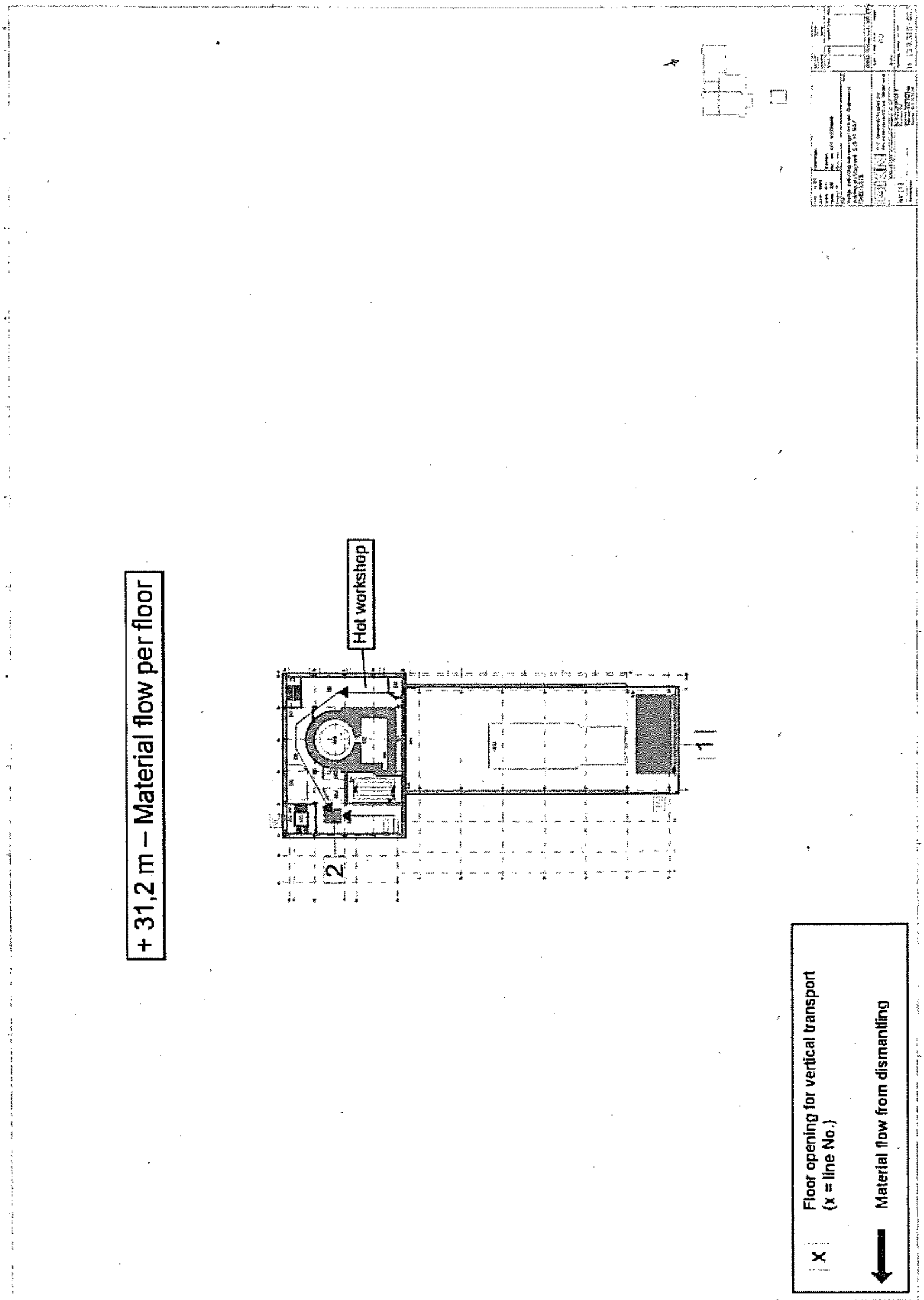

Figure 8-6: Transport routes (level E - 31,2 m)

10 1 b

[redacted]

Figure 8-8: Layout of treatment area (Turbine building level B – 13,2 m)

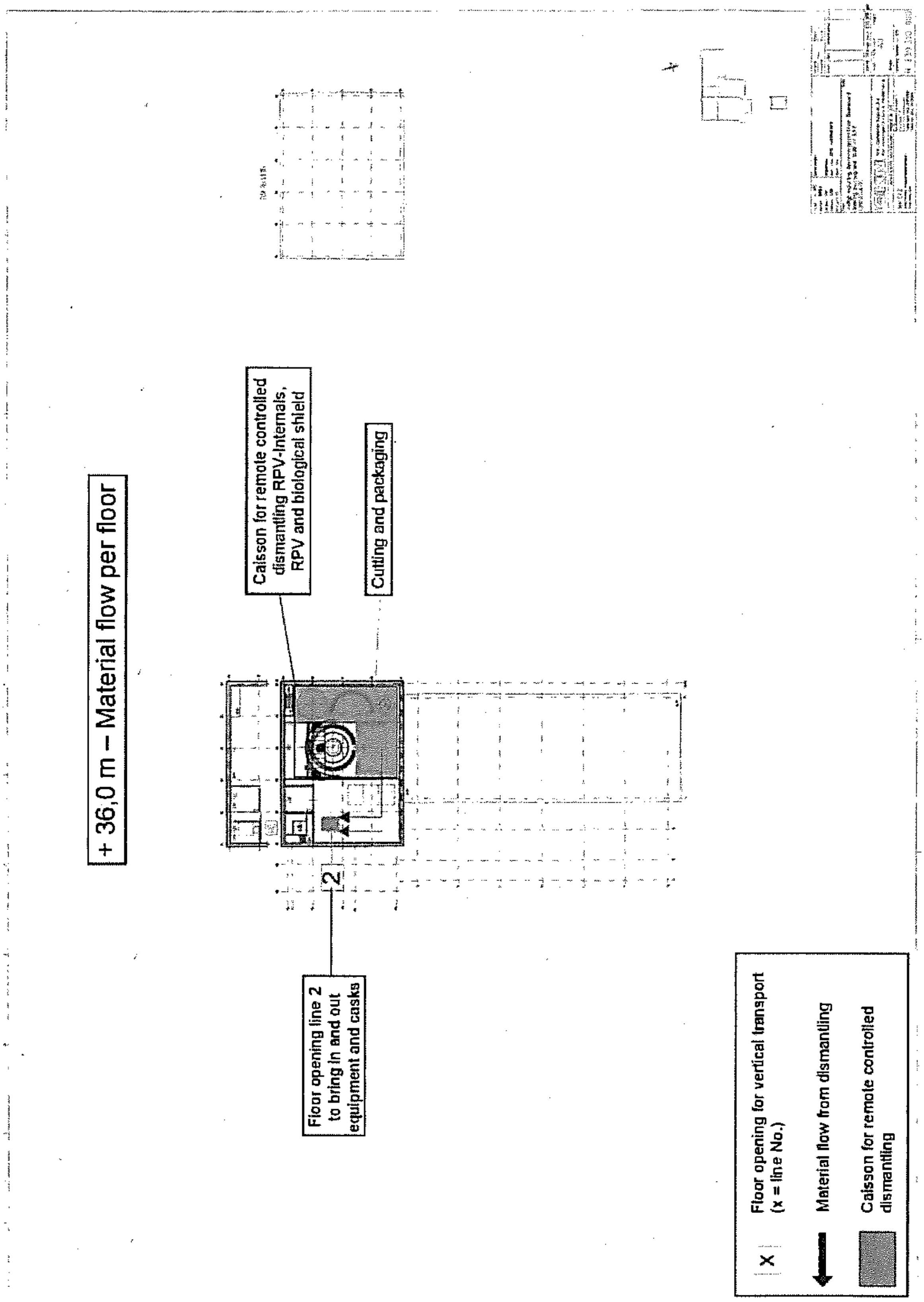

Figure 8-7: Transport routes (level F - 36,0 m)

Siempelkamp
NIS Ingenieurgesellschaft mbH

TECHNICAL DOCUMENT

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Title:

Explanations of the main differences in the results between the Dodewaard NPP decommissioning cost studies of 1999 and 2009 (Task 3: "1999 study" compared with Task 1 of "2009 study")

01	27.05.2010	IC /	10 2 e [redacted]	
00	06.05.2010	IC /		
Rev.	Release Date	BU / (Name) Prepared	(Signed) Reviewed	(Signed) Approved

Rev.	Chapter	Amendment index
00	All	First edition
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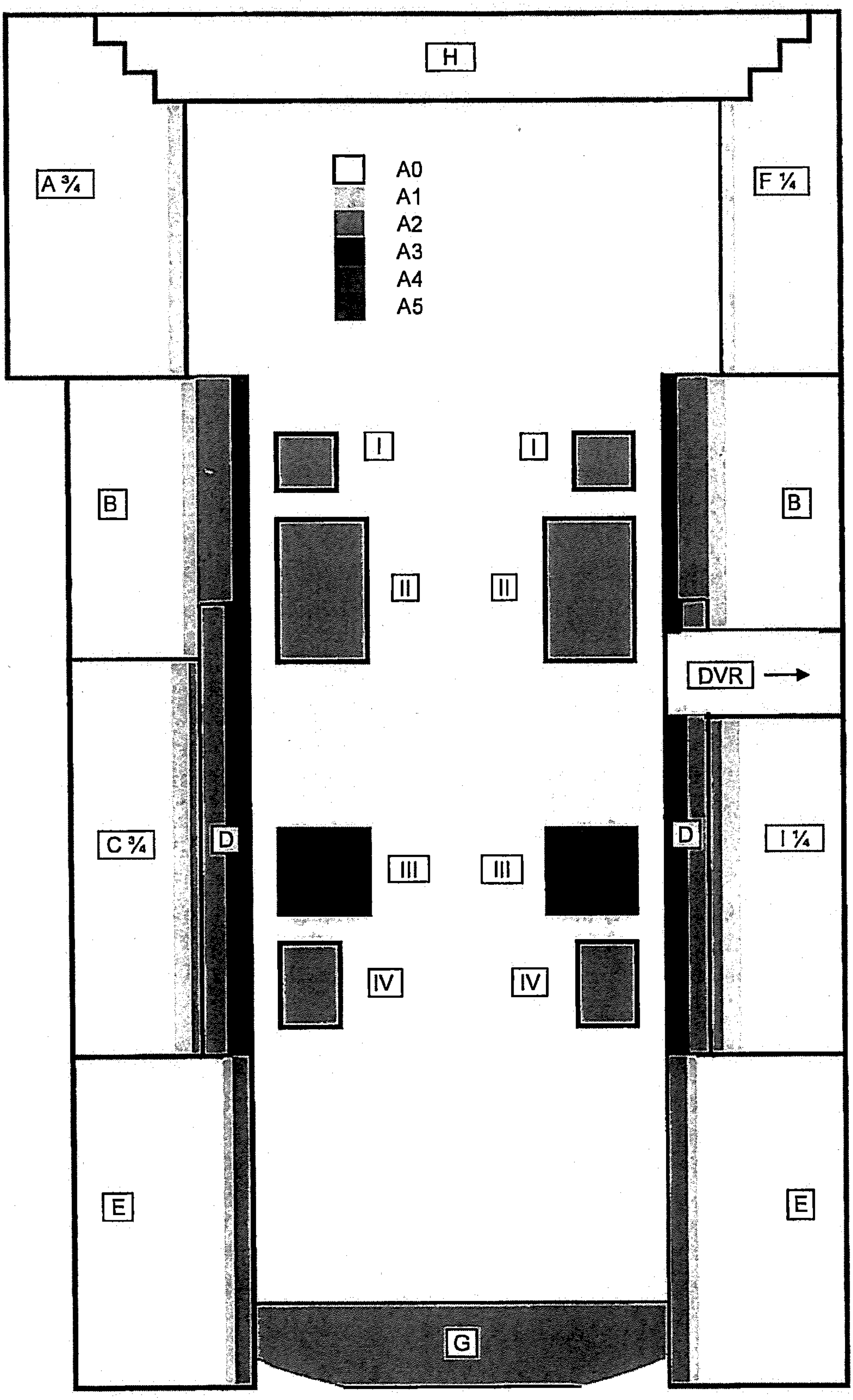

Figure 3-1: Drywell Internals and Activated Layers of the Biological Shield

4 Boundary conditions and assumptions underlying the cost estimates

In both studies, "1999 study" and "2009 study", a lot of boundary conditions and assumptions have to be taken into account, because in both cases the decommissioning work starts in the future and not all specific situations and conditions at that time can be foreseen. Therefore, the considered boundary conditions and assumptions are listed in both studies.

The following sections are comparing and describing the most important differences in the two studies.

4.1 General items

Some general items and their differences are listed in Table 4-1.

Description	1999 study	2009 study
1. Reference date for price level	01.01.2000	01.01.2009
2. Duration of Safe Enclosure period	40 years	10 years
3. Costs for authorities	not included	included with [redacted]
4. Costs for corporate management	not included	included in Project management costs
5. Release limits for clearance measurements (e.g. key-nuclide Co-60)	0,1 Bq/g	1,0 Bq/g
6. Envisaged wages (see section 4.2)	previous NIS study combined with GKN and Demkolec experience	German wages used by NIS for decommissioning cost estimates
7. Radioactivity level of activated parts (e.g. RPV, Biological Shield)	Assumptions taken by NIS in analogy to other NPP decomm. projects	Detailed figures available, stored in DIS

Table 4-1: Different Boundary conditions and Assumptions of the "1999 study" compared with the "2009 study"

Item 1:

For comparison purposes, the estimated decommissioning costs of the"1999 study" have to be escalated to the price level of the "2009 study". This has been done taking into account an overall inflation rate of 3% per year[1]. Nine years have been considered.

Item 2:

A longer duration of the Safe Enclosure period is leading to lower radioactivity levels. This should result in lower costs due to better dismantling conditions (more and easier hands on work etc.) and less radioactive waste, which reduces the number of storage packages. This assumption has been documented by some estimates, carried out in combination with the "2009 study", taking into account a longer duration for the Safe Enclosure period. As a result, the estimated total costs have been decreased in a range of Therefore, as a tendency, an increase of the costs in the "2009 study" compared to the "1999 study" can also be expected. Nevertheless a reasonable absolute value can not be given, because the basis of both studies is too different.

[1] According to the International Monetary Fund (IMF), the average yearly inflation rate in The Netherlands, between 2000 and 2008 (included) was 2,43% per year with a range of 1,38% per year up to 5,11% per year. For the purpose of the present study a rounded figure of 3% per year has been taken into account.

Item 3:

The estimated overall costs in the "2009 study" for authorities is about , which is negligible compared to the total costs of both studies, "1999 study" and "2009 study respectively.

Item 4:

The corporate management costs are not taken into account in the "1999 study". In the "2009 study" the complete project organization (GKN staff and contractor staff) is considered and therefore the costs are included in the study. This leads to higher costs in the "2009 study". For instance, the costs for the "GKN Plant management" are estimated to More details are given in section 5.8.

Item 5:

The "2009 study" shows that a decrease of the clearance levels leads to higher costs. This is a result of two estimates carried out in the "2009 study", taking into account the clearance levels defined in the Dutch KEW (Co-60: 1 Bq/g) and in the IAEA regulation RS-G-1.7 (Co-60: 0,1 Bq/g) respectively. The total costs for decommissioning the Dodewaard NPP have been increased in a range of taking into account the IAEA clearance levels. Therefore, it can be assumed that the estimated costs of the "1999 study" would also be lower if the clearance level of the Dutch KEW was taken into account, but how much this would be can not be given today.

Item 6:

The influence of the wages is described in section 4.2.

Item 7:

The radioactivity level of the activated parts has an influence on following aspects:

- Amount of radioactive waste, especially from the Biological Shield (see section 3);
- Number of containers;
- Type of container (with or without additional shielding).

More details are given in section 5.5.

4.2 Staff costs

The staff costs are calculated taking into account a qualification and hourly wages per qualification. The envisaged wages for the staff have been based on a previous NIS study /1/ combined with GKN and Demkolec experience in the "1999 study". For the "2009 study" it is agreed with GKN and the members of the working group (see /3/) that the staff wages used for the calculation of the decommissioning cost are based on relevant wages of German companies active in D&D activities (GKN staff and contractor staff).

In the "1999 study" the costs and hence the wages are given in Dutch Gulden (NLG) on price level 01.01.2000. For comparison purpose, the Dutch Gulden has been converted to Euro (€) by using the official conversion factor of 2,20371 NLG/€. Then the figures are escalated to the price level of 01.01.2009 by using an inflation rate of 3% per year. These figures can then be compared to the figures used in the "2009 study". The used qualifications and corresponding wages are shown in Table 4-2. This table also shows that the number of qualifications has been reduced in the "2009 study" compared to the "1999 study", i.e. the amount of qualifications (partly with no or only minor differences) used in the "1999 study" are concentrated to a few significant qualifications.

1999 study				2009 study	
Qualification	Wages 01/2000 NLG/h	Wages 01/2000 €/h	01/2009 *) €/h	Qualification	Wages 01/2009 €/h
Project manager				Project manager	10 1 c [redacted]
On-site manager					
Engineer				Engineer	
Accountant				Accountant	
Senior health physics technician				Foreman / master craftsman	
Technician					
Technical designer					
Foreman					
Health physics technician					
Craftsman				Craftsman	
Health physics worker				Worker	
Worker					
Secretary					
Cleaner					
Security staff				Guard (site security)	

*) Assumption: 9 years with an increase of 3% per year (01/2000 to 01/2009)

Table 4-2: Staff Qualifications and Wages

The total staff cost in the "2009 study" is about higher than the total staff cost in the "1999 study". This figure includes both, the new wages and the new manpower. The difference due only to the wages is not available.

4.3 Waste management costs

The waste management costs include the following aspects:

- Treatment (e.g. cutting, decontamination) of dismantled components:
- Distribution to the final destination, i.e.
  - Cleared material (unrestricted release, landfill, etc.);
  - Storage as radioactive waste.
- Packaging of radioactive waste;
- Conditioning (immobilization) of radioactive waste;
- Transport, interim storage and final disposal.

The total waste management costs are dealt with in section 5.5. In this section important boundary conditions (container, transport, interim storage and disposal) are compared.

Table 4-3 shows the assumed costs for the containers used for the packaging of the radioactive waste. It can be seen that the costs for higher shielded KONRAD Type II and MOSAIK containers (used for higher activated components) have considerably increased above inflation.

Container type	Container costs			
	1999 study			2009 study
	01/2000		01/2009	01/2009
	[NLG]	[€]	[€]	[€]
200-l Drum				
1000-l Container (NC)				
1000-l Container (NC) / 60mm Fe	*)	*)	*)	
KONRAD Type II				
KONRAD Type II / 180mm NC	*)	*)	*)	
KONRAD Type II / 180mm NC / 30 mm Fe				
KONRAD Type II / 180mm NC / 100 mm Fe				
MOSAIK Type II / 0mm Fe	*)	*)	*)	
MOSAIK Type II / 100mm Fe	*)	*)	*)	
MOSAIK Type II / 120mm Fe				

NC = Normal Concrete
*) Container is not used in cost estimate

Table 4-3: Costs for Waste Packages / Containers

Due to the new waste management concept (see section 5.5), the total costs for containers could be reduced in the "2009 study" (about , although the costs for a single container has been increased.

In the Netherlands all radioactive waste has to be handed over to COVRA for storage and disposal. Therefore, for the purpose of the "2009 study" COVRA has given specific costs per container and depending on the surface dose rate on the outside of the container for "Transport, Interim Storage at COVRA and Disposal". These costs are compared to the cost figure (cost per m³ of storage volume) used in the "1999 study" (see Table 4-4). For comparison purposes, the cost per container is also given in the corresponding cost per m³ outer volume. In all cases, the cost for "Transport, Interim Storage at COVRA and Disposal" has considerably increased above inflation.

Transport, interim storage at COVRA, disposal	Costs: 1999 study 01/2000 [NLG/m³]	Costs: 1999 study 01/2000 [€/m³]	Costs: 1999 study 01/2009 [€/m³]	Costs: 2009 study 01/2009 [€/container]	Outer volume of container [m³]	Costs per m³ outer volume of container [€/m³]
- based on outer volume of container				*)		
- based on container type and surface dose rate:						
200-l drum, with a surface dose rate <= 0,2 mSv/h	*)	*)	*)		0,2	
200-l drum, with a surface dose rate > 0,2 <= 2,0 mSv/h	*)	*)	*)		0,2	
200-l drum, with a surface dose rate > 2,5 <= 4,0 mSv/h	*)	*)	*)		0,2	
1000-l container, with a surface dose rate > 0,2 <= 2,0 mSv/h	*)	*)	*)		1,0	
MOSAIK Type II container	*)	*)	*)		1,3	
KONRAD Type II container	*)	*)	*)		4,6	

*) Not used in cost estimate

Table 4-4: Costs for Transport, Interim Storage at COVRA and Disposal

5 Preliminary Decommissioning Plan

In both studies, the decommissioning project is structured in a hierarchical organisation. The so called Work Breakdown Structure (WBS) is mandatory for the planning activities as well as for the cost estimate. The WBS "describes" the project. The overall project is divided in subprojects, task, etc. until the lowest level is reached, where the individual activities can be calculated. The WBS is adapted and the individual activities are defined according to the needs of the plant specific decommissioning plan.

For the purpose of the present comparison the results on the first level of the WBS, the Working Packages (WP), are used. This level is available in the "1999 study" as well as in the "2009 study". The contents of the different WP are also comparable.

The estimated decommissioning costs for the NPP Dodewaard of the "1999 study" and the "2009 study" are listed in Table 5-1. In both studies, no inflation has been included for the duration of the projects.

To get comparable figures the following activities have been carried out:

- The results of the "1999 study", given in Dutch Gulden (NLG), are listed in column A of Table 5-1.
- To get costs in Euro (€), these costs are converted from NLG to € by using the official conversion factor of 2,20371 NLG/€, column B of Table 5-1.
- Then the figures are escalated to the price level of 01.01.2009 by using an inflation rate of 3% per year (taking into account 9 years), column C of Table 5-1.
- The estimated costs in the WP "Radiological and work protection" and the WP "Decontamination" are distributed to other WP according to the distributions shown in Table 5-2; column D of Table 5-1.
- These figures can now be compared to the figures used in the "2009 study", column F of Table 5-1.

Comparing the total costs of the "1999 study" with the total costs of the "2009 study" a difference of [redacted] [redacted] (see bottom line of column H) occurs, corresponding to a total increase in the decommissioning costs of 49% (see bottom line of column I).

About 84% of the total increase in costs is caused by the working packages "Waste processing, transport, storage and disposal" (, and "Project management, engineering and site support as well as site security, surveillance and maintenance" corresponding to a percentage increase of 46% and 38% respectively (see column J of Table 5-1).

Taking into account the major percentage increases in individual working packages then, in addition to the above mentioned working packages, the working packages "Dismantling Drywell and Dismantling Biological Shield" and "Clearance of building structures" are in focus. There are increases per working package of about 137% and 93% respectively, but each item reflects only 4% of the total increase (see column I and J of Table 5-1).

The next sections are focused on the description of these essential differences, but do also provide a short look at the other working packages. For a better comparability some working packages are summarised.

Working package (WP)	1999 study A 01/2000 MNLG	B 01/2000 M€	C 01/2009 *) M€	D 01/2009 **) M€	E (D/Total D) %	2009 study Working package	F 01/2009 M€	G (F/Total F) ***) %	Delta H (F-D) M€	I (F/D) per WP %	J (H/Total H) ***) %
Planning and licensing					[redacted]	Pre-decommissioning actions and Licensing procedure		[redacted]	[redacted]	[redacted]	[redacted]
Preparation of the plant for dismantling					[redacted]	Preparatory work		[redacted]	[redacted]	[redacted]	[redacted]
Dismantling of cont. Components (1)					[redacted]	Dismantling controlled area (contaminated) - CA-C1		[redacted]	[redacted]	[redacted]	[redacted]
Dismantling of activated parts (RV and internals)					[redacted]	Dismantling RPV internals and Dismantling RPV		[redacted]	[redacted]	[redacted]	[redacted]
Dismantling of activated parts (RK and internals)					[redacted]	Dismantling Drywell and Dismantling Biological Shield		[redacted]	[redacted]	[redacted]	[redacted]
Dismantling of cont. Components (2)					[redacted]	Dismantling remaining systems and components (contaminated) - CA-C2		[redacted]	[redacted]	[redacted]	[redacted]
Decontamination of buildings					[redacted]	Clearance of building structures		[redacted]	[redacted]	[redacted]	[redacted]
Measurements of building surfaces					[redacted]			[redacted]	[redacted]	[redacted]	[redacted]
Radiological and work protection				****)	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]
Decontamination				****)	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]
Waste management					[redacted]	Waste processing, transport, storage and disposal		[redacted]	[redacted]	[redacted]	[redacted]
Demolition of buildings, site recovery					[redacted]	Conventional demolition and site restoration, cleanup and landscaping		[redacted]	[redacted]	[redacted]	[redacted]
					[redacted]	Asbestos removal		[redacted]	[redacted]	[redacted]	[redacted]
Operation on site, project management, site security					[redacted]	Project management, engineering and site support as well as Site security, surveillance and maintenance		[redacted]	[redacted]	[redacted]	[redacted]
					[redacted]	Authorities		[redacted]	[redacted]	[redacted]	[redacted]
Total					100%			100%		49%	100%

*) Assumption: 9 years with an increase of 3% per year (01/2000 to 01/2009)
**) New distribution of "Decontamination" and "Radiological and Work protection" according to new estimates in the "2009 study"
***) "0%" means that the percentage is below 0,5%
****) Activities included in other working packages according to the distribution given in Table 5-2

Table 5-1: Decommissioning Costs

Working Package	$MNLG_{01/2000}$	$MNLG_{01/2000}$	
Radiological and work protection			
Preparation of the plant for dismantling			[redacted]
Dismantling of cont. Components (1)			[redacted]
Dismantling of activated parts (RV and internals)			[redacted]
Dismantling of activated parts (RK and internals)			[redacted]
Dismantling of cont. Components (2)			[redacted]
Decontamination of buildings			[redacted]
Waste management			[redacted]
Operation on site, project management, site security			[redacted]
			[redacted]
Decontamination			[redacted]
Dismantling of cont. Components (1)			[redacted]
Dismantling of activated parts (RV and internals)			[redacted]
Dismantling of activated parts (RK and internals)			[redacted]
Dismantling of cont. Components (2)			[redacted]
Decontamination of buildings			[redacted]
Waste management			[redacted]
Operation on site, project management, site security			[redacted]

Table 5-2: Decommissioning Costs (distribution of old WP costs)

5.1 WP 01 & 02: Pre-decommissioning actions and Licensing procedure

There is no significant impact coming from this working package. The content of the working package is almost the same in both studies, so that the escalated costs of the "1999 study" are very close to the costs of the "2009 study".

5.2 WP 03: Preparatory work

The same as in the above working package appears for the working package "Preparatory work".

5.3 WP 04 till 09: Dismantling

The dismantling of the contaminated and activated parts of the NPP Dodewaard is considering the present knowledge of such activities taken from practical experience. NIS is involved in a lot of actual decommissioning projects in Germany (e.g. NPP Würgassen, Stade, Obrigheim and Kahl). The activities of NIS are covering both aspects, planning and cost controlling activities (with the use of CORA / CALCOM) as well as practical dismantling work (e.g. dismantling of RPV internals in NPP Würgassen, dismantling of the RPV of NPP Stade, building decontamination of NPP Kahl, health physics work in different projects). A lot of these experiences were gathered after the preparation of the "1999 study" so that these experiences could only be used in the "2009 study". Following major aspects have been taken into account:

- Present status of the installations of NPP Dodewaard;
- Depth of activation in reactor vessel pit;
- Necessary modifications and/or new installations to guarantee a safe dismantling;
- Possibilities to handle and move on the dismantled parts;
- Number of container transports per time unit (e.g. per day or per week)
- Sequence of dismantling to get a robust time schedule.

Additionally, in the "2009 Study" the focus is set on the local situation of the plant, e.g.:

- Available space at the place of dismantling;
- Transport routes inside the buildings;
- Available space for treatment area;
- Available space for buffer storage;
- Size of sanitary area and entrance to controlled area.

Besides these items there are time consuming aspects like hardening of the immobilization material, time for radiological analysis of samples or waiting for approvals from authorities which may influence the necessary size of buffer storage areas.

All the above mentioned aspects and the local situation lead to the decision to switch from two shift work ("1999 study") to one shift work ("2009 study"). In some respects, this is a conservative assumption, which gives confidence that the dismantling can be done in the planned way.

The dismantling of the Biological Shield has also an important influence. Due to the fact that the depth of the activated part is now well known, the amount of concrete which has to be removed has increased. This leads to a longer duration for the dismantling of the Biological Shield and an increase in costs at about (corresponding to 4% of the total increase).

In total, the new assumptions lead to a significant increase in the duration (about 4 years longer), but so there is a guarantee that the dismantling work can be done without getting logistic or spatial problems and the schedule is robust which has been requested in the TRF /3/. The total increase in costs for all dismantling work is about staff costs, investments and consumables) and is reflecting about 11% of the total cost difference (see Table 5-1). Basically, the investments and consumables are not linked to the project duration, but result from the techniques used. The reason for the increase in costs is based on the present dismantling concept and has been derived from actual market prices.

5.4 WP 10: Clearance of building structures

The cost for clearance of the building structures has increased by in the "2009 study", which is about 93% of the working package cost of the "1999 study" and is about 4% of the total cost difference of both studies.

The increase is resulting from the experiences gathered from real decommissioning projects in recent years. In almost all present decommissioning projects the expenditures for the clearance of the building structures are higher than expected, because the removal of the contamination and the clearance measurements are more laborious than previously planned. These experiences have been taken into account in the "2009 study" and lead to a longer duration for these activities resulting into an increase in the necessary manpower (see Table 5-7) and costs (see Table 5-1).

5.5 WP 11: Waste processing, transport, storage and disposal

The most significant difference (10 1 c [redacted] of the decommissioning costs presented in the "1999 study" and the "2009 study" is resulting from the waste management cost estimate (see Table 5-1).

In that case, the amount of radioactive waste, the packaging and the transport to the storage facility at COVRA and the final disposal are of interest.

Table 5-3 gives an overview of the estimated amounts of radioactive waste for final disposal.

Description	1999 study (A) [Mg]	2009 study (B) [Mg]	Delta (B - A) [Mg]
Primary and tertiary mass (without buildings)	5.049	6.233	1.184
Final disposal mass	1.409	1.082	-327
Percentage	**28%**	**17%**	
Secondary waste mass (incl. concrete rubble from building decontamination)	104	302	198
Total final disposal mass	**1.513**	**1.384**	**-129**

Table 5-3: Final Disposal Masses

In total, the mass for final disposal in the "2009 study" is about 129 Mg less than in the "1999 study" even if the secondary mass is about 198 Mg higher. The reasons for the lower radioactive waste amount from primary and tertiary masses for final disposal are the following:

- Better knowledge of the radioactivity content of the contaminated and activated parts;
- New Distribution Factors Sets (based on "Return of Experience" of current decommissioning projects);
- Higher clearance level for free release.

The increase in the secondary mass has three major reasons:

- More concrete rubble from building decontamination due to the knowledge of surface contamination and new assumptions regarding surface removal gathered from experiences in real decommissioning projects ("1999 study": 45 Mg; "2009 study": 72 Mg);
- More waste (e.g. tools, combustible waste like foils, clothes) produced during dismantling and treatment due to experiences gathered from real decommissioning projects ("1999 study": 37 Mg; "2009 study": 153 Mg);
- Use of dry decontamination only which leads to more solid waste for final disposal ("1999 study": 17 Mg; "2009 study": 77 Mg).

The radioactive waste has to be packed for interim storage and final disposal. The containers used, the produced number of containers, the container costs, the storage volume as well as the costs for transport, interim storage and disposal are shown in Table 5-4 ("1999 study", costs converted to € and escalated to price level 01/2009) and in Table 5-5 ("2009 study").

Container Type	Packed Mass [Mg]	Number of Containers [-]	Container Costs [k€2009]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal *) [k€2009]
KONRAD Type II-Container	1.480	331		1.526	
MOSAIK-Container	33	44		58	
Total	**1.513**	**375**		**1.584**	

*) Calculated with (price level: 01/2000) or (price level 01/2009), see Table 4-4

Table 5-4: Container Data and Disposal Costs ("1999 study")

Container Type	Packed Mass [Mg]	Number of Containers [-]	Container Costs [k€2009]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal *) [k€2009]
200-l Container, with a surface dose rate <= 0,2 mSv/h	469	2.487		604	
200-l Container, with a surface dose rate > 0,2 <= 2,0 mSv/h	2	10		3	
200-l Container, with a surface dose rate > 2,5 <= 4,0 mSv/h	1	6		2	
1000-l Container, with a surface dose rate > 0,2 <= 2,0 mSv/h	1	3		2	
KONRAD Type II-Container	905	201		927	
MOSAIK-Container	6	17		23	
Total	**1.384**	**2.724**		**1.560**	

*) Calculated per container type and surface dose rate, see Table 4-4

Table 5-5: Container Data and Disposal Costs ("2009 study")

It can be seen in the tables that in the "2009 study" a lot of 200-l drums are used for the packaging. In the "1999 study" these drums were not used. It is assumed that all waste is packed in KONRAD or MOSAIK containers. But due to the very high cost for transport, interim storage and disposal for KONRAD and MOSAIK containers, which has to be used in the "2009 study", also 200-l drums are used for the packaging of radioactive waste.

The new packaging concept in the "2009 study" leads to a decrease in the container costs of about 1,7 M€ compared to the "1999 study". But due to the new fees for "Transport, interim storage at COVRA and disposal", which lead to an increase in costs of abou M€, the total costs have also increased (plus €). This explains more or less the total difference of the above mentioned M€.

5.6 WP 12 & 13: Conventional demolition and site restoration, cleanup and landscaping

In the "1999 study" costs for conventional demolition and site restoration were estimated by a Dutch company and were only included in the report by NIS. The costs estimated in the "2009 study" are based on specific costs given by a Dutch company. The costs of the price adjusted "1999 study" are very close to the results of the "2009 study".

5.7 WP 14: Asbestos removal

The cost of asbestos removal has been deliberately left out in the "1999 study". Starting from the known amount of asbestos in the NPP Dodewaard, GKN has estimated a cost of 1 MNLG (price level 1999) for the removal of it. Converted to Euro and escalated to the price level 2009 this would be about €. This figure is very close to the new cost estimate in the "2009 study", where costs of about [redacted] are estimated.

5.8 WP 15 & 16: Project management, engineering and site support as well as Site security, surveillance and maintenance

Besides the working package "Waste processing, transport, storage and disposal" the working packages 15 & 16 lead to a significant cost increase. The difference is abou[redacted] corresponding to a [redacted]cost. Compared to the total difference of €, it represents an increase of 38%.

In the "2009 study", the complete project organization (GKN staff and contractor staff) is considered and the costs are included in the study. The necessary activities are based on experiences of actual decommissioning projects which were not available at the performance time of the "1999 study". In addition, the necessary consumable costs for the operation of the site during the decommissioning period have been reassessed, using the gathered information from real decommissioning projects. Together with the longer duration of the total project this leads to higher costs in the "2009 study". The most important aspects for the cost increase are:

- Detailed analysis of necessary manpower for project management and site operation;
- Detailed analysis of necessary yearly operational costs;
- Wages;
- Longer duration of the project.

The € are resulting from an increase in staff costs of about € (see also Table 5-7) and an increase of the other costs (e.g. electricity, consumables) of about €.

From today's point of view, these activities were underestimated in the "1999 study".

5.9 WP 17: Authorities

The cost of € are negligible compared to the total cost (see item 3 in section 4.1).

5.10 Project duration

Taking into account all above mentioned impacts on the decommissioning duration of the "2009 study" compared to the "1999 study", the resulting and essential differences are shown in Table 5-6.

Period	Duration				
	1999 study [years]		2009 study [years]		Delta [years]
	not time critical	time critical	not time critical	time critical	time critical
Pre-decommissioning / Licensing (duration until the license is granted)		3,8		4,0	0,2
Dismantling (from preparatory work until end of dismantling work)		2,8	0,7	7,1	4,3
Clearance of buildings (building decontamination and release measurements)	0,3	0,1	0,6	0,8	0,7
Conventional demolition (until reaching "green field" conditions)		1,1	0,4	1,7	0,6
Total		**7,8**		**13,6**	**5,8**

Table 5-6: Duration of the Decommissioning

5.11 Manpower

The essential increases in manpower are resulting from the WP "Clearance of Buildings" and the WPs "Project management, engineering and site support as well as Site security, surveillance and maintenance" (see the corresponding sections above). In total, the essential differences are shown in Table 5-7.

Activity Description	Manpower		Delta	
	A 1999 study [man-years]	B 2009 study [man-years]	(B-A) [man-years]	(B/A) [%]
Pre-decommissioning / Licensing	10 1 c [redacted]			
Dismantling (from preparatory work until end of dismantling work)	[redacted]			
Clearance of buildings (building decontamination and release measurements)	[redacted]			
Waste management	[redacted]			
Project management, engineering and site support as well as Site security, surveillance and maintenance	[redacted]			
Sub-Total	[redacted]			
Conventional demolition and site restoration, cleanup and landscaping	[redacted]			
Total	[redacted]			

*) The costs were taken from an external company in "1999 study" (the manpower was not given)

Table 5-7: Estimated Manpower for the Decommissioning

6 Summary

Summarising all above mentioned impacts on the decommissioning costs of the "2009 study" compared to the "1999 study", the essential differences are shown in Table 6-1.

	Costs in M€	
Total decommissioning costs "2009 study" (price level 01/2009)		
Total decommissioning costs "1999 study" (price level 01/2009)		
Total difference		
Essential differences:		
Dismantling activities (higher manpower and wages)		
Dismantling activities (investments and consumables)		
Clearance of building structures (higher manpower and wages)		
Waste containers costs		
Waste containers transports, interim storage and disposal		
Site operation (higher manpower and wages)		
Site operation (yearly costs for consumables and services)		
Others in total (not described in detail)		
Essential differences (sum):		

Table 6-1: Essential Differences comparing the "1999 study" with the "2009 study"

References

/1/ Costs of decommissioning the nuclear power plant at Dodewaard
Document No.: 1363/3179/0
NIS Ingenieurgesellschaft mbH
Hanau, October 1994

/2/ Costs of decommissioning the nuclear power plant at Dodewaard
Document No.: 5229/ CA / F 0005151
NIS Ingenieurgesellschaft mbH
Hanau, November 1999

/3/ New Decommissioning Cost Estimate – Technical Requisition File
TIERSDI/4FG/6154/000/02
Suez-Tractebel S.A.
Brussels, November 2008

/4/ GKN - Evaluation of Decommissioning of the Dodewaard NPP
- New Decommissioning Cost Estimate -
Task 1: Reference Scenario
Starting date of decommissioning: 2015
Clearance levels: KEW and IAEA
Document No.: 8229 / CA / F 008157 7 / 00
NIS Ingenieurgesellschaft mbH
Alzenau, April 2010

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Document No.: 8229 / CA / F 008424 4 / 01

Title:

Explanations of the main differences in the results between the Dodewaard NPP decommissioning cost studies of 1999 and 2009 (Task 4: "1999 study" compared with Task 2 of "2009 study")

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Rev.	Chapter	Amendment index
00	All	First edition
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1 Introduction

NIS Ingenieurgesellschaft mbH (NIS) has performed cost studies for the decommissioning of the Dodewaard Nuclear Power Plant (NPP) under different contracts.

The first one in 1994 /1/ in the frame of two scenarios: immediate dismantling after final shut-down in 2004 and a deferred dismantling scenario, i.e. dismantling 40 years after the reactor final shutdown.

A second study was performed in 1999 /2/ in the frame of a deferred dismantling scenario, i.e. to cover the costs for preparation of the "Safe enclosure", the "Safe enclosure period" (40 years) and the "Dismantling phase".

In February 2009, B.V. Gemeenschappelijke Kernenergiecentrale Nederland (GKN) placed an order with NIS focusing on the goal to provide a new Decommissioning Cost Estimate to be detailed in a Preliminary Decommissioning Plan (PDP). The scope of the KCD (Kernenergiecentrale Dodewaard) new Decommissioning Cost Estimate is described in a Technical Requisition File (TRF) /3/.

The present report explains the essential differences in the results of the two studies (/2/, called "1999 study" and /4/, called "2009 study") for KCD. Both studies provide overnight cost estimates, i.e. an estimate made under the assumption that all D&D activities would be performed at the costs considered at the reference date. No inflation is taken into account during the decommissioning phase. The reference dates for the price level of the cost estimates are 01.01.2000 for the "1999 study" and 01.01.2009 for the "2009 study".

In the "2009 study" two cases concerning the clearance levels have been taken into account, firstly the clearance level as defined in the Dutch "Kernenergiewet" (KEW) and secondly with IAEA RS-G-1.7 clearance levels. For the purpose of the present comparison the results considering the IAEA clearance levels are used (same values for both studies "1999 study" and "2009 study", see Table 4-1).

2 Methodology

The results of the studies are based on three main items:

- The plant inventory (e.g. masses, radioactivity);
- The boundary conditions and assumptions underlying the cost estimates (e.g. price level, duration of safe enclosure period, wages, container costs);
- The preliminary decommissioning plan (e.g. work breakdown structure, costs, sequence of dismantling activities).

These three items are also the basis for the explanations of the differences in the estimated results. Firstly the differences in the main values of the plant inventory, secondly in the boundary conditions and assumptions and thirdly in the preliminary decommissioning plan (described in different working packages) are compared.

3 Plant inventory

As described in the above mentioned studies ("1999 study" and "2009 study") the plant inventory is a major aspect within the decommissioning cost estimate for a nuclear power plant. Therefore, it is necessary to know as accurately as possible the masses of the installations and of the buildings, especially of the buildings with a controlled area, and the corresponding radiological inventory (contamination and activation) of these materials.

The physical and radiological inventory of the plant is taken from the database "Dodewaard Information System (DIS)" in both studies. The information and data about the NPP have been updated from time to time. In an annual report the actual status of the inventory of the facility is described. The differences in the plant inventory data used for the "1999 study" and the "2009 study" are shown in Table 3-1 and Table 3-2.

One considerable mass increase in the "2009 study" is due to the fact that the entire treatment (cutting, decontamination, super-compaction, packaging and conditioning) of the dismantled components is performed on site. Therefore, the mass for new equipment (so called Tertiary mass) had to be increased (see Table 3-2).

The main difference arises from the masses in the Reactor building. It is obvious that the mass amount in the DIS database is based on a mass collection philosophy with much more details and, in the case of the Biological Shield, the object of mass collection has been changed; from only relevant for the decommissioning work to the consideration of the complete part of the building. In the "1999 study" all components inside the drywell had been classified as "Activated Parts", i.e. the Reactor Pressure Vessel (RPV) and its internals, the Drywell components and the Drywell shroud. But "Activated parts" doesn't give an indication for the level of radioactivity. It can be recognized that the main difference in the mass amount is given by the concrete mass. For example, in the "1999 study" the concrete of the components I, II, III, IV and G inside the Drywell have been assigned to the Activated parts as "Installation", but now, in DIS and in the "2009 study", they are assigned to the category "Biological Shield" (see Figure 3-1 for these components).

The mass of the Biological Shield is given in the "1999 study" (see Table 3-4 of the present report) by:

- 72 Mg activated concrete and reinforcement steel;
- 956 Mg non-activated concrete and reinforcement steel.

These masses are calculated assuming that a maximum of 50 cm of the inner layer of the Biological Shield (BS) is activated.

Due to the new definition of the expression "Biological Shield", the mass has increased to a total mass of 2336 Mg in the "2009 study" (see Table 3-4 of the present report):

- 441 Mg activated concrete and reinforcement steel;
- 1.895 Mg non-activated concrete and reinforcement steel.

The mentioned aspects, new classification and new BS mass, lead to the shifting of masses from the class "Installations" to the class "Biological Shield" and to an increase of the total mass of the Biological Shield.

Building	Mass [Mg]		
	1999 study (A)	2009 study (B)	Delta (B - A)
Reactor building:			
Installations	1.357	942	-415
Biological shield	1.027	2.336	1.309
Building structures	11.160	11.160	0
Turbine building:			
Installations	1.343	1.305	-38
Building structures	15.020	15.020	0
Other buildings (AB, VB, WB):			
Installations	862	851	-11
Building structures	22.800	22.800	0
Sums:			
Installations	3.562	3.099	-463
Biological shield	1.027	2.336	1.309
Building structures	48.980	48.980	0
Total	**53.569**	**54.415**	**847**

AB = Auxiliary building
VB = Ventilation building
WB = Waste Building

Table 3-1: Primary Mass of Installations and Buildings

Description	1999 study (A)	2009 study (B)	Delta (B - A)
Masses from Preparation for Safe Enclosure	30	30	0
Tertiary Masses (without buildings)	430	768	338
Total	**460**	**798**	**338**

Table 3-2: Mass from Preparation for Safe Enclosure (PSE) and Tertiary Mass

Activated Parts	Mass [Mg]		
	1999 study (A)	2009 study (B)	Delta (B - A)
RPV Internals	7	7	0
RPV	85	87	2
RPV Insulation	5	5	0
Drywell Internals	133	133	0
Drywell	86	82	-4
Total	**316**	**314**	**-2**

Table 3-3: Activated parts of Reactor Pressure Vessel and Drywell

Biological shield	Mass [Mg]		
	1999 study (A)	2009 study (B)	Delta (B - A)
Activated part	72	441	370
Non-activated part	956	1.895	940
Total	**1.027**	**2.336**	**1.309**

Table 3-4: Activated and non-activated parts of Biological Shield

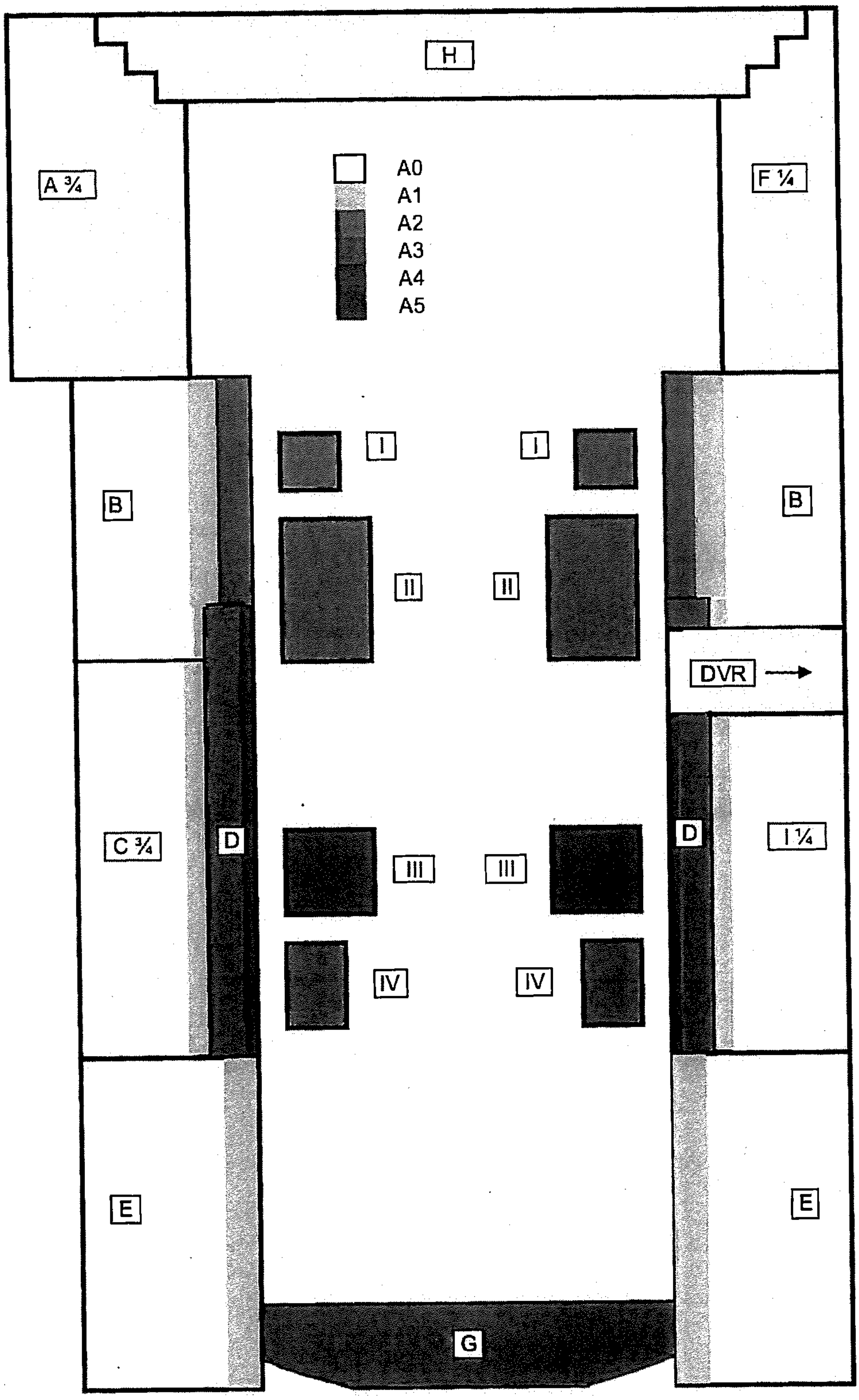

Figure 3-1: Drywell Internals and Activated Layers of the Biological Shield

4 Boundary conditions and assumptions underlying the cost estimates

In both studies, "1999 study" and "2009 study", a lot of boundary conditions and assumptions have to be taken into account, because in both cases the decommissioning work starts in the future and not all specific situations and conditions at that time can be foreseen. Therefore, the considered boundary conditions and assumptions are listed in both studies.

The following sections are comparing and describing the most important differences in the two studies.

4.1 General items

Some general items and their differences are listed in Table 4-1.

Description	1999 study	2009 study
1. Reference date for price level	01.01.2000	01.01.2009
2. Duration of Safe Enclosure period	40 years	40 years
3. Costs for authorities	not included	[redacted]
4. Costs for corporate management	not included	included in Project management costs
5. Release limits for clearance measurements (e.g. key-nuclide Co-60)	0,1 Bq/g	0,1 Bq/g
6. Envisaged wages (see section 4.2)	previous NIS study combined with GKN and Demkolec experience	German wages used by NIS for decommissioning cost estimates
7. Radioactivity level of activated parts (e.g. RPV, Biological Shield)	Assumptions taken by NIS in analogy to other NPP decomm. projects	Detailed figures available, stored in DIS

Table 4-1: Different Boundary conditions and Assumptions of the "1999 study" compared with the "2009 study"

Item 1:

For comparison purposes, the estimated decommissioning costs of the"1999 study" have to be escalated to the price level of the "2009 study". This has been done taking into account an overall inflation rate of 3% per year[1]. Nine years have been considered.

Item 2:

The duration of the Safe Enclosure period is 40 years for both studies. There is no difference only due to the duration of Safe Enclosure.

Item 3:

The estimated overall costs in the "2009 study" for authorities is about [redacted] which is negligible compared to the total costs of both studies, "1999 study" and "2009 study respectively.

[1] According to the International Monetary Fund (IMF), the average yearly inflation rate in The Netherlands, between 2000 and 2008 (included) was 2,43% per year with a range of 1,38% per year up to 5,11% per year. For the purpose of the present study a rounded figure of 3% per year has been taken into account.

Item 4:

The corporate management costs are not taken into account in the "1999 study". In the "2009 study" the complete project organization (GKN staff and contractor staff) is considered and therefore the costs are included in the study. This leads to higher costs in the "2009 study". For instance, the costs for the "GKN Plant management" are estimated to €. More details are given in section 5.8.

Item 5:

There is no difference in the clearance levels which have been taken into account for both studies.

Item 6:

The influence of the wages is described in section 4.2.

Item 7:

The radioactivity level of the activated parts has an influence on following aspects:

- Amount of radioactive waste, especially from the Biological Shield (see section 3);
- Number of containers;
- Type of container (with or without additional shielding).

More details are given in section 5.5.

4.2 Staff costs

The staff costs are calculated taking into account a qualification and hourly wages per qualification. The envisaged wages for the staff have been based on a previous NIS study /1/ combined with GKN and Demkolec experience in the "1999 study". For the "2009 study" it is agreed with GKN and the members of the working group (see /3/) that the staff wages used for the calculation of the decommissioning cost are based on relevant wages of German companies active in D&D activities (GKN staff and contractor staff).

In the "1999 study", the costs and hence the wages are given in Dutch Gulden (NLG) on price level 01.01.2000. For comparison purpose, the Dutch Gulden has been converted to Euro (€) by using the official conversion factor of 2,20371 NLG/€. Then the figures are escalated to the price level of 01.01.2009 by using an inflation rate of 3% per year. These figures can then be compared to the figures used in the "2009 study". The used qualifications and corresponding wages are shown in Table 4-2. This table also shows that the number of qualifications has been reduced in the "2009 study" compared to the "1999 study", i.e. the amount of qualifications (partly with no or only minor differences) used in the "1999 study" are concentrated to a few significant qualifications.

1999 study

Qualification	Wages 01/2000 NLG/h	Wages 01/2000 €/h	Wages 01/2009 *) €/h
Project manager			
On-site manager			
Engineer			
Accountant			
Senior health physics technician			
Technician			
Technical designer			
Foreman			
Health physics technician			
Craftsman			
Health physics worker			
Worker			
Secretary			
Cleaner			
Security staff			

2009 study

Qualification	Wages 01/2009 €/h
Project manager	
Engineer	
Accountant	
Foreman / master craftsman	
Craftsman	
Worker	
Guard (site security)	

*) Assumption: 9 years with an increase of 3% per year (01/2000 to 01/2009)

Table 4-2: Staff Qualifications and Wages

The total staff cost in the "2009 study" is about 20 M€ higher than the total staff cost in the "1999 study". This figure includes both, the new wages and the new manpower. The difference due only the wages is not available.

4.3 Waste management costs

The waste management costs include the following aspects:

- Treatment (e.g. cutting, decontamination) of dismantled components:
- Distribution to the final destination, i.e.
  - Cleared material (unrestricted release, landfill, etc.);
  - Storage as radioactive waste.
- Packaging of radioactive waste;
- Conditioning (immobilization) of radioactive waste;
- Transport, interim storage and final disposal.

The total waste management costs are dealt with in section 5.5. In this section important boundary conditions (container, transport, interim storage and disposal) are compared.

Table 4-3 shows the assumed costs for the containers used for the packaging of the radioactive waste. It can be seen that the costs for higher shielded KONRAD Type II and MOSAIK containers (used for higher activated components) have considerably increased above inflation.

Container type	Container costs			
	1999 study			2009 study
	01/2000		01/2009	01/2009
	[NLG]	[€]	[€]	[€]
200-l Drum				
1000-l Container (NC)				
KONRAD Type II				
KONRAD Type II / 180mm NC	*)	*)	*)	
KONRAD Type II / 180mm NC / 30 mm Fe				
KONRAD Type II / 180mm NC / 100 mm Fe				
MOSAIK Type II / 0mm Fe	*)	*)	*)	
MOSAIK Type II / 60mm Fe	*)	*)	*)	
MOSAIK Type II / 120mm Fe				

NC = Normal Concrete
*) Container is not used in cost estimate

Table 4-3: Costs for Waste Packages / Containers

Due to the new waste management concept (see section 5.5), the total costs for containers could be reduced in the "2009 study" (about 2,7 M€), although the costs for a single container has been increased.

In the Netherlands all radioactive waste has to be handed over to COVRA for storage and disposal. Therefore, for the purpose of the "2009 study" COVRA has given specific costs per container and depending on the surface dose rate on the outside of the container for "Transport, Interim Storage at COVRA and Disposal". These costs are compared to the cost figure (cost per m³ of storage volume) used in the "1999 study" (see Table 4-4). For comparison purposes, the cost per container is also given in the corresponding cost per m³ outer volume. In all cases, the cost for "Transport, Interim Storage at COVRA and Disposal" has considerably increased above inflation.

Transport, interim storage at COVRA, disposal	Costs				Outer volume of container	Costs per m³ outer volume of container
	1999 study			2009 study		
	01/2000		01/2009	01/2009		
	[NLG/m³]	[€/m³]	[€/m³]	[€/container]	[m³]	[€/m³]
- based on outer volume of container				*)		
- based on container type and surface dose rate:						
200-l drum, with a surface dose rate <= 0,2 mSv/h	*)	*)	*)		0,2	
MOSAIK Type II container	*)	*)	*)		1,3	
KONRAD Type II container	*)	*)	*)		4,6	

*) Not used in cost estimate

Table 4-4: Costs for Transport, Interim Storage at COVRA and Disposal

5 Preliminary Decommissioning Plan

In both studies, the decommissioning project is structured in a hierarchical organisation. The so called Work Breakdown Structure (WBS) is mandatory for the planning activities as well as for the cost estimate. The WBS "describes" the project. The overall project is divided in subprojects, task, etc. until the lowest level is reached, where the individual activities can be calculated. The WBS is adapted and the individual activities are defined according to the needs of the plant specific decommissioning plan.

For the purpose of the present comparison the results on the first level of the WBS, the Working Packages (WP), are used. This level is available in the "1999 study" as well as in the "2009 study". The contents of the different WP are also comparable.

The estimated decommissioning costs for the NPP Dodewaard of the "1999 study" and the "2009 study" are listed in Table 5-1. In both studies, no inflation has been included for the duration of the projects.

To get comparable figures, the following activities have been carried out:

- The results of the "1999 study", given in Dutch Gulden (NLG), are listed in column A of Table 5-1.
- To get costs in Euro (€), these costs are converted from NLG to € by using the official conversion factor of 2,20371 NLG/€, column B of Table 5-1.
- Then the figures are escalated to the price level of 01.01.2009 by using an inflation rate of 3% per year (taking into account 9 years), column C of Table 5-1.
- The estimated costs in the WP "Radiological and work protection" and the WP "Decontamination" are distributed to other WP according to the distributions shown in Table 5-2; column D of Table 5-1.
- These figures can now be compared to the figures used in the "2009 study", column F of Table 5-1.

Comparing the total costs of the "1999 study" with the total costs of the "2009 study" a difference of 59,3 M€ (see bottom line of column H) occurs, corresponding to a total increase in the decommissioning costs of 44% (see bottom line of column I).

About 83% of the total increase in costs is caused by the working packages "Waste processing, transport, storage and disposal" (€) and "Project management, engineering and site support as well as site security, surveillance and maintenance" (€) corresponding to a percentage increase of [redacted] respectively (see column J of Table 5-1).

Taking into account the major percentage increases in individual working packages then, in addition to the above mentioned working packages, the working packages "Dismantling Drywell and Dismantling Biological Shield" and "Clearance of building structures" are in focus. There are increases per working package of about 137% and 93% respectively, but the items reflect only 5% and 4% of the total increase (see column I and J of Table 5-1).

The next sections are focused on the description of these essential differences, but do also provide a short look at the other working packages. For a better comparability some working packages are summarised.

Working package (WP)	1999 study A 01/2000 MNLG	B 01/2000 M€	C 01/2009 *) M€	D 01/2009 **) M€	E (D/Total D) %	Working package 2009 study	F 01/2009 M€	G (F/Total F) ***) %	Delta H (F-D) ---	I (F/D) per WP --	J (H/Total H) ***)
Planning and licensing						Pre-decommissioning actions and Licensing procedure					
Preparation of the plant for dismantling						Preparatory work					
Dismantling of cont. Components (1)						Dismantling controlled area (contaminated) - CA-C1					
Dismantling of activated parts (RV and internals)						Dismantling RPV internals and Dismantling RPV					
Dismantling of activated parts (RK and internals)						Dismantling Drywell and Dismantling Biological Shield					
Dismantling of cont. Components (2)						Dismantling remaining systems and components (contaminated) - CA-C2					
Decontamination of buildings						Clearance of building structures					
Measurements of building surfaces											
Radiological and work protection											
Decontamination											
Waste management						Waste processing, transport, storage and disposal					
Demolition of buildings, site recovery						Conventional demolition and site restoration, cleanup and landscaping					
						Asbestos removal					
Operation on site, project management, site security						Project management, engineering and site support as well as site security, surveillance and maintenance					
						Authorities					
Total											

*) Assumption: 9 years with an increase of 3% per year (01/2000 to 01/2009)
**) New distribution of "Decontamination" and "Radiological and Work protection" according to new estimates in the "2009 study"
***) "0%" means that the percentage is below 0,5%
****) Activities included in other working packages according to the distribution given in Table 5-2

Table 5-1: Decommissioning Costs

Working Package	$MNLG_{01/2000}$	$MNLG_{01/2000}$	
Radiological and work protection			
Preparation of the plant for dismantling			10 1 c [redacted]
Dismantling of cont. Components (1)			
Dismantling of activated parts (RV and internals)			
Dismantling of activated parts (RK and internals)			
Dismantling of cont. Components (2)			
Decontamination of buildings			
Waste management			
Operation on site, project management, site security			
Decontamination			
Dismantling of cont. Components (1)			
Dismantling of activated parts (RV and internals)			
Dismantling of activated parts (RK and internals)			
Dismantling of cont. Components (2)			
Decontamination of buildings			
Waste management			
Operation on site, project management, site security			

Table 5-2: Decommissioning Costs (distribution of old WP costs)

5.1 WP 01 & 02: Pre-decommissioning actions and Licensing procedure

There is no significant impact coming from this working package. The content of the working package is almost the same in both studies, so that the escalated costs of the "1999 study" are very close to the costs of the "2009 study".

5.2 WP 03: Preparatory work

The same as in the above working package appears for the working package "Preparatory work".

5.3 WP 04 till 09: Dismantling

The dismantling of the contaminated and activated parts of the NPP Dodewaard is considering the present knowledge of such activities taken from practical experience. NIS is involved in a lot of actual decommissioning projects in Germany (e.g. NPP Würgassen, Stade, Obrigheim and Kahl). The activities of NIS are covering both aspects, planning and cost controlling activities (with the use of CORA / CALCOM) as well as practical dismantling work (e.g. dismantling of RPV internals in NPP Würgassen, dismantling of the RPV of NPP Stade, building decontamination of NPP Kahl, health physics work in different projects). A lot of these experiences were gathered after the preparation of the "1999 study" so that these experiences could only be used in the "2009 study". Following major aspects have been taken into account:

- Present status of the installations of NPP Dodewaard;
- Depth of activation in reactor vessel pit;
- Necessary modifications and/or new installations to guarantee a safe dismantling;
- Possibilities to handle and move on the dismantled parts;
- Number of container transports per time unit (e.g. per day or per week)
- Sequence of dismantling to get a robust time schedule.

Additionally, in the "2009 study", the focus is set on the local situation of the plant, e.g.:

- Available space at the place of dismantling;
- Transport routes inside the buildings;
- Available space for treatment area;
- Available space for buffer storage;
- Size of sanitary area and entrance to controlled area.

Besides these items, there are time consuming aspects like hardening of the immobilization material, time for radiological analysis of samples or waiting for approvals from authorities, which may influence the necessary size of buffer storage areas.

All the above mentioned aspects and the local situation lead to the decision to switch from two shift work ("1999 study") to one shift work ("2009 study"). In some respects, this is a conservative assumption, which gives confidence that the dismantling can be done in the planned way.

The dismantling of the Biological Shield has also an important influence.. Due to the fact that the depth of the activated part is now well known, the amount of concrete which has to be removed has increased. This leads to a longer duration for the dismantling of the Biological Shield and an increase in costs of about € (corresponding to [redacted]

In total, the new assumptions lead to a significant increase in the duration (about 4 years longer), but so there is a guarantee that the dismantling work can be done without getting logistic or spatial problems and the schedule is robust, which has been requested in the TRF /3/. The total increase in costs for all dismantling work is about € (I€ staff costs, € investments and consumables) and is reflecting about [redacted] of the total cost difference (see Table 5-1). Basically, the investments and consumables are not linked to the project duration, but do result from the techniques used. The reason for the increase in costs is based on the present dismantling concept and has been derived from actual market prices.

5.4 WP 10: Clearance of building structures

The cost for clearance of the building structures has increased by [redacted] € in the "2009 study", which is about 93% of the working package cost of the "1999 study" and is [redacted] total cost difference of both studies.

The increase is resulting from the experiences gathered from real decommissioning projects in recent years. In almost all present decommissioning projects, the expenditures for the clearance of the building structures are higher than expected, because the removal of the contamination and the clearance measurements are more laborious than previously planned. These experiences have been taken into account in the "2009 study" and lead to a longer duration for these activities, resulting into an increase in the necessary manpower (see Table 5-7) and costs (see Table 5-1).

5.5 WP 11: Waste processing, transport, storage and disposal

One of the two most significant differences [redacted] corresponding to [redacted] of total difference) of the decommissioning costs presented in the "1999 study" and the "2009 study" is resulting from the waste management cost estimate (see Table 5-1).

In that case, the amount of radioactive waste, the packaging and the transport to the storage facility at COVRA and the final disposal are of interest.

Table 5-3 gives an overview of the estimated amounts of radioactive waste for final disposal.

Description	**1999 study (A) [Mg]**	**2009 study (B) [Mg]**	**Delta (B - A) [Mg]**
Primary and tertiary mass (without buildings)	5.049	6.233	1.184
Final disposal mass	1.409	1.083	-326
Percentage	**28%**	**17%**	
Secondary waste mass (incl. concrete rubble from building decontamination)	104	261	157
Total final disposal mass	**1.513**	**1.344**	**-169**

Table 5-3: Final Disposal Masses

In total, the mass for final disposal in the "2009 study" is about 169 Mg less than in the "1999 study", although the secondary mass is about 157 Mg higher. The reasons for the lower radioactive waste amount from primary and tertiary masses for final disposal are the following:

- Better knowledge of the radioactivity content of the contaminated and activated parts;
- New Distribution Factors Sets (based on "Return of Experience" of current decommissioning projects).

The increase in the secondary mass has three major reasons:

- More concrete rubble from building decontamination due to the knowledge of surface contamination and new assumptions regarding surface removal gathered from experiences in real decommissioning projects ("1999 study": 45 Mg; "2009 study": 50 Mg);
- More waste (e.g. tools, combustible waste like foils, clothes) produced during dismantling and treatment due to experiences gathered from real decommissioning projects ("1999 study": 37 Mg; "2009 study": 151 Mg);
- Use of dry decontamination only which leads to more solid waste for final disposal ("1999 study": 17 Mg; "2009 study": 61 Mg).

The radioactive waste has to be packed for interim storage and final disposal. The containers used, the produced number of containers, the container costs, the storage volume as well as the costs for transport, interim storage and disposal are shown in Table 5-4 ("1999 study", costs converted to € and escalated to price level 01/2009) and in Table 5-5 ("2009 study").

Container Type	Packed Mass [Mg]	Number of Containers [-]	Container Costs [k€$_{2009}$]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal *) [k€$_{2009}$]
KONRAD Type II-Container	1.480	331		1.526	
MOSAIK-Container	33	44		58	
Total	**1.513**	**375**		**1.584**	

*) Calculated with 15.000 NLG/m³ (price level: 01/2000) or 8881 €/m³ (price level 01/2009), see Table 4-4

Table 5-4: Container Data and Disposal Costs ("1999 study")

Container Type	Packed Mass [Mg]	Number of Containers [-]	Container Costs [k€$_{2009}$]	Storage Volume [m³]	Costs for Transport, Interim Storage, Disposal *) [k€$_{2009}$]
200-l Container, with a surface dose rate <= 0,2 mSv/h	402	2.169		527	
KONRAD Type II-Container	937	190		880	
MOSAIK-Container	6	12		16	
Total	**1.344**	**2.371**		**1.423**	

*) Calculated per container type and surface dose rate, see Table 4-4

Table 5-5: Container Data and Disposal Costs ("2009 study")

It can be seen in the tables that in the "2009 study" a lot of 200-l drums are used for the packaging. In the "1999 study" these drums were not used. It is assumed that all waste is packed in KONRAD or MOSAIK containers. But due to the very high cost for transport, interim storage and disposal for KONRAD and MOSAIK containers, which have to be used in the "2009 study", also 200-l drums have been used for the packaging of radioactive waste.

The new packaging concept in the "2009 study" leads to a decrease in the container costs of about €, compared to the "1999 study". But due to the new fees for "Transport, interim storage at COVRA and disposal", which lead to an increase in costs of about €, the total costs have also increased (plus €). This explains more or less the total difference of the above mentioned €.

5.6 WP 12 & 13: Conventional demolition and site restoration, cleanup and landscaping

In the "1999 study" costs for conventional demolition and site restoration were estimated by a Dutch company and were only included in the report by NIS. The costs estimated in the "2009 study" are based on specific costs given by a Dutch company. The costs of the price adjusted "1999 study" are very close to the results of the "2009 study".

5.7 WP 14: Asbestos removal

The cost of asbestos removal has been deliberately left out in the "1999 study". Starting from the known amount of asbestos in the NPP Dodewaard, GKN has estimated a cost of (price level 1999) for the removal of it. Converted to Euro and escalated to the price level 2009 this would be about €. This figure is very close to the new cost estimate in the "2009 study", where costs of about € are estimated.

5.8 WP 15 & 16: Project management, engineering and site support as well as Site security, surveillance and maintenance

Besides the working package "Waste processing, transport, storage and disposal" the working packages 15 & 16 lead to a significant cost increase. The difference is about corresponding to a 71% higher cost. Compared to the total difference of €, it represents an increase of 41%.

In the "2009 study", the complete project organization (GKN staff and contractor staff) is considered and the costs are included in the study. The necessary activities are based on experiences of actual decommissioning projects which were not available at the performance time of the "1999 study". In addition, the necessary consumable costs for the operation of the site during the decommissioning period have been reassessed, using the gathered information from real decommissioning projects. Together with the longer duration of the total project this leads to higher costs in the "2009 study". The most important aspects for the cost increase are:

- Detailed analysis of necessary manpower for project management and site operation;
- Detailed analysis of necessary yearly operational costs;
- Wages;
- Longer duration of the project.

The € are resulting from an increase in staff costs of about (see also Table 5-7) and an increase of the other costs (e.g. electricity, consumables) of about €.

From today's point of view, these activities were underestimated in the "1999 study".

5.9 WP 17: Authorities

The [redacted] are negligible compared to the total cost (see item 3 in section 4.1).

5.10 Project duration

Taking into account all above mentioned impacts on the decommissioning duration of the "2009 study" compared to the "1999 study", the resulting and essential differences are shown in Table 5-6.

Period	Duration				
	1999 study [years]		2009 study [years]		Delta [years]
	not time critical	time critical	not time critical	time critical	time critical
Pre-decommissioning / Licensing (duration until the license is granted)		3,8		4,0	0,2
Dismantling (from preparatory work until end of dismantling work)		2,8	0,7	7,0	4,2
Clearance of buildings (building decontamination and release measurements)	0,3	0,1	0,6	0,8	0,7
Conventional demolilion (until reaching "green field" conditions)		1,1	0,4	1,7	0,6
Total		**7,8**		**13,5**	**5,7**

Table 5-6: Duration of the Decommissioning

5.11 Manpower

The essential increases in manpower are resulting from the WP "Clearance of Buildings" and the WPs "Project management, engineering and site support as well as Site security, surveillance and maintenance" (see the corresponding sections above). In total, the essential differences are shown in Table 5-7.

Activity Description	Manpower		Delta	
	A	B	(B-A)	(B/A)
	1999 study	2009 study		
	[man-years]	[man-years]	[man-years]	[%]
Pre-decommissioning / Licensing	10 1 c [redacted]			
Dismantling (from preparatory work until end of dismantling work)	[redacted]			
Clearance of buildings (building decontamination and release measurements)	[redacted]			
Waste management	[redacted]			
Project management, engineering and site support as well as Site security, surveillance and maintenance	[redacted]			
Sub-Total	[redacted]			
Conventional demolition and site restoration, cleanup and landscaping	[redacted]			
Total	[redacted]			

*) The costs were taken from an external company in "1999 study" [redacted]

Table 5-7: Estimated Manpower for the Decommissioning

6 Summary

Summarising all above mentioned impacts on the decommissioning costs of the "2009 study" compared to the "1999 study", the essential differences are shown in Table 6-1.

	Costs in M€	
Total decommissioning costs "2009 study" (price level 01/2009)		
Total decommissioning costs "1999 study" (price level 01/2009)		
Total difference		
Essential differences:		
Dismantling activities (higher manpower and wages)		
Dismantling activities (investments and consumables)		
Clearance of building structures (higher manpower and wages)		
Waste containers costs		
Waste containers transports, interim storage and disposal		
Site operation (higher manpower and wages)		
Site operation (yearly costs for consumables and services)		
Others in total (not described in detail)		
Essential differences (sum):		

Table 6-1: Essential Differences comparing the "1999 study" with the "2009 study"

References

/1/ Costs of decommissioning the nuclear power plant at Dodewaard
Document No.: 1363/3179/0
NIS Ingenieurgesellschaft mbH
Hanau, October 1994

/2/ Costs of decommissioning the nuclear power plant at Dodewaard
Document No.: 5229/ CA / F 0005151
NIS Ingenieurgesellschaft mbH
Hanau, November 1999

/3/ New Decommissioning Cost Estimate – Technical Requisition File
TIERSDI/4FG/6154/000/02
Suez-Tractebel S.A.
Brussels, November 2008

/4/ GKN - Evaluation of Decommissioning of the Dodewaard NPP
- New Decommissioning Cost Estimate -
Task 2: Deferred Scenario
Starting date of decommissioning: 2045
Clearance levels: KEW and IAEA
Document No.: 8229 / CA / F 008240 8 / 00
NIS Ingenieurgesellschaft mbH
Alzenau, April 2010

20100611-2 - VROM

Ruimte en Milieu
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

B.V. NEA
10 2 e [redacted]
6669 ZG Dodewaard

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2010016235

Datum 11 JUNI 2010
Betreft Overleg inzake ontmantelingskosten

Geachte [redacted], geachte [redacted],

Hierbij stuur ik u een kopie van mijn brief aan GKN, waarvan de inhoud voor zich spreekt.

Hoogachtend,
de secretaris-generaal,

[redacted]

SCAN01/00079227

VROM 11

Ruimte en Milieu
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

GKN
[redacted]
Waalbanddijk 112a
6669 ZG Dodewaard

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2010016237

archiefkopie

Afschrift aan
dgM
dRb, [redacted]
BJZ: [redacted]

Paraaf
dRb
[redacted]

Datum
Betreft Overleg inzake ontmantelingkosten

Geachte [redacted], geachte [redacted],

Verwijzend naar mijn laatste brief met kenmerk RB/2010008230 (waarvan een kopie met kenmerk RB/2010010251 is verzonden naar NEA), herinner ik u aan onze op 3 februari 2010 gemaakte afspraak om, na het beschikbaar komen van de resultaten van diverse actiepunten, een nieuw gesprek te arrangeren.

Voor de volledigheid vat ik de stand van zaken van de belangrijkste actiepunten kort samen:

- De resultaten van de nieuwe berekeningen van de ontmantelingskosten, alsmede een analyse van de verschillen met de studie uit 1999, zijn inmiddels beschikbaar;
- COVRA heeft een onderbouwing verstrekt voor de nieuwe tarieven;
- Ik heb aangegeven dat het verstrekken van informatie over de financiële voorziening van EPZ, met het oog op het momenteel nog niet afgeronde overleg, niet opportuun is;
- De juridische positie van het rijk heb ik (nogmaals) toegelicht.

In bovengenoemde brief heb ik voorts aangegeven dat ik mij zorgen maak over hoe GKN aan zijn verplichtingen denkt te kunnen voldoen, en het daarom wenselijk acht dat NEA aansprakelijkheid erkent voor tekorten in GKN.

Ik acht het daarom wenselijk om een nieuw gesprek te arrangeren, en zal mijn secretariaat vragen contact met u op te nemen voor het vastleggen van een datum.

Hoogachtend,
de secretaris-generaal

[redacted]

20100614 - GKN

Ruimte en Milieu
Ministerie van Volkshuisvesting,
Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

GKN
t.a.v. [redacted]
Waalbanddijk 112a
6669 ZG Dodewaard

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2010016237

Datum 11 JUNI 2010
Betreft Overleg inzake ontmantelingkosten

Geachte [redacted], geachte [redacted],

Verwijzend naar mijn laatste brief met kenmerk RB/2010008230 (waarvan een kopie met kenmerk RB/2010010251 is verzonden naar NEA), herinner ik u aan onze op 3 februari 2010 gemaakte afspraak om, na het beschikbaar komen van de resultaten van diverse actiepunten, een nieuw gesprek te arrangeren.

Voor de volledigheid vat ik de stand van zaken van de belangrijkste actiepunten kort samen:

- De resultaten van de nieuwe berekeningen van de ontmantelingskosten, alsmede een analyse van de verschillen met de studie uit 1999, zijn inmiddels beschikbaar;
- COVRA heeft een onderbouwing verstrekt voor de nieuwe tarieven;
- Ik heb aangegeven dat het verstrekken van informatie over de financiële voorziening van EPZ, met het oog op het momenteel nog niet afgeronde overleg, niet opportuun is;
- De juridische positie van het rijk heb ik (nogmaals) toegelicht.

In bovengenoemde brief heb ik voorts aangegeven dat ik mij zorgen maak over hoe GKN aan zijn verplichtingen denkt te kunnen voldoen, en het daarom wenselijk acht dat NEA aansprakelijkheid erkent voor tekorten in GKN.

Ik acht het daarom wenselijk om een nieuw gesprek te arrangeren, en zal mijn secretariaat vragen contact met u op te nemen voor het vastleggen van een datum.

Hoogachtend,
de secretaris-generaal,

[redacted]

20100624 - GKN

10-2-2011

B.V. Gemeenschappelijke Kernenergiecentrale Nederland

De Secretaris-Generaal van het Ministerie van VROM
10 2 e [redacted]
Rijnstraat 8
2515 XP DEN HAAG

Uw kenmerk	Ons kenmerk	Behandeld door	Doorkiesnummer
RB/2010016237 [redacted]	DR10-013	[redacted]	[redacted]

Onderwerp	Datum
Overleg inzake ontmantelingskosten KCD	14 juni 2010

Geachte [redacted],

Hiermede bevestig ik de ontvangst van uw brief van 11 juni 2010 met kenmerk RB/2010016237 waarin u kenbaar maakt het wenselijk te achten om een nieuw gesprek te arrangeren over de ontmantelingskosten van de Kernenergiecentrale Dodewaard (KCD).

Ik kan u mededelen dat GKN zich thans beraad over dit onderwerp en hierover op een nog nader te bepalen tijdstip met u zal communiceren.

Met vriendelijke groeten
[redacted]
Bestuurder GKN

Kopie: [redacted]

20100625 - VROM

10-2-2011

GKN

B.V. Gemeenschappelijke Kernenergiecentrale Nederland

VROM / DGM
zaak | doss
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3e ......
4e ......
Na behandeling retour archief
Deponeren dd.

IPC 645

Ministerie van VROM
Portefeuille Milieu, Directie Risicobeleid
10 2 e [redacted]
Postbus 30945
2500 GX DEN HAAG

Uw kenmerk	Ons kenmerk	Behandeld door	Doorkiesnummer
	DR10-016	[redacted]	[redacted]

Onderwerp
Evaluation New Decommissioning Cost Estimate Dodewaard NPP

Datum
24 juni 2010

Geachte [redacted], beste [redacted],

Bijgaand doe ik u de originele door NIS Ingenieurgesellschaft mbH opgestelde rapporten toekomen te weten:

1. GKN - Evaluation of Decommissioning of the Dodewaard NPP
   - New Decommissioning Cost Estimate -
   Task 1: Reference Scenario (decommissioning starting 2015)
   Document No.: 8229 / CA / F 008157 7 / 00
2. GKN - Evaluation of Decommissioning of the Dodewaard NPP
   - New Decommissioning Cost Estimate -
   Task 2: Deferred Scenario (decommissioning starting 2045)
   Document No.: 8229 / CA / F 008240 8 / 00
3. Explanations of the main differences in the results between the Dodewaard NPP decommissioning cost studies of 1999 and 2009
   (Task 3: "1999 study" compared with Task 1 of "2009 study")
   Document No.: 8229 / CA / F 008124 5 / 01
4. Explanations of the main differences in the results between the Dodewaard NPP decommissioning cost studies of 1999 and 2009
   (Task 4: "1999 study" compared with Task 2 of "2009 study")
   Document No.: 8229 / CA / F 008424 4 / 01

Ik verzoek u vriendelijk de ontvangst van de rapporten per brief te bevestigen. Tevens verzoek ik u vriendelijk in dezelfde brief te verklaren dat de rapporten zijn opgesteld met inachtneming van de door het Ministerie van VROM ingebrachte voorwaarden en u akkoord gaat met de door NIS uitgevoerde berekeningen.

Met vriendelijke groeten

[redacted]

directeur NEA

Bijlagen

Waalbandijk 112a
6669 MG Dodewaard
Postbus 40
NL-6669 ZG Dodewaard
Telefoon (0488) 41 88 11
Telefax (0488) 41 21 28

ABN AMRO
Rek.nr. 534423566
Handelsregister Rivierenland
Nr. 09031421
BTW nr. NL 009749494B05

20100630-1 - COVRA

Ruimte en Milieu
Ministerie van Volkshuisvesting,
Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

GKN
[redacted]
6669 ZG DODEWAARD

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2010017946

Datum 25 JUNI 2010
Betreft Overleg inzake ontmantelingskosten

Geachte [redacted]

NEA/GKN en VROM zijn, op initiatief van NEA/GKN en naar aanleiding van een door NEA opgestelde Strategienota, al sinds geruime tijd 'sans prejudice' in gesprek over de afwikkeling van het dossier ontmanteling kerncentrale Dodewaard. In dit kader is in het afgelopen jaar gewerkt aan het opnieuw vaststellen van de te verwachten kosten van ontmanteling van de centrale. Dat hiermee in een constructieve sfeer aanzienlijke gezamenlijke voortgang is gemaakt, wordt door mij zeer op prijs gesteld.

Ik heb u middels mijn brieven d.d. 1 april (kenmerk RB/2010008230) en 11 juni 2010 (kenmerk RB/2010016237) uitgenodigd in overleg te treden om o.a. de verantwoordelijkheid van de NEA aan de orde te stellen. Tot mijn teleurstelling heb ik echter van u moeten vernemen dat er nog beraad plaatsvindt over mijn brieven, en thans geen datum voor nieuw overleg kan worden vastgesteld. Het overleg in dit dossier loopt immers reeds geruime tijd en niet valt in te zien waarom niet eens een datum zou kunnen worden bepaald voor een bespreking. Daarnaast zou ik u een aantal vragen willen voorleggen omtrent het dividendbeleid van GKN en NEA in de afgelopen jaren.

Ik wil u daarom nogmaals verzoeken akkoord te gaan met het arrangeren van een gesprek voor 9 juli 2010. Het te lang opschorten van overleg zou geen recht doen aan de gemaakte gezamenlijke voortgang en aan het belang van een goede afwikkeling van de zaak. Mocht u hier geen gehoor aan willen geven, dan brengt dit de noodzaak van juridische geschillenbeslechting dichterbij.

Een afschrift van deze brief heb ik gezonden naar de NEA, alsmede naar de commissarissen van de NEA.

Hoogachtend,
de secretaris-generaal
[redacted]

20100630-2 - GKN

COVRA NV
Centrale Organisatie Voor Radioactief Afval

Spanjeweg 1 (Havennummer 8601)
4455 TW Nieuwdorp
Correspondentieadres:
Postbus 202
4380 AE VLISSINGEN
Telefoon : 0113-616666
Telefax : 0113-616650
E-mail : info@covra.nl

BV GKN
[redacted]
Postbus 40
6669 ZG DODEWAARD

Ons kenmerk: [redacted]100261 Uw kenmerk: -- Datum: 30 juni 2010

Onderwerp bevestiging ontvangst

Geachte heer [redacted]

In antwoord op uw brief, met kenmerk DR10-017 van 24 juni, bevestigt COVRA de ontvangst van de vier rapporten betreffende de kosten van ontmanteling van de kernenergiecentrale Dodewaard. De rapporten zijn opgesteld op basis van de TRF welke in gezamenlijk overleg tussen VROM, COVRA en GKN tot stand is gekomen. Op basis van de uitgangspunten in de TRF heeft NIS met een computerprogramma berekeningen uitgevoerd, waarvan het resultaat is neergelegd in genoemde rapporten.

Hoogachtend,

CENTRALE ORGANISATIE VOOR RADIOACTIEF AFVAL (COVRA) N.V.

[redacted]

Directeur

COVRA NV, Centrale Organisatie Voor Radioactief Afval
KvK Middelburg, dossiernr. 22029665

20100706 - VROM

GKN

11-8-2011

Aanvullende informatie betreffende Ontmantelingplan GKN.

1. StralingsControleDienst (SCD)
Tijdens de ontmanteling van de kernenergiecentrale zal een StralingsControleDienst aanwezig zijn. Deze SCD houdt toezicht op alle radiologische werkzaamheden en let tevens op conventionele veiligheidsaspecten bij het uitvoeren van werkzaamheden..
De dienst zal bestaan uit voldoende medewerkers van voldoende gekwalificeerd nivo. Omdat er veel uitvoerend werk plaats vindt zal veel toezicht op de werkplek aanwezig zijn. De hiervoor benodigde stralingstechnici hebben een deskundigheid nivo 4 of 5.
De leiding van de SCD zal een deskundigheid nivo 3 hebben.
Daarnaast zal een "onafhankelijke stralingsdeskundige" benoemd worden.
De SCD zal de beschikking hebben over voldoende meetmiddelen, geschikt voor het uitvoeren van haar taken. Daarnaast zal zij de beschikking hebben over een meetplaats waar besmettingsmetingen kunnen worden uitgevoerd.
Voor de zogenaamde "vrijgave metingen" van materialen zal een aparte ruimte worden ingericht met daarin apparatuur welke speciaal voor deze metingen zal worden aangehouden.
De SCD bewaakt de radiologische dosis van de medewerkers en zal hiervoor dosisregistratie apparatuur onder beheer hebben.
Voor het uitvoeren van haar taken heeft de SCD de beschikking over werkinstructies.

2. Voorzieningen om radiologische kennis en informatie over de inrichting te behouden.
GKN heeft haar oude archieven onder gebracht bij het Gelders Archief. Het splijtstof archief is gedigitaliseerd. De procedures en werkinstructies van de bediening van installatie tijdens de fase Vermogensbedrijf en de fase Veilige Insluiting zijn digitaal beschikbaar op een server met interne- en externe back-up mogelijkheden.
De radiologische inventaris van de installatie is vastgelegd in het Dodewaard Information System (DIS). Dit DIS wordt beheerd door een externe firma. Het DIS wordt gehouden op een externe server met back-up mogelijkheid. In het DIS is ook relevante informatie opgenomen over locaties waar zich asbest in de installatie bevindt. Jaarlijks wordt een rapport gemaakt van de actuele situatie van de radioactieve inventaris. Dit rapport wordt aangeboden aan de dKFD. Een exemplaar van het rapport 2010 is bij deze notitie gevoegd.
Van de methode van dataopslag van GKN is een overzicht opgenomen als "good practice" in IAEA-publicatie "*Long Term Preservation of Information for Decommissioning Projects*" (Technical Report Series, nr 467, august 2008).

3. Maatregelen om de veiligheid van de omgeving van de inrichting te waarborgen.
GKN beschikt thans over een Brandweeraanvalsplan voor de fase Veilige Insluiting, waarin opgenomen alle relevante informatie voor de locale brandweer. Dit plan is goedgekeurd door de locale brandweer en de dKFD. Ook oefent GKN regelmatig met de locale brandweer. Voor aanvang van de ontmanteling zal dit plan geheel worden herzien en aangepast op de dan ontstane situatie. Dit plan zal weer worden voorgelegd voor goedkeuring aan de locale brandweer en de dKFD.
GKN beschikt over een Rampenbestrijdingsplan dat is opgesteld in samenwerking met de locale brandweer, de politie, het GHOR en de Gemeente Neder-Betuwe. Dit plan zal voor aanvang van de ontmanteling worden aangepast op de actuele situatie.

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NIS

Siempelkamp

NIS Ingenieurgesellschaft mbH

TECHNICAL DOCUMENT

Document No.: 6849 / CA / F 008401 3 / 00

Title: Status of the Dodewaard Plant Annual Report 2010

(as per June 30th 2010)

00	22.07.2010	[redacted]		
Rev.	Release Date	BU / (Name) Prepared	(Signed) Reviewed	(Signed) Approved

File: ANNUAL REPORT 2010.DOC

[redacted]

Table of Contents

Appendix

1 Objective of the Annual Report

The Dodewaard NPP (KCD) has been shut down at March 26th 1997. The dismantling strategy is a complete dismantling of the plant to **Greenfield Conditions** after a **Waiting Period** (WP) of 40 years as a so called **Safe Enclosure** (SE). The complete dismantling comprises the following phases:

- **Preparation for Safe Enclosure** (PSE), started when all fuel had been removed from the plant and the licence being in force at April 23th 2003.
- **Safe Enclosure** (SE) or **Waiting Period** (WP); the waiting period started on July 1st 2005 for a period of 40 years.
- **Complete Dismantling** (CD), will start after 40 years of WP.

In order to control the radioactive inventory of the facility during the PSE and the WP a database containing the contaminated and activated materials of the facility has been developed. This tool enables the operator to get information of the activation and contamination levels in the facility for operational, decommissioning as well as license purposes.

It is the objective of this annual report on hand to inform stakeholders concerning the actual status of the inventory of the radioactive materials in the facility. This is also a license requirement (Kew-license article 1.7B2.1). Future annual reports will show the changes of the radioactive inventory due to the natural decay of the nuclides and changes of material inventory.

Adjustment in the database

In the course of the ongoing cost calculation for the decommissioning of the Dodewaard NPP it was discovered that the height of room 04 in building RG-E was given as 405 m. As this is apparently wrong, the height was corrected to 4,05 m.

2 Status of the Plant

The KCD is out of operation since March 26th 1997. On April 23th 2003 the phase "Preparation for Safe Enclosure" started. This phase lasted till June 30th 2005. On July 1st 2005, the phase "Safe Enclosure" started. This phase is supposed to last for 40 years.

All presently redundant systems have been retired. Briefly this means that these systems have been drained, oil removed and isolated mechanically and electrically. Other systems are still in operation to maintain the required safety level for personnel and environment.

All nuclear and non nuclear licenses have been issued and are in force.

The size of the organisation itself has been reduced to three engineers.

3 Progress of the Decommissioning Work

Contracts for the major activities in the phase "Safe Enclosure (SE)" have been concluded:

1. Maintenance of buildings, site and components
2. Security
3. Health physics and general support

As time proceeds, the total mass of components changes due to

- increases on account of the installation of new systems
- decreases on account of the removal of components.

GKN reported to NIS that no components were removed from site, and no new equipment was installed during the period covered by this report. Radioactive waste generated in the laboratory facility is not added to the DIS data base as this waste is collected by COVRA on a regular base.

4 KCD Plant Situation

The following chapter describes the plant situation on June 30th 2010 based on the information already stored in the Dodewaard Information System (DIS). DIS allows a detailed evaluation of the inventory data regarding several criteria like material, locations, activity classes and dose rates.

The total mass of the components and building structures registered in the DIS database amounts to 5550,0 Mg. This mass includes all material classes as shown in Table 1.

Material Classes	Mass (Mg) Still in Plant	Mass (Mg) Already Removed
Activated Parts	369,7	14,0
Biological Shield	2336,5	-
Contaminated Systems and Components	898,8	3,6
Contaminated Equipment	850,6	37,7
Steel Constructions	600,2	24,3
Concrete and Shielding	207,5	18,2
Others	127,8	61,2
Total	5391,1	158,9

Table 1: Registered Masses in the DIS Database

The components which are already removed are still stored in the DIS database but marked as "removed".

4.1 Masses in DIS Compared to the Mass Estimation of 1994 and 1999

The mass inventory of the KCD Plant is categorized in material classes which are originally defined in the cost estimation study "Costs of Decommissioning of the Nuclear Power Plant at Dodewaard" (NIS Report 1363/3179/0, October 1994; NIS Report 5229 / CA / F 000515 1, November 1999). These material classes were also used in the DIS database but different in some aspects based on the more detailed data collection during the last years. The material classes and/or radioactivity categories will be compared and the differences explained in the following paragraphs.

The total mass amount calculated in the '94 and '99 studies and the correlated mass registered in DIS is shown in Table 2.

Material and/or Radioactivity Category	Studies '94/'99 (Mg)	DIS Database* (Mg)
Activated Parts		
Concrete	360,9	119,7
Steel	253,9	261,1
Insulation	5,2	-
Lead	5,2	1,9
Others	-	1,0
Biological Shield		
Radioactive Concrete and Reinforcement	71,5	440,8
Non-radioactive Concrete and Reinforcement	955,5	1895,7
Contaminated Systems and Components	1369,2	902,4
Contaminated Equipment	1510,3	888,2
Steel Constructions	57,0	624,5
Concrete and Shielding	-	225,7
Others	-	189,0
Total	4588,7	5550,0

* Total mass incl. the already dismantled components, related to 30.06.2010

Table 2: Comparison of the Masses

It is obvious that the mass amount in the DIS database is based on a mass collection philosophy with much more details and, in the case of the Biological Shield, the object of mass collection has been changed; from only relevant for the decommissioning work to the consideration of the complete part of the building.

4.1.1 Material Class "Activated Parts"

In the '94 and in the '99 cost estimation studies all components inside the drywell had been classified as "Activated Parts", i.e. the reactor pressure vessel and its internals, the drywell components and the drywell shroud. But "Activated Parts" doesn't give an indication for the level of the radioactivity.

It can be recognised that the main difference in the mass amount is given by the concrete mass. In the '94 and '99 studies the concrete components I, II, III and IV inside the drywell have been assigned to the Activated Parts, but in the DIS they are assigned to the category "Biological Shield" (see Fig. 2 for these components).

4.1.2 Material Class "Biological Shield"

The mass of the "Biological Shield" was given in the '99 study by:

- 71,5 Mg activated concrete and reinforcement steel
- 955,5 Mg non-activated concrete and reinforcement steel

These masses were calculated assuming that a maximum of 50 cm of the inner layer of the Biological Shield can be activated.

In the DIS database the Biological Shield is considered as a complete building part as shown in Figure 2. This definition includes also the components I, II, III, IV inside the drywell (see Fig. 2). Due to this new definition of the expression "Biological Shield (BS)", the mass of the

BS has increased by a factor of about 2,3 to the total mass of 2.336,5 Mg. Although all this concrete material is categorised as "Biological Shield", not all this material is radioactive. Table 5 shows that only 440,8 Mg is classified in one of the activity classes A2 to A5 (related to 30.06.2010). In future these quantities will even further decrease by natural decay. All other concrete belonging to the BS is either categorised in the activity class A0 or A1 (beyond the present release limit) or is classified as non radioactive concrete. It is calculated that after 40 years the release limit of the BS concrete, taking into account the future isotopic composition and based on present standards, will be 30 Bq/g. This means also that after 40 years the BS mass presently belonging to the activation class A2 will also be beyond the release limit, taking the natural decay into account. The release limits of the nuclides are shown in table 8.1.

4.1.3 Other Material Classes

The mass of the systems, components and equipment outside the reactor area is grouped in the '94/'99 studies in the categories:

- Contaminated Systems and Components
- Contaminated Equipment
- Steel Constructions

The DIS contains the additional material classes

- Concrete and Shielding
- Others

These values from the DIS database indicate that the data collection actions during the DIS evaluation work have used a more detailed categorisation but the total sum gives a difference in the range of the general tolerance of estimations (3,6% less in the DIS).

4.2 Mass Figures in the DIS Database

The following paragraphs concern the DIS database only and do not consider the '94/'99 studies again. The explanation should give a technical and radiological survey of the existing components at the reference date June 30th 2010.

4.2.1 Mass of Activated Components

The activation of the material was generated by the neutron irradiation during the reactor operation. Because of that the activated area is limited to the reactor area in the rooms RG-B 3A (Reaktorkamer above 13 m), RG-C 10 (Reaktorkamer above 16 m) and RG-D 02 (SOB).

The range of radioactivity is largely spread within the group of the activated material. Therefore the total mass is divided in the radioactivity classes A0 to A5 with an increasing specific radioactivity.

As shown in table 3 the total mass of the activated material is 2706,1 Mg; the total activity is 7,75E+13Bq.

Activity Class	Activity Range	Mass [Mg]*	Total Radioactivity Content [Bq] 30.06.2010
A0	$< 10^{-1}$ Bq/g	1735,8	3,95E+06
A1	$> 10^{-1}$ Bq/g $< 10^{0}$ Bq/g	183,7	5,77E+07
A2	$> 10^{0}$ Bq/g $< 10^{2}$ Bq/g	476,4	1,00E+10
A3	$> 10^{2}$ Bq/g $< 10^{4}$ Bq/g	276,4	3,63E+11
A4	$> 10^{4}$ Bq/g $< 10^{6}$ Bq/g	27,1	1,13E+12
A5	$> 10^{6}$ Bq/g	6,8	7,60E+13
Total		2706,1	7,75E+13

* Only components still in plant

Table 3: Mass and Activity of Activated Components

Figure 1 shows the different materials of the activated components.

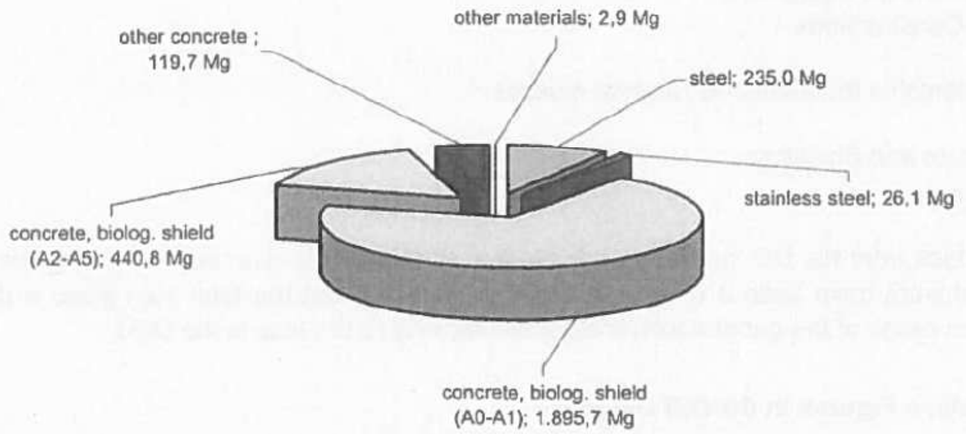


Figure 1: Composition of the Activated Inventory versus Materials

Table 4, 5 and 6 show mass and activity of the different activated materials.

Activity Class	Activity Range	Mass [Mg]*	Total Radioactivity Content [Bq] 30.06.2010
A0	< 10^{-1} Bq/g	3,0	8,33E+03
A1	> 10^{-1} Bq/g < 10^{0} Bq/g	20,7	1,08E+07
A2	> 10^{0} Bq/g < 10^{2} Bq/g	75,8	2,79E+09
A3	> 10^{2} Bq/g < 10^{4} Bq/g	116,4	1,51E+11
A4	> 10^{4} Bq/g < 10^{6} Bq/g	27,1	1,13E+12
A5	> 10^{6} Bq/g	6,8	7,60E+13
Total		249,8	7,73E+13

* Only components still in plant

Table 4: Mass and Activity of Activated Components, that are <u>not Concrete</u>

Activity Class	Activity Range	Mass [Mg]*					Total Radio-activity Content [Bq] related to 30.06.2010
		Wall deep-ness 0 – 50 cm	Wall deep-ness 51 – 75 cm	Wall deep-ness 76 – 100 cm	Wall deep-ness > 101 cm	Total Mass	
A0	< 10^{-1} Bq/g	186,5	207,5	271,0	1067,7	1732,8	4,54E+06
A1	> 10^{-1} Bq/g < 10^{0} Bq/g	65,7	32,7	64,6		162,9	4,69E+07
Total A0/A1		252,2	240,2	335,6	1067,7	1895,7	5,14E+07
A2	> 10^{0} Bq/g < 10^{2} Bq/g	226,9	82,9	-	-	309,9	4,35E+09
A3	> 10^{2} Bq/g < 10^{4} Bq/g	130,9	-	-	-	130,9	1,96E+11
A4	> 10^{4} Bq/g < 10^{6} Bq/g	-	-	-	-	-	-
A5	> 10^{6} Bq/g	-	-	-	-	-	-
Total A2 to A5		357,8	82,9	-	-	440,8	2,00E+11
Total		610,0	323,2	335,6	1067,7	2336,5	2,00E+11

* Only components still in plant

Table 5: Mass and Activity of <u>Concrete of the Biological Shield</u>

Activity Class	Activity Range	Mass [Mg]*	Total Radioactivity Content [Bq] 30.06.2010
A0	< 10^{-1} Bq/g	-	-
A1	> 10^{-1} Bq/g < 10^{0} Bq/g	-	-
A2	> 10^{0} Bq/g < 10^{2} Bq/g	90,7	2,87E+09
A3	> 10^{2} Bq/g < 10^{4} Bq/g	29,0	1,73E+10
A4	> 10^{4} Bq/g < 10^{6} Bq/g	-	-
A5	> 10^{6} Bq/g	-	-
Total		119,7	2,01E+10

* Only components still in plant

Table 6: Mass and Activity of Concrete other than Biological Shield

The material in class A0 is not radioactive. The classification A0 rather means that this material is directly linked to or is in a component or in a building part which can be radioactive.

Figure 2 and Table 5 show the meaning of the class A0 taking as an example the Biological Shield with its total wall thickness of about 1,8 m. The activated part above the level of class A0 is restricted to the coloured inner parts of the Biological Shield, to a depth of 90 cm in maximum (sub-parts 01.03.15 and 01.09.15), referred to 30.06.2010.

Projected to the more important dismantling date after the Safe Enclosure Period the depth of the activated part will decrease by the radioactive decay to about 50 cm.

The biggest part of the Biological Shield is not activated and non radioactive but nevertheless in the radioactivity class A0 because it is a part of a radioactive building.

Masses of the Biological Shield

- Class A0: 1732,8 Mg
- Class A1: 162,9 Mg
- Class A2: 309,9 Mg
- Class A3: 130,9 Mg
- Class A4: 0 Mg
- Class A5: 0 Mg

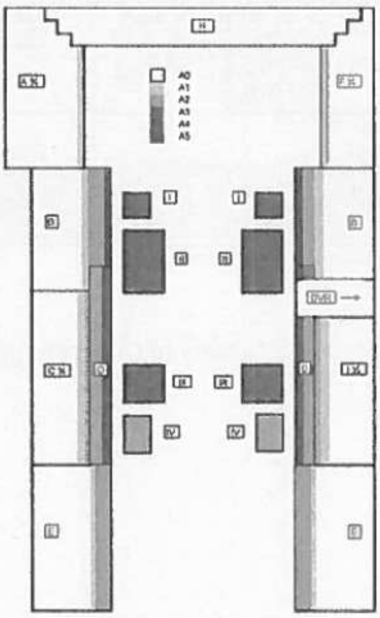


Figure 2: Activation of the Biological Shield (Reference Date 30.06.10)

4.2.2 Mass of Contaminated Components

All material in the controlled area is defined contaminated until the evidence for the non-radioactivity is given. As shown in Table 7, the total mass of the contaminated material is 2612,0 Mg; the total radioactivity is 2,72 E+11 Bq (related to June 30th 2010).

Activity Class	Activity Range	Component Mass* [Mg]	Component Surface [m²]	Total Radioactivity Content [Bq] Related to 30.06.2010
C1	< 0.4 Bq/cm²	1430,0	23870,4	1,74E+07
C2	> 0.4 Bq/cm² < 4 Bq/cm²	460,3	7041,3	9,75E+07
C3	> 4 Bq/cm² < 40 Bq/cm²	475,2	7291,6	1,04E+09
C4	> 40 Bq/cm² < 400 Bq/cm²	149,1	2545,3	2,93E+09
C5	> 400 Bq/cm²	97,4	1415,4	2,68E+11
Total		2612,0	42164,0	2,72E+11

* Only components still in plant

Table 7: Mass, Surface and Activity of Contaminated Material

Fig. 3 shows the distribution of the contaminated components concerning the materials, Fig. 4 the distribution concerning the types of components and Fig. 5 the distribution in the buildings.

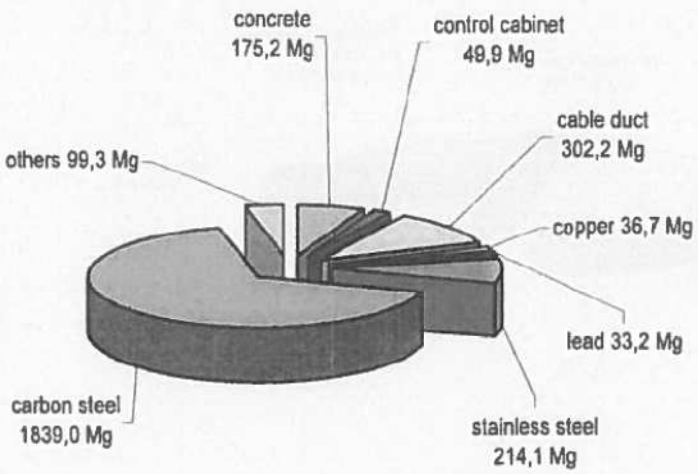


Figure 3: Composition of the Contaminated Components versus Materials

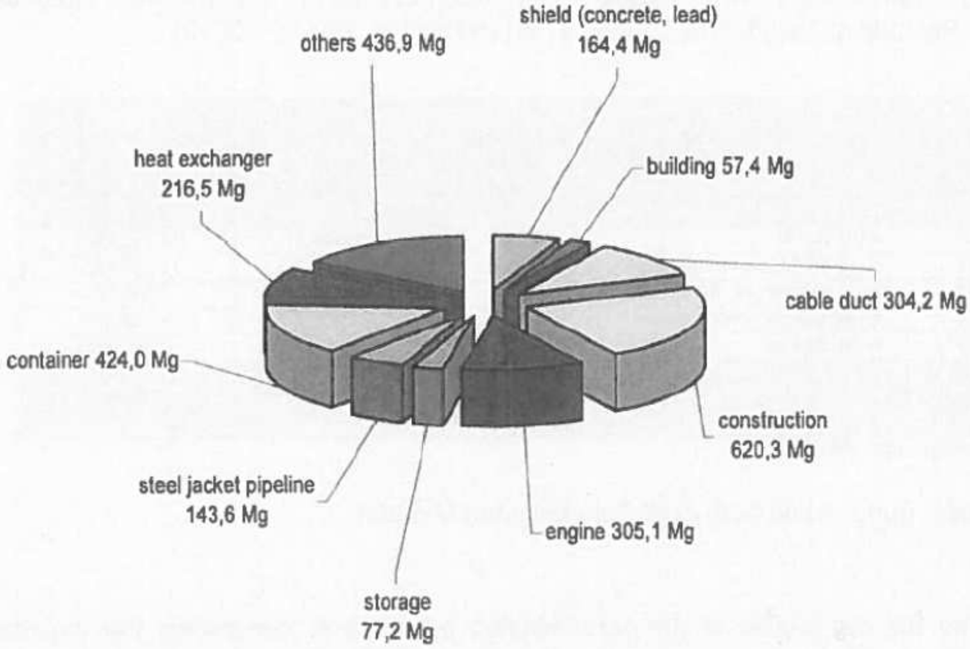


Figure 4: Mass of the Contaminated Components versus Types of Components

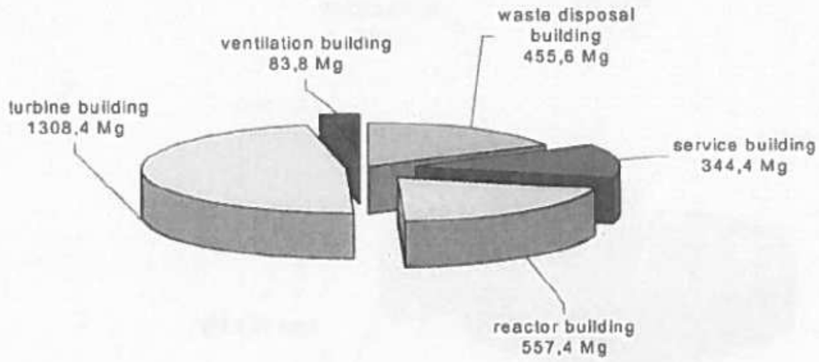


Figure 5: Mass of the Contaminated Components in the Buildings

4.2.3 Mass in the Radioactivity Class "Not Defined Material"

As stored in the DIS different components with a total mass of 79,8 Mg are not defined regarding the activity classes. This means that in the DIS no information to the radioactivity of the components is given.

5 Nuclide Vectors

The radioactivity and the nuclear decay is characterised by the nuclide vectors (= percentage of different nuclides in a material). According to the earlier operation characteristics the nuclide vectors will be different in the different buildings and/or systems. The nuclide vectors have been changed corresponding with the nuclear decay of the different nuclides.

Table 8 shows the nuclide vectors for two different dates:

- 26.03.1997 (values at the day of the shutdown of the plant)
- 30.06.2010 (actual values)

Name of Nuclide Vector	Building or Component	Used for			Reference Date	Nuclides Composition [%]									
		1)	2)	3)		Mn-54	Fe-55	Co-60	Ni-63	Zn-65	Sb-125	Ba-133	Cs-134	Cs-137	Eu-152
AG	Waste Building	x		x	26.03.1997	17,8		79,1						3,1	
					30.06.2010	<0,1		85,8						14,2	
BS-LB	Light concrete of biolog. shield		x		26.03.1997			28,0					9,0		63,0
					30.06.2010			13,3					0,3		86,4
BS-ZB	Heavy concrete of biolog. shield		x		26.03.1997	3,5		8,0		28,0		51,0	1,5		8,0
					30.06.2010			5,2				79,6	<0,1		15,1
C-Staal	Steel	x	x		26.03.1997	3,2	92,6	4,2	<0,1						
					30.06.2010	<0,1	79,9	17,9	2,2						
NG	Service Building	x		x	26.03.1997	34,0		63,6						2,4	
					30.06.2010	<0,1		86,3						13,7	
RG	Reactor Building	x		x	26.03.1997	43,9		56,1							
					30.06.2010	<0,1		100,0							
RVS	Stainless Steel	x	x		26.03.1997	4,2	69,3	24,5	2,0						
					30.06.2010	<0,1	28,7	50,0	21,3						
SB	Core Parts		x		26.03.1997			26,4			73,6				
					30.06.2010			63,7			36,3				
TG	Turbine Building	x		x	26.03.1997	51,9		45,7		1,3	0,7			0,4	
					30.06.2010	<0,1		96,1			0,3			3,5	
VG	Ventilation Building	x		x	26.03.1997	26,7		66,7						6,6	
					30.06.2010	<0,1		70,6						29,4	

1) Used for the contamination of components
2) Used for the activation of components
3) Used for the contamination of room surfaces

Table 8: Nuclide Vectors

Release Limit in	Mn-54	Fe-55	Co-60	Ni-63	Zn-65	Sb-125	Ba-133	Cs-134	Cs-137	Eu-152
Bq/g	1,0E+01	1,0E+04	1,0E+00	1,0E+05	1,0E+01	1,0E+02	1,0E+02	1,0E+01	1,0E+01	1,0E+01
Bq	1,0E+06	1,0E+06	1,0E+05	1,0E+08	1,0E+06	1,0E+06	1,0E+06	1,0E+04	1,0E+04	1,0E+06

Table 8.1: Release Limits of Nuclides according to the Dutch law (Kew)

6 Contamination of Rooms

The room data (dimensions, surfaces and contamination values) are registered and evaluated in the DIS. Every room is defined by the dimensions (which enables to calculate the surfaces) and by a contamination value (a reference value for a room).

The total surface of the rooms is calculated to 56.952 m² with a total contamination inventory of 2,18E+09 Bq (related to 30.06.2010).

7 Dose Rate

DIS contains dose rate information on components and on rooms.

7.1 Components in Dose Rate Classes

The components are grouped by dose rate classes as shown in Table 9.

Dose Rate Class	Dose Rate Range	Mass [Mg]*
A	< 10 µSv/h	2201,2
B	> 10 µSv/h < 100 µSv/h	292,9
C	> 100 µSv/h < 1 mSv/h	118,9
D	> 1 mSv/h < 10 mSv/h	34,2
E	> 10 mSv/h	69,3
Subtotal in Dose Rate Class		2716,5
Not Defined		2674,6
Total		5391,1

*Only components still in plant.

Table 9: Mass of Components in the Dose Rate Classes

7.2 Rooms in Dose Rate Classes

All the rooms of the KCD stored in the DIS are allocated to the dose rate classes A – E. The dose rate class ranges are the same as for the components shown in table 9.

Coloured drawings of the building levels (see Appendix 1 to 8) demonstrate the room dose rates of the reactor building. The colours indicate:

Blue - Dose Rate Class A
Green - Dose Rate Class B
Yellow - Dose Rate Class C
Orange - Dose Rate Class D
Red - Dose Rate Class E
Grey - Not defined (or is linked to an other building level)

8 Total Radioactive Inventory

The total radioactivity inventory in the Dodewaard plant is given in table 10. This table shows the data of the components that are still in the plant (in and out of process).

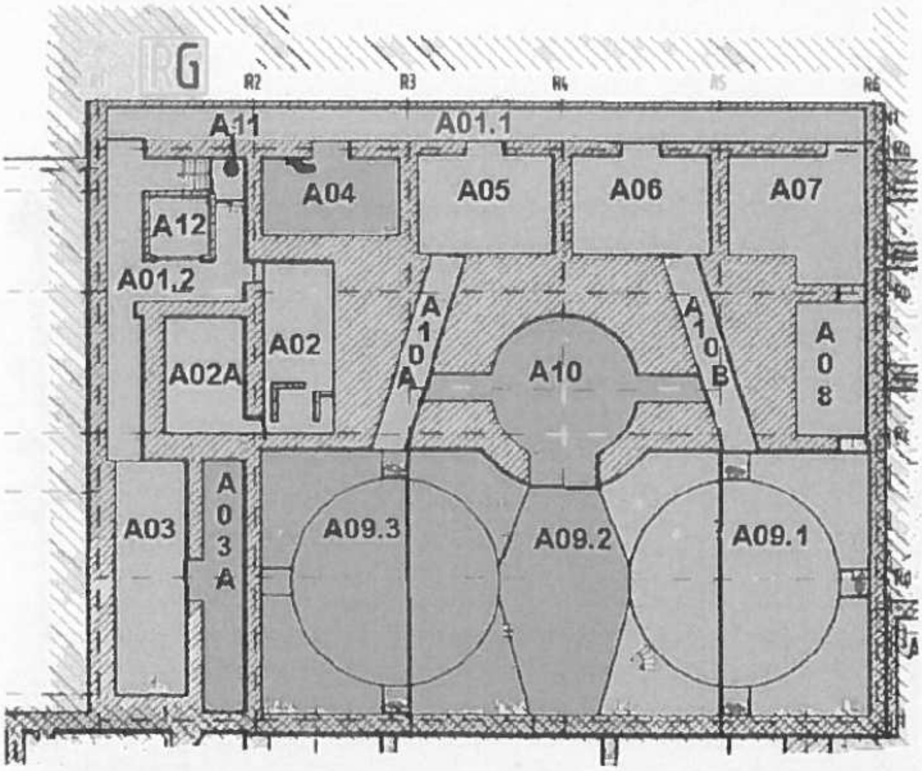
date	status	Components		Rooms	Total activity [Bq]
		activation [Bq]	contamination [Bq]	contamination [Bq]	
30.06.2009	in process	0	2,04E+09	2,49E+09	
	out of process	8,93E+13	3,08E+11		
	total GKN	8,93E+13	3,10E+11	2,49E+09	8,96E+13
30.06.2010	in process	0	1,81E+09	2,18E+09	
	out of process	7,73E+13	2,70E+11		
	total GKN	7,73E+13	2,72E+11	2,18E+09	7,76E+13

Table 10: Total Activity of Components and Rooms

APPENDIX

BLAUW < 10µSv/h
GROEN ≥ 10µSv/h <100µSv/h
GEEL ≥ 100µSv/h <1000µSv/h
ORANJE ≥ 1000µSv/h < 10000µSv/h
ROOD ≥ 10000µSv/h

GRIJS = ANDERE VLOER HOOGTE

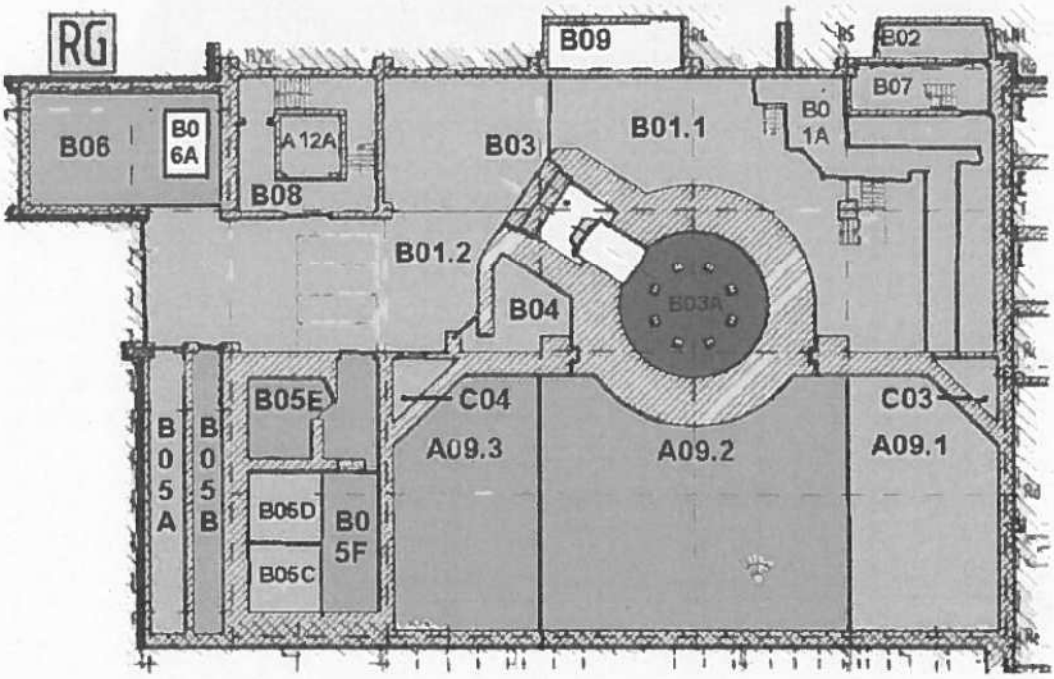


REACTORGEBOUW NIVO 10.00 +m

Appendix 1: Dose Rates in the Reactor Building Level +10m

BLAUW < 10 µSv/h
GROEN ≥ 10 µSv/h < 100 µSv/h
GEEL ≥ 100 µSv/h < 1000 µSv/h
ORANJE ≥ 1000 µSv/h < 10000 µSv/h
ROOD ≥ 10000 µSv/h

GRIJS = ANDERE VLOER HOOGTE

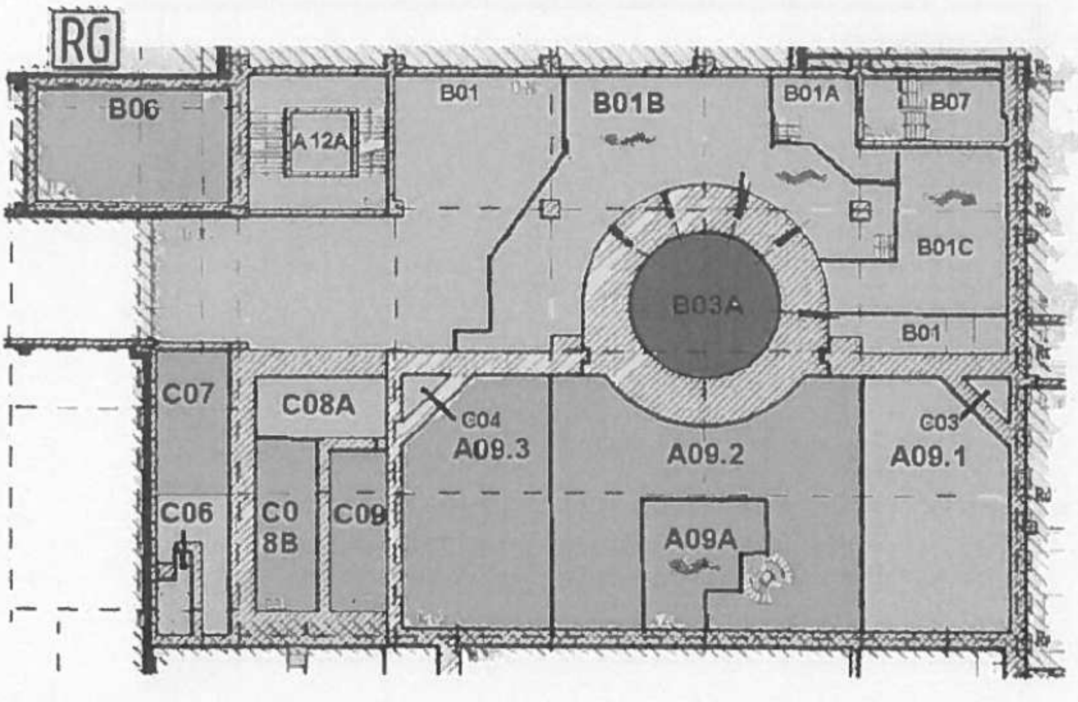


REACTORGEBOUW NIVO 13.20 +m

Appendix 2: Dose Rates in the Reactor Building Level +13,2m

BLAUW < 10 µSv/h
GROEN ≥ 10 µSv/h < 100 µSv/h
GEEL ≥ 100 µSv/h < 1000 µSv/h
ORANJE ≥ 1000 µSv/h < 10000 µSv/h
ROOD ≥ 10000 µSv/h

GRIJS = ANDERE VLOER HOOGTE

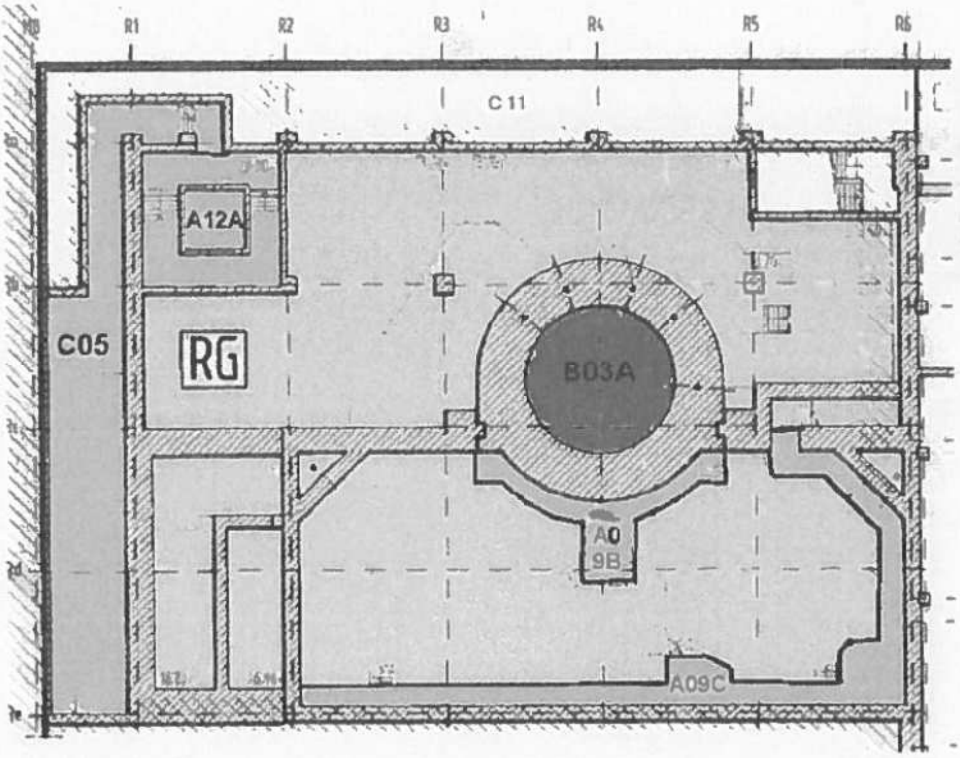


REACTORGEBOUW NIVO 17.20 +m

Appendix 3: Dose Rates in the Reactor Building Level +17,2m

BLAUW < 10 µSv/h
GROEN ≥ 10 µSv/h < 100 µSv/h
GEEL ≥ 100 µSv/h < 1000 µSv/h
ORANJE ≥ 1000 µSv/h < 10000 µSv/h
ROOD ≥ 10000 µSv/h

GRIJS = ANDERE VLOER HOOGTE

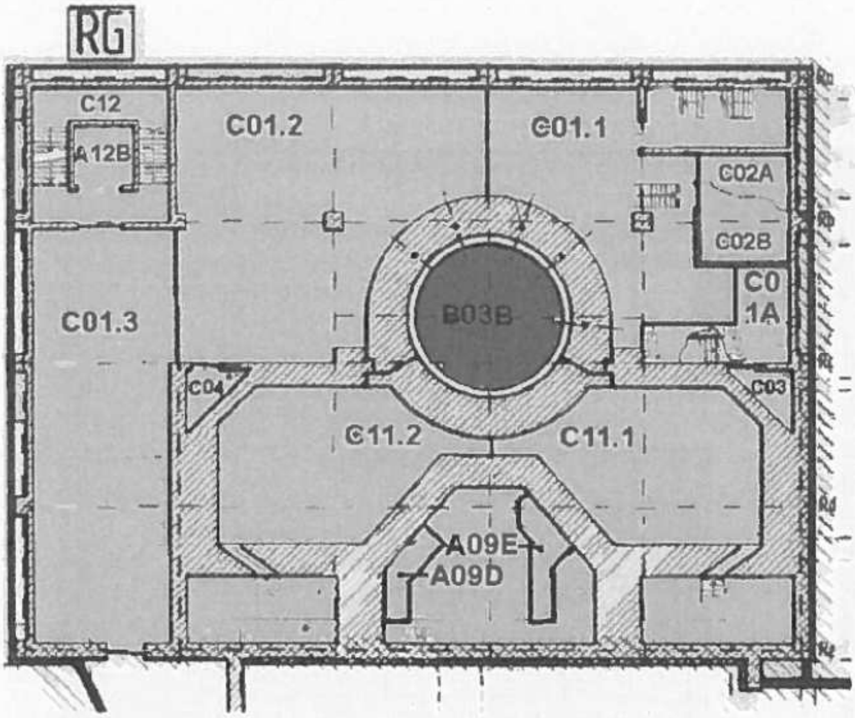


REACTORGEBOUW NIVO 19.20 +m

Appendix 4: Dose Rates in the Reactor Building Level +19,2m

BLAUW < 10 µSv/h
GROEN ≥ 10 µSv/h < 100 µSv/h
GEEL ≥ 100 µSv/h < 1000 µSv/h
ORANJE ≥ 1000 µSv/h < 10000 µSv/h
ROOD ≥ 10000 µSv/h

GRIJS = ANDERE VLOER HOOGTE

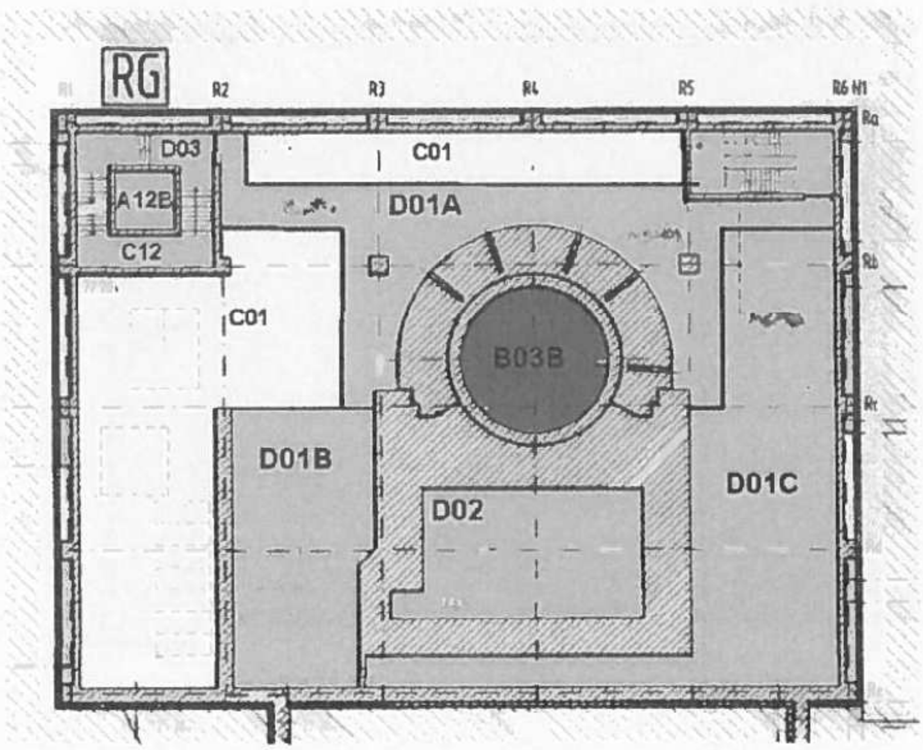


REACTORGEBOUW NIVO 22.20 +m

Appendix 5: Dose Rates in the Reactor Building Level +22,2m

BLAUW < 10 µSv/h
GROEN ≥ 10 µSv/h < 100 µSv/h
GEEL ≥ 100 µSv/h < 1000 µSv/h
ORANJE ≥ 1000 µSv/h < 10000 µSv/h
ROOD ≥ 10000 µSv/h

GRIJS = ANDERE VLOER HOOGTE

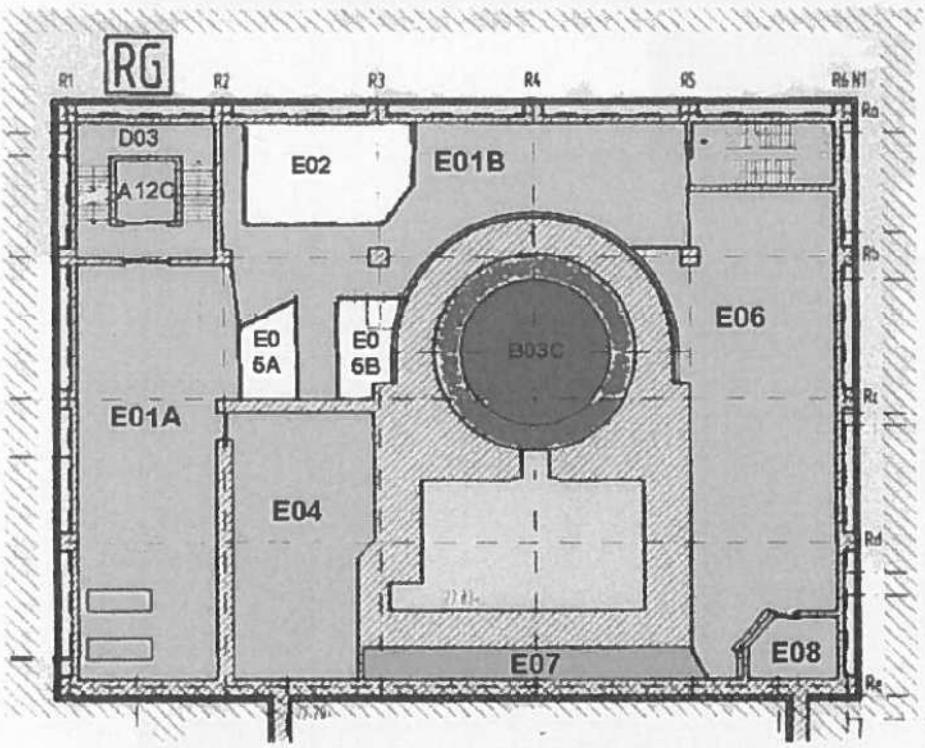


REACTORGEBOUW NIVO 28.20 +m

Appendix 6: Dose Rates in the Reactor Building Level +28,2m

BLAUW < 10 µSv/h
GROEN ≥ 10 µSv/h < 100 µSv/h
GEEL ≥ 100 µSv/h < 1000 µSv/h
ORANJE ≥ 1000 µSv/h < 10000 µSv/h
ROOD ≥ 10000 µSv/h

GRIJS = ANDERE VLOER HOOGTE

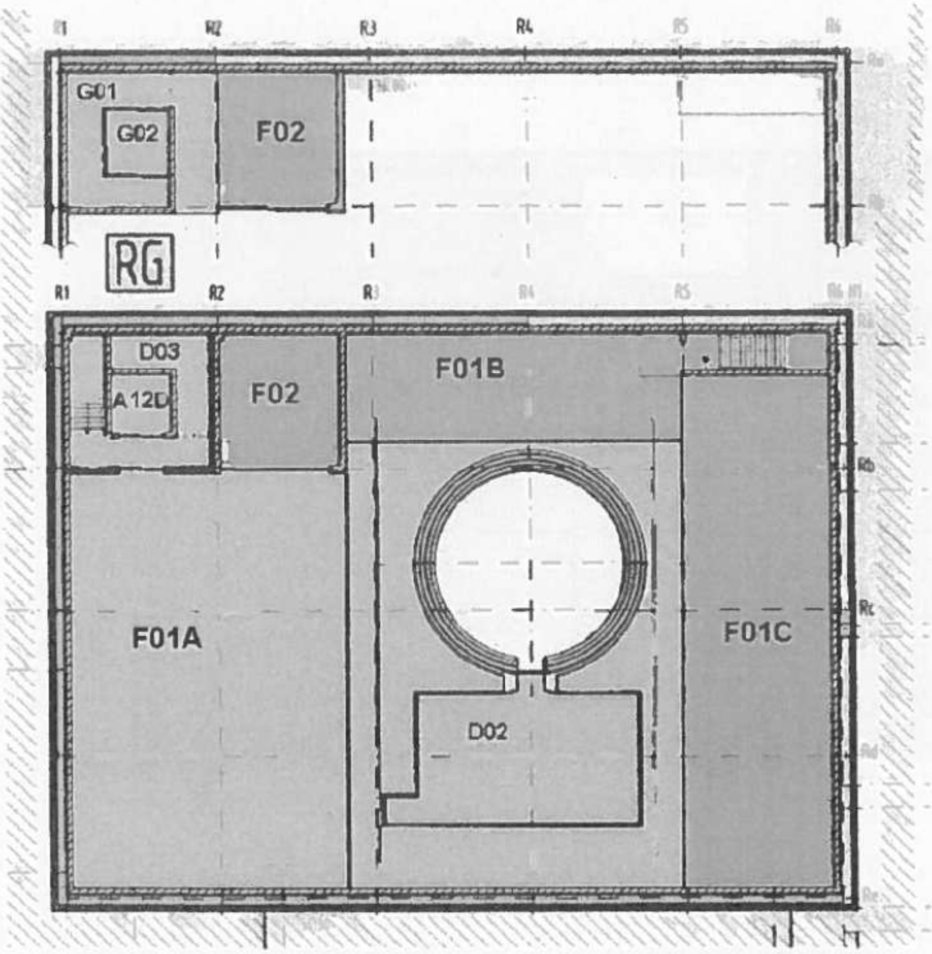


REACTORGEBOUW NIVO 31.20 +m

Appendix 7: Dose Rates in the Reactor Building Level +31,2m

BLAUW < 10 µSv/h
GROEN ≥ 10 µSv/h < 100 µSv/h
GEEL ≥ 100 µSv/h < 1000 µSv/h
ORANJE ≥ 1000 µSv/h < 10000 µSv/h
ROOD ≥ 10000 µSv/h

GRIJS = ANDERE VLOER HOOGTE



REACTORGEBOUW NIVO 36.00 +m

Appendix 8: Dose Rates in the Reactor Building Level +36,0m

GKN	Dodewaard Inventory System Mass per Activity Class	Date : 2010.06.16 Page 1 of 2

Mass Sums per Activity Class

Act. Class	Description	Mass [kg]
A0	< 0.1 Bq/g	1736775
A1	> OF GELIJK AAN 0.1 Bq/g EN < 1 Bq/g	187111
A2	> OF GELIJK AAN 1 Bq/g EN < 100 Bq/g	476364
A3	> OF GELIJK AAN 100 Bq/g EN < 10 kBq/g	276365
A4	> OF GELIJK AAN 10 kBq/g EN 1MBq/g	30110
A5	> OF GELIJK AAN 1 MBq/g	13998
C1	<0,4 Bq/cm2	1519214
C2	> OF GELIJK AAN 0,4 EN <4 Bq/cm2	487612
C3	> OF GELIJK AAN 4 EN <40 Bq/cm2	492999
C4	> OF GELIJK AAN 40 EN <400 Bq/cm2	151974
C5	> OF GELIJK AAN 400 Bq/cm2	97783
NOT DEF	NOT DEFINED	79760
	Total Sum :	5550065

Parameters:

User: PE

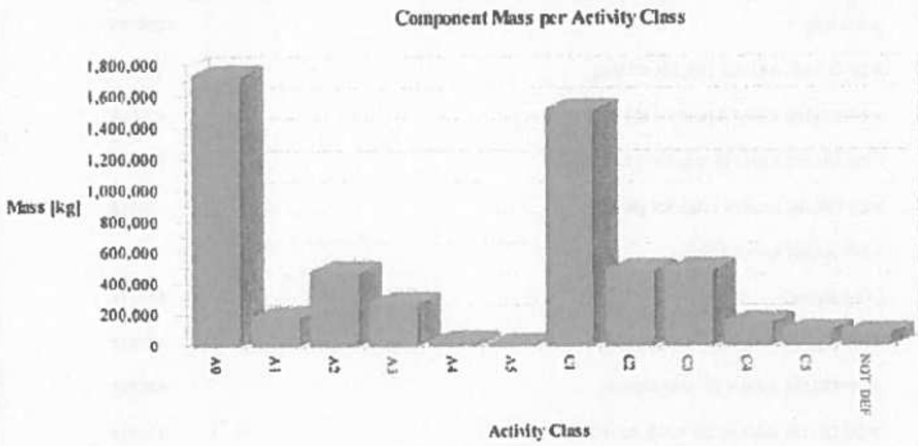
Activity Class	%	Estimation Date	2010.06.30
System	%		
Material	%		
Materialclass	%		
Type	%		
Status	%		

Modul : MPACR Version : 10

GKN	Dodewaard Inventory System Mass per Activity Class	Date : 2010.06.16 Page 2 of 2

Mass Sums per Activity Class

Act. Class	Description	Mass [kg]



Parameters:	Activity Class	%	Estimation Date	2010.06.30
User: PE	System	%		
	Material	%		
	Materialclass	%		
	Type	%		
	Status	'%'		

Modul : MPACR Version : 10

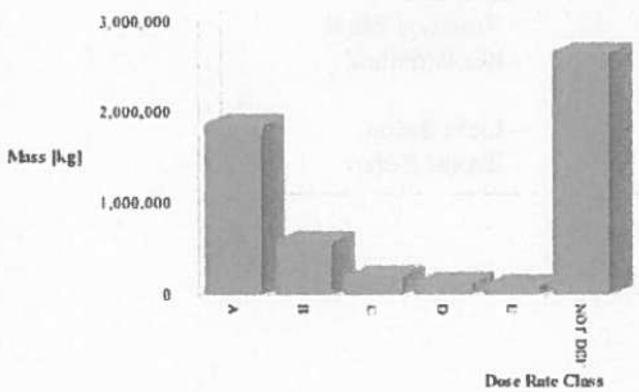
Appendix 9: Mass per Activity Class in the DIS database

GKN	Dodewaard Inventory System Mass per Dose Rate Class	Date : 2010.06.16 Page 1 of 1

Mass Sums per Dose Rate Class

DR Class	Description	Mass [kg]
A	< 10 microSv/h	2304619
B	> OF GELIJK AAN 10 EN < 100 microSv/h	314579
C	> GELIJK AAN 100 EN < 1000 microSv/h	132690
D	> GELIJK AAN 1000 EN < 10000 microSv/h	36247
E	> DAN 10000 microSv/h	83627
NOT DEF	NOT DEFINED	2678303
	Total Sum :	5550065

Component Mass per Dose Rate Class



Parameters:	Dose Rate Class	%
User: PE	Status	'%'

Modul : MPDCR Version : 8

Appendix 10: Mass per Dose Rate Class in the DIS database

11-8-2011

List of abbreviations

DIS	- Dodewaard Inventory System	- Dodewaard Inventaris Systeem
KCD	- Nuclear Power Plant Dodewaard	- Kerncentrale Dodewaard
NPP	- Nuclear Power Plant	- Kerncentrale
WP	- Waiting Period	- Wachttijd
SE	- Safe Enclosure	- Veilige Insluiting
PSE	- Preparation for Safe Enclosure	- Realisatie Veilige Insluiting
CD	- Complete Dismantling	- Algehele Ontmanteling
KeW	-	- Kernenergiewet
COVRA	-	- Centrale Opslagplaats Voor Radioactief Afval
BS	- Biological Shield	- Biologisch Schild
RG	- Reactor Building	- Reactorgebouw
TG	- Turbine Building	- Turbine Gebouw
NG	- Service Building	- Neven Gebouw
VG	- Ventilation Building	- Ventilatie Gebouw
AG	- Waste Building	- Afval Gebouw
SB	- Startup Source	- Startbron
RVS	- Stainless Steel	- Roestvrij Staal
C-Staal	- Carbon Steel	- Koolstofstaal
Bq	- Bequerel	
LB	- Light Concrete	- Licht Beton
ZB	- Heavy Concrete	- Zwaar Beton

Appendix 11: List of abbreviations

20100708 - GKN

Ruimte en Milieu
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

B.V. NEA
[redacted]
6669 ZG Dodewaard

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2010017945

Datum 6 juli 2010
Betreft Afschrift brief aan GKN inzake overleg inzake ontmantelingskosten

Geachte [redacted],

Hierbij stuur ik u een kopie van de brief aan GKN van de secretaris-generaal de [redacted], waarvan de inhoud voor zich spreekt.

Hoogachtend,

[redacted]
Managementteamlid directie Risicobeleid

Ruimte en Milieu
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

GKN
[redacted]
6669 ZG DODEWAARD

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2010017946

Datum 25 JUNI 2010
Betreft Overleg inzake ontmantelingskosten

Geachte [redacted]

NEA/GKN en VROM zijn, op initiatief van NEA/GKN en naar aanleiding van een door NEA opgestelde Strategienota, al sinds geruime tijd 'sans prejudice' in gesprek over de afwikkeling van het dossier ontmanteling kerncentrale Dodewaard. In dit kader is in het afgelopen jaar gewerkt aan het opnieuw vaststellen van de te verwachten kosten van ontmanteling van de centrale. Dat hiermee in een constructieve sfeer aanzienlijke gezamenlijke voortgang is gemaakt, wordt door mij zeer op prijs gesteld.

Ik heb u middels mijn brieven d.d. 1 april (kenmerk RB/2010008230) en 11 juni 2010 (kenmerk RB/2010016237) uitgenodigd in overleg te treden om o.a. de verantwoordelijkheid van de NEA aan de orde te stellen. Tot mijn teleurstelling heb ik echter van u moeten vernemen dat er nog beraad plaatsvindt over mijn brieven, en thans geen datum voor nieuw overleg kan worden vastgesteld. Het overleg in dit dossier loopt immers reeds geruime tijd en niet valt in te zien waarom niet eens een datum zou kunnen worden bepaald voor een bespreking. Daarnaast zou ik u een aantal vragen willen voorleggen omtrent het dividendbeleid van GKN en NEA in de afgelopen jaren.

Ik wil u daarom nogmaals verzoeken akkoord te gaan met het arrangeren van een gesprek voor 9 juli 2010. Het te lang opschorten van overleg zou geen recht doen aan de gemaakte gezamenlijke voortgang en aan het belang van een goede afwikkeling van de zaak. Mocht u hier geen gehoor aan willen geven, dan brengt dit de noodzaak van juridische geschillenbeslechting dichterbij.

Een afschrift van deze brief heb ik gezonden naar de NEA, alsmede naar de commissarissen van de NEA.

Hoogachtend,
de secretaris-generaal
[redacted]

20100816 - VROM

GKN

B.V. Gemeenschappelijke Kernenergiecentrale Nederland

De Secretaris-Generaal van het Ministerie van VROM
10 2 e [redacted]
Rijnstraat 8
2515 XP DEN HAAG

Uw kenmerk	Ons kenmerk	Behandeld door	Doorkiesnummer
RB/2010017946 [redacted]	DR10-022	[redacted]	

Onderwerp	Datum
Overleg inzake ontmantelingskosten KCD	8 juli 2010

Geachte [redacted]

In reactie op de brief van de minister van VROM van 1 april jl. en uw brieven van 6 april jl. en 15 en 25 juni jl. bericht ik u namens NEA en GKN als volgt.

- De door u geuite zorgen over hoe GKN in 2045 aan haar financiële verplichtingen zal kunnen voldoen, kan ik niet plaatsen in het licht van enerzijds de huidige financiële situatie van GKN en anderzijds de recente NIS rapporten.
- COVRA heeft enkel uiteengezet dat zij eind jaren 90 te lage tarieven aan NEA heeft gecommuniceerd, maar niet, zoals u betoogt, een afdoende onderbouwing voor de nieuwe tarieven verstrekt.
- Ik ben het niet met u eens dat het niet opportuun is informatie over de financiële zekerheidstelling door EPZ te verstrekken. Deze informatie valt onder de Wet openbaarheid van bestuur. Het gelijkheidsbeginsel vereist dat EPZ en GKN gelijk worden behandeld, en daarvan lijkt geen sprake.
- De juridische positie van VROM dat NEA aansprakelijk is voor schulden van GKN heeft u inderdaad nogmaals bevestigd, maar na 10 jaar nog steeds niet juridisch onderbouwd.
- Het dividendbeleid van GKN volgt uit de jaarverslagen van GKN die jaarlijks aan VROM worden verstrekt. Er is meer dan 20 jaar geen dividend uitgekeerd. Het dividendbeleid van NEA doet niet ter zake en volgt bovendien uit de jaarverslagen van NEA die jaarlijks bij de Kamer van Koophandel worden neergelegd.

NEA en VROM zijn sinds 2001 met elkaar in gesprek over de overdracht van de aandelen in GKN aan COVRA. Breekpunt in de discussie is sinds jaar en dag dat het Ministerie van VROM – anders dan NEA en het Ministerie van Economische Zaken – meent dat NEA aansprakelijk is voor een eventueel tekort in GKN. Zoals meermalen toegelicht, is NEA daarvoor niet aansprakelijk, noch op grond van de OEPS, noch op grond van de Kernenergiewet, noch op grond van het commune civiele recht (zie onder meer de brief van [redacted] aan de minister van VROM van 23 juli 2009). VROM houdt niettemin vast aan zijn standpunt, maar weigert tot op de dag van vandaag een (juridische) onderbouwing daarvan te verstrekken ondanks herhaalde verzoeken van NEA èn herhaalde beloftes van VROM daartoe.

Waalbandijk 112a
6669 MG Dodewaard
Postbus 40
NL-6669 ZG Dodewaard
Telefoon (0488) 41 88 11
Telefax (0488) 41 21 28

ABN AMRO
Rek.nr. 534423566
Handelsregister Rivierenland
Nr. 09031421
BTW nr. NL 009749494B05

Daarnaast is VROM – ondanks het feit dat de Staat voor een eventueel tekort in GKN zal opdraaien en er daarom belang bij heeft dat tekort zo veel mogelijk te verkleinen – niet bereid mee te werken aan de voorkoming of verkleining van een tekort. Integendeel, VROM zorgt er juist voor dat de uiteindelijke omvang van de amoveringsvoorziening van GKN mogelijk niet voldoende zal zijn om de amoveringskosten te dekken door (i) GKN een beleggingsbeleid op te leggen waarmee zij een laag en onvoldoende rendement kan behalen en (ii) toe te staan dat COVRA ongefundeerd de kosten van eindberging thans vele malen hoger begroot dan in 1995.

In het licht van het voorgaande achten NEA en GKN het thans niet zinvol verdere gesprekken met VROM aan te gaan. Dit zou alleen anders zijn, indien VROM alsnog – zoals het Ministerie van Economische Zaken al heeft gedaan – zou erkennen dat NEA niet aansprakelijk is voor een eventueel tekort in GKN. Met u ben ik van mening dat het uitblijven van verdere gesprekken de noodzaak van juridische geschillenbeslechting dichterbij brengt. Ik acht het daarom geïndiceerd dat de advocaten van partijen de zaak met elkaar bespreken. Ik zal [redacted] 10 2 e verzoeken hiertoe begin augustus contact op te nemen met de landsadvocaat.

Hoogachtend,

[redacted]

Bestuurder GKN

Kopie: Raad van Commissarissen en directie van NEA
[redacted]

20100907 - GKN

Ruimte en Milieu
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

GKN
[redacted]
6669 ZG Dodewaard

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2010020957

Uw kenmerk
DR 10-016

Datum 16 AUG. 2010
Betreft Ontvangst en acceptatie NIS studie ontmantelingkosten

Geachte [redacted],

Verwijzend naar uw brief met bovengenoemd kenmerk, waarin u mij de eindrapporten van NIS Ingenieurgesellschaft mbH doet toekomen, en mij verzoekt de ontvangst ervan te bevestigen en akkoord te gaan met de door NIS uitgevoerde berekeningen bericht ik u, mede namens de directeur van de Kernfysische dienst, als volgt:

Ik heb de rapporten in goede orde ontvangen. De rapporten van NIS zijn opgesteld met inachtneming van de in de - door VROM geaccordeerde - Technical Requisition File (TRF) beschreven uitgangspunten. De door NIS uitgevoerde berekeningen zijn gebaseerd op deze uitgangspunten, en geven naar huidig inzicht een goede raming van de kosten van ontmanteling van de centrale te Dodewaard.

Hoogachtend,
[redacted]

20101013 - VROM

GKN

B.V. Gemeenschappelijke Kernenergiecentrale Nederland

De Secretaris-Generaal van het Ministerie van VROM
10 2 e [redacted]
Rijnstraat 8
2515 XP DEN HAAG

Uw kenmerk	Ons kenmerk	Behandeld door	Doorkiesnummer
RB/2010023539 [redacted]	DR10-030	[redacted]	[redacted]

Onderwerp	Datum
Overleg inzake ontmantelingskosten KCD	7 september 2010

Geachte [redacted],

Ik heb uw brief van 31 augustus jl., die antwoordt op mijn brief van alweer 8 juli jl., in goede orde ontvangen.

Helaas behelst uw brief geen antwoord op het kernpunt van mijn brief van 8 juli jl.

Bij uw brief van 6 april jl. hebt u mij geschreven dat u het wenselijk en "noodzakelijk" acht dat NEA aansprakelijkheid voor eventuele tekorten in GKN "erkent". Bij diezelfde brief liet u ondanks na jaren en talloze malen aandringen zijdens NEA en herhaalde toezeggingen zijdens VROM, opnieuw na om zelfs maar een summiere juridische onderbouwing te geven voor het standpunt dat NEA daarvoor aansprakelijk zou zijn. U schreef slechts dat u meent dat NEA aansprakelijk zou zijn omdat "de vervuiler betaalt" (hetgeen uw conclusie herhaalt en geen juridische onderbouwing daarvoor vormt) en omdat de aansprakelijkheid in de OEPS niet zou zijn "afgekocht" (hetgeen - als het al juist zou zijn - niet adresseert dat die aansprakelijkheid er wel zou zijn).
In de brieven die op uw brief van 6 april jl. zijn gevolgd, hult u zich verder in stilzwijgen over de onderbouwing, of verwijst u ongespecificeerd naar "eerdere brieven". Er is echter in geen van uw brieven een juridische onderbouwing van uw standpunt te vinden. Reeds tijdens de besprekingen over de Strategienota in 2007 hebt u immers ondanks herhaald verzoek nagelaten uw standpunt te onderbouwen.

Bij uw brieven van 11 en 25 juni jl. hebt u er sterk op aangedrongen dat spoedig overleg zou worden gevoerd over "de verantwoordelijkheid van NEA" en herhaald dat u wenst dat NEA aansprakelijkheid "erkent". De brief van 25 juni jl. behelst zelfs dat spoedige voortgang wenselijk is en dat bij gebreke van een overleg voor 9 juli juridische geschillenbeslechting naderbij zou komen.
Ik heb u op 8 juli jl. bij brief bericht dat NEA niet aansprakelijk is, en deze aansprakelijkheid dus niet zal erkennen. Ik heb vervolgens aangegeven verdere gesprekken niet zinvol te achten, en het met u eens te zijn dat juridische geschillenbeslechting nabij is. Tot slot heb ik aangegeven dat daarom overleg tussen de landsadvocaat en de advocaten van GKN en NEA zou moeten plaatsvinden.

De advocaten van NEA en GKN hebben inderdaad contact gezocht, eerst informeel en daarna formeel per brief van 19 juli jl., maar de landsadvocaat reageert ondanks herhaalde herinnering niet.

Uw brief van 31 augustus jl. is voor mij uiterst lastig te plaatsen in het licht van het vorenstaande. Ten eerste veronderstelde ik gezien uw dringende brieven van 11 en 25 juni jl. dat u haast had in deze, hetgeen moeilijk te verenigen valt met het gebrek aan enige reactie van de lansadvocaat en de termijn die u hebt genomen voor uw brief. Ten tweede schrijft u dat NEA plots voorwaarden zou stellen aan een nader overleg. Dat is niet juist. Ik heb u geschreven nader overleg niet zinvol te achten, in het licht van uw standpunt - zoals geuit in diverse brieven - dat NEA aansprakelijk is en die aansprakelijkheid dient te erkennen. Over dat standpunt kan niet zinvol nader overlegd worden, omdat het nog steeds in het geheel niet juridisch is onderbouwd. Bij gebreke van enige onderbouwing, voelt NEA zich gesterkt in haar wél herhaaldelijk en tot in detail onderbouwde standpunt dat zij niet aansprakelijk is. Het belang van een gebrek aan onderbouwing heb ik u in mijn brief van 8 juli jl. nog eens duidelijk kenbaar gemaakt. U gaat daaraan helaas opnieuw voorbij.

Uw brief behelst tot slot geen nadere mededeling over uw constatering in uw brief van 25 juni jl. dat geschillenbeslechting naderbij is gekomen, noch een reactie op mijn aankondiging dat onze advocaten en de landsadvocaat zouden moeten overleggen. Dat overleg komt echter gezien het stilzwijgen van de landsadvocaat niet tot stand, zodat ik moet constateren dat u geschillenbeslechting blijkbaar tóch niet nabij acht. Voor NEA blijft dan ook de vraag welke weg voorwaarts u wel voor ogen ziet.

Per saldo is thans bijna een jaar verstreken sinds de minister aan NEA schreef dat zij onderzoek zou (laten) doen naar de civielrechtelijke aansprakelijkheid van NEA voor eventuele tekorten in GKN. Gezien de aanhoudende weigering zijdens VROM om enige argumentatie voor de gecontinueerde bewering van aansprakelijkheid te geven, kan NEA niet anders dan concluderen dat ook VROM uit dit onderzoek is gebleken dat NEA niet aansprakelijk is en dat er zelfs geen argumenten voor die aansprakelijkheid te bedenken zijn. Het Ministerie van Economische Zaken is al jaren geleden tot die conclusie gekomen. Het komt mij als strijdig met de algemene beginselen van behoorlijk bestuur voor, dat de Staat daarmee tegen beter weten in NEA onder druk blijft zetten om aansprakelijkheid te erkennen. NEA beschouwt het voorts als ernstig en buitengewoon ongelukkig dat VROM en COVRA zich niet inspannen om het ontstaan van eventuele tekorten in GKN te voorkomen, maar schijnbaar op die punten bewust tegenwerken. Ook dit heb ik u in mijn brief van 8 juli jl. reeds geschreven.

NEA beraadt zich op volgende stappen.

Hoogachtend

10 2 e [redacted]

Bestuurder GKN

Kopie: Raad van Commissarissen en directie van NEA
De Brauw Blackstone Westbroek, 10 2 e [redacted]

20110810 - GKN

Ruimte en Milieu
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer

> Retouradres Postbus 30945 2500 GX Den Haag

B.V. GKN
10 2 e [redacted]
6669 ZG Dodewaard

Portefeuille Milieu
Directie Risicobeleid

Rijnstraat 8
Postbus 30945
2500 GX Den Haag
Interne postcode 645
www.vrom.nl

Contactpersoon
[redacted]

Kenmerk
RB/2010027622

Uw kenmerk
DR10-030

Datum 13 OKT. 2010
Betreft Overleg inzake ontmantelingskosten

Geachte [redacted],

Ik heb uw brief d.d. 7 september in goede orde ontvangen, en heb van de inhoud kennis genomen. Voor het vervolg refereer ik naar het inmiddels geplande gesprek tussen de advocaten.

Hoogachtend,
de secretaris-generaal,
10 2 e [redacted]

20110913 - EL&I

GKN

B.V. Gemeenschappelijke Kernenergiecentrale Nederland

Ministerie van Economische Zaken, Landbouw en
Innovatie,
[redacted]
Plv. directeur-generaal Energie, Telecom en
Mededinging,
Postbus 20101,
2500 EC Den Haag.

Uw kenmerk	Ons kenmerk	Behandeld door	Doorkiesnummer
ETM/ED 11113089	2011-VI-W017	10 2 e [redacted]	[redacted]

Onderwerp	Datum
Ontmantelingsplan GKN	10 augustus 2011

Geachte [redacted],

Op 24 juni 2010 hebben wij een brief met kenmerk DR 10-016 aan het ministerie van VROM gezonden waarin de resultaten van de studie "New Decommissioning Cost Estimate" van de "Evaluation of Decommissioning of the Dodewaard NPP" waren opgenomen. Deze evaluatie bestond uit vier rapporten, waarvan de rapporten met kenmerk Task 1 en Task 2 tevens gelezen dienen te worden als ontmantelingsplan voor GKN.

Naar onze mening is in deze studie voor dit moment op voldoende detailniveau weergegeven hoe de ontmanteling van onze kernenergiecentrale zal verlopen. Uiteraard zal een verdere verdieping van de diverse onderwerpen plaats vinden wanneer het tijdstip van de (eind-) Ontmanteling nadert, dan wel op het moment dat deze studies worden aangepast aan de actuele situatie.

Recentelijk is nieuwe regelgeving van kracht geworden die ziet op de inhoud van een ontmantelingsplan. Naar aanleiding daarvan sturen wij u hierbij een notitie met aanvullende informatie. Wij verzoeken u het rapport met kenmerk Task 2, in samenhang met deze notitie, goed te keuren als ontmantelingsplan als bedoeld in de Kernenergiewet, en ons dit schriftelijk te bevestigen.

Voor de goede orde merken wij op dat de uitgangspunten van de studies tot stand zijn gekomen in nauw overleg met de directeur COVRA, [redacted], en VROM-medewerkers, de heren [redacted]
Juist om discussies na gereedkomen van de studie te voorkomen is als basis voor de studie een Technical Requisition File (TRF) opgesteld. In dit TRF zijn alle onderwerpen beschreven waarover in het verleden discussie tussen partijen was ontstaan. Voor elke parameter die van invloed op het eindresultaat van de studie kon zijn is na overleg tussen partijen een waarde of bandbreedte vastgesteld in het TRF.
Het TRF is door de toenmalige secretaris-generaal van VROM, [redacted], na overleg met de directeur COVRA, vastgesteld. Dit is vastgelegd in een brief van de directeur Risicobeleid, [redacted], met kenmerk RB 2009004167,

Waalbandijk 112a
6669 MG Dodewaard
Postbus 40
NL-6669 ZG Dodewaard
Telefoon (0488) 41 88 11
Telefax (0488) 41 21 28

ABN AMRO
Rek.nr. 534423566
Handelsregister Rivierenland
Nr. 09031421
BTW nr. NL 009749494B05

Op 16 augustus 2010 ontvingen wij een brief met kenmerk RB/2010020957 van [redacted], waarin hij stelt dat de studie is uitgevoerd op basis van de door VROM geaccordeerde uitgangspunten, en naar huidig inzicht een goede raming geven van de ontmantelingkosten.

Volgens de huidige regelgeving dient een ontmantelingsplan ook een overzicht van de in de inrichting aanwezige radioactieve stoffen te bevatten, en een asbest inventarisatierapport. Beide rapporten zijn in het bezit van GKN, en vormden één van de invoerparameters van de studie naar de ontmantelingkosten. Het overzicht van de aanwezige radioactieve stoffen wordt jaarlijks geactualiseerd. Dit maakt deel uit van het Dodewaard Inventarisatie Systeem (DIS). Het overzicht wordt jaarlijks aan de directeur KFD gezonden. Het asbest inventarisatierapport is in te zien bij GKN, en die plaatsen in de installatie waar asbest voorkomt zijn vermeld in het DIS.

Hoogachtend,

BV Gemeenschappelijke
[redacted]

Site manager GKN

Aanvullende informatie betreffende Ontmantelingplan GKN.

1.StralingsControleDienst (SCD)

Tijdens de ontmanteling van de kernenergiecentrale zal een StralingsControleDienst aanwezig zijn. Deze SCD houdt toezicht op alle radiologische werkzaamheden en let tevens op conventionele veiligheidsaspecten bij het uitvoeren van werkzaamheden..
De dienst zal bestaan uit voldoende medewerkers van voldoende gekwalificeerd nivo. Omdat er veel uitvoerend werk plaats vindt zal veel toezicht op de werkplek aanwezig zijn. De hiervoor benodigde stralingstechnici hebben een deskundigheid nivo 4 of 5.
De leiding van de SCD zal een deskundigheid nivo 3 hebben.
Daarnaast zal een "onafhankelijke stralingsdeskundige" benoemd worden.
De SCD zal de beschikking hebben over voldoende meetmiddelen, geschikt voor het uitvoeren van haar taken. Daarnaast zal zij de beschikking hebben over een meetplaats waar besmettingsmetingen kunnen worden uitgevoerd.
Voor de zogenaamde "vrijgave metingen" van materialen zal een aparte ruimte worden ingericht met daarin apparatuur welke speciaal voor deze metingen zal worden aangehouden.
De SCD bewaakt de radiologische dosis van de medewerkers en zal hiervoor dosisregistratie apparatuur onder beheer hebben.
Voor het uitvoeren van haar taken heeft de SCD de beschikking over werkinstructies.

2. Voorzieningen om radiologische kennis en informatie over de inrichting te behouden.

GKN heeft haar oude archieven onder gebracht bij het Gelders Archief. Het splijtstof archief is gedigitaliseerd. De procedures en werkinstructies van de bediening van installatie tijdens de fase Vermogensbedrijf en de fase Veilige Insluiting zijn digitaal beschikbaar op een server met interne- en externe back-up mogelijkheden.
De radiologische inventaris van de installatie is vastgelegd in het Dodewaard Information System (DIS). Dit DIS wordt beheerd door een externe firma. Het DIS wordt gehouden op een externe server met back-up mogelijkheid. In het DIS is ook relevante informatie opgenomen over locaties waar zich asbest in de installatie bevindt. Jaarlijks wordt een rapport gemaakt van de actuele situatie van de radioactieve inventaris. Dit rapport wordt aangeboden aan de dKFD. Een exemplaar van het rapport 2010 is bij deze notitie gevoegd.
Van de methode van dataopslag van GKN is een overzicht opgenomen als "good practice" in IAEA-publicatie "*Long Term Preservation of Information for Decommissioning Projects*" (Technical Report Series, nr 467, august 2008).

3. Maatregelen om de veiligheid van de omgeving van de inrichting te waarborgen.

GKN beschikt thans over een Brandweeraanvalsplan voor de fase Veilige Insluiting, waarin opgenomen alle relevante informatie voor de locale brandweer. Dit plan is goedgekeurd door de locale brandweer en de dKFD. Ook oefent GKN regelmatig met de locale brandweer. Voor aanvang van de ontmanteling zal dit plan geheel worden herzien en aangepast op de dan ontstane situatie. Dit plan zal weer worden voorgelegd voor goedkeuring aan de locale brandweer en de dKFD.
GKN beschikt over een Rampenbestrijdingsplan dat is opgesteld in samenwerking met de locale brandweer, de politie, het GHOR en de Gemeente Neder-Betuwe. Dit plan zal voor aanvang van de ontmanteling worden aangepast op de actuele situatie.

Opgesteld door [redacted] Site manager GKN
10 aug. 2011

20130719-1 - GKN

Ministerie van Economische Zaken, Landbouw en Innovatie

> Retouradres Postbus 20101 2500 EC Den Haag

B.V. Gemeenschappelijke Kernenergiecentrale Nederland
[redacted]
Postbus 40
6669 ZG DODEWAARD

Directoraat-generaal voor Energie, Telecom en Markten
Directie Energie en Duurzaamheid

Bezuidenhoutseweg 30
Postbus 20101
2500 EC Den Haag

T 070 379 8911 (algemeen)
www.rijksoverheid.nl/eleni

Ons kenmerk
ETM/ED / 11117735

Uw kenmerk
2011-VI-W017

Datum 13 SEP 2011

Betreft Goedkeuring ontmantelingsplan kerncentrale Dodewaard

Besluit:

1. Uw aanvraag
Op 11 augustus 2011, kenmerk 2011-VI-W017, is uw aanvraag ontvangen om goedkeuring voor het ontmantelingsplan van de kerncentrale Dodewaard, te Dodewaard. Bij de aanvraag is het rapport "GKN-Evaluation of Decommissioning of the Dodewaard NPP/New Decommissioning Cost Estimate" van Siempelkamp NIS Ingenieurgesellschaft mbH, van 16 april 2010 gevoegd, alsmede een notitie met aanvullende informatie.

2. Beoordeling
2.1 Beoordelingskader
Uw ontmantelingsplan moet voldoen aan de eisen die daaraan in de artikelen 26, eerste en tweede lid, van het Besluit kerninstallaties, splijtstoffen en ertsen (hierna: Bkse) en 3, eerste en tweede lid, van de Regeling buitengebruikstelling en ontmanteling nucleaire inrichtingen (hierna: Rboni) worden gesteld. Wanneer dat niet het geval is, wordt de goedkeuring van ontmantelingsplan geweigerd (art. 27, tweede lid, Bkse). Overigens geldt op grond van artikel VI van het Besluit van 12 februari 2011 tot wijziging van het Besluit detectie radioactief besmet schroot, het Besluit kerninstallaties, splijtstoffen en ertsen, het Besluit stralingsbescherming, het Besluit vervoer splijtstoffen, ertsen en radioactieve stoffen en het Vrijstellingsbesluit defensie Kernenergiewet in verband met de wet van 19 november 2009 tot wijziging van de Kernenergiewet in verband met vereenvoudiging van het bevoegd gezag, invoering van een verplichting tot financiële zekerheidstelling en enkele andere wijzigingen (Stb. 2010, 18) het vereiste van een directe buitengebruikstelling en ontmanteling (art. 30, eerste lid, Bkse) *niet* voor de kerncentrale Dodewaard.

2.2 Inhoud van het ontmantelingsplan
Uw ontmantelingsplan bevat op dit moment voldoende gedetailleerd de voorgeschreven informatie (artt. 26, eerste lid, Bkse en 3, eerste lid, Rboni).

2.3 Ontmantelingsstrategie
Uw ontmantelingsplan voorziet erin dat:

Directoraat-generaal voor Energie, Telecom en Markten
Directie Energie en Duurzaamheid

Ons kenmerk
ETM/ED / 11117735

1. in 2045 met de buitengebruikstelling en ontmanteling van de kerncentrale Dodewaard wordt begonnen en deze in 2054 wordt voltooid (art. 30, derde lid, Bkse),
2. er aan het einde van de buitengebruikstelling en ontmanteling van de kerncentrale Dodewaard een "groene weide-situatie" is gerealiseerd (art. 30a, eerste lid, Bkse).

3. Conclusie
Bij gebreke van een grond tot weigering verleen ik bij deze goedkeuring aan uw ontmantelingsplan voor de kerncentrale Dodewaard, zoals dit in uw aanvraag is omschreven.

Tot slot maak ik u er attent op dat ieder ontmantelingsplan ten minste elke vijf jaar moet worden geactualiseerd (art. 29, eerste lid, Bkse) en dat wijzigingen van het ontmantelingsplan mijn voorafgaande goedkeuring behoeven (art. 27, eerste lid, Bkse).

[redacted]

Minister van Economische Zaken, Landbouw en Innovatie

Tegen dit besluit kan degene wiens belang rechtstreeks bij dit besluit is betrokken binnen 6 weken na de dag van verzending een gemotiveerd bezwaarschrift indienen bij de Minister van Economische Zaken, Landbouw en Innovatie, directie Wetgeving en Juridische Zaken, ALP X/50, Postbus 20101, 2500 EC Den Haag. Dit besluit is verzonden op de in de aanhef van deze brief vermelde datum.

20130719-2 - GKN

N.V. Gemeenschappelijke Kernenergiecentrale Nederland

Centrale Dodewaard:
Waalbandijk 112a
6669 MG Dodewaard
Postbus 40
6669 ZG Dodewaard
Telefoon (0488) 41 88 11
Telefax (0488) 41 21 28

Ministerie van Economische Zaken
Directoraat-generaal Energie, Telecom en Mededinging
10 2 e [redacted]
Plv. directeur Energie & Duurzaamheid
Postbus 20401
2500 EK DEN HAAG

Uw kenmerk	Ons kenmerk	Behandeld door	Doorkiesnummer
DGETM-ED/ 14021774	DR 14-004	[redacted]	

Onderwerp	Datum
Kostenreductie Ontmantelingsplan 2011 KCD als gevolg van innovatie en overige ontwikkelingen	20 februari 2014

Geachte [redacted]

Hiermede refereer ik aan uw brief gedateerd 7 februari 2014 alsmede ons overleg op 6 februari 2014. Zoals afgesproken zal ik uw brief met als onderwerp "Brief met vragen over aanvraag goedkeuring financiële zekerheidstelling kosten ontmanteling KCD" uiterlijk 24 maart 2014 beantwoorden.

Tijdens ons overleg op 6 februari 2014 is afgesproken vraag 1. van de aanvullende vragen met als aanhef "Verwachting inzake innovatie en prijsontwikkeling" reeds nu in concept te beantwoorden voor wat betreft de kostenreductie van het "Ontmantelingsplan 2011 KCD". Daartoe heeft GKN bijgaande concept-notitie "Kostenreductie Ontmantelingskosten Ontmantelingsplan 2011 KCD" als gevolg van innovatie en overige ontwikkelingen" opgesteld. Deze notitie zal gebruikt worden bij de volledige beantwoording van de genoemde vraag 1.

GKN heeft bewust gekozen voor een concept-notitie zodat deze na de interne beoordeling uwerzijds geschikt geacht wordt om gebruikt te worden bij de volledige beantwoording van alle aanvullen vragen zoals gesteld in uw brief van 7 februari 2014.

GKN is uiteraard bereid toelichting te geven mocht u daarom verzoeken .

Hoogachtend,
B.V. Nederlands Elektriciteit Administratiekantoor,
directie B.V. Gemeenschappelijke Kernenergiecentrale Nederland
vertegenwoordigd door haar directeur
[redacted]

Bijlagen:

20130719-3 - GKN

10 2 e [redacted]

Van: [redacted]
Verzonden: dinsdag 4 februari 2014 15:19
Aan: [redacted]
Onderwerp: FW: Verwijdering van het reactorvat in Dodewaard
Bijlagen: 2013 July - Nuclear Engineering Int'l - Greifswald, two ways - Decommissioning.pdf; 2013 - NEI - Greifswald, two ways - Decommissioning zwartwit scan.pdf

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Van: [redacted]
Verzonden: vrijdag 19 juli 2013 8:23
Aan: [redacted]
Onderwerp: Fw: Verwijdering van het reactorvat in Dodewaard

Op verzoek van gkn stuur ik onderstaande mail door

Gr
[redacted]

Van: [redacted]
Verzonden: Friday, July 19, 2013 08:00 AM W. Europe Standard Time
Aan: [redacted]
Onderwerp: Verwijdering van het reactorvat in Dodewaard

Beste [redacted],

Hoewel ik ervan uitga dat jullie de vakliteratuur goed bijhouden, stuur ik je wat informatie over het verwijderen van de reactorvaten in Rheinsberg en Greifswald, zoals dat recent is gepubliceerd in Nuclear Engineering International. Zoals je weet is de centrale Rheinsberg qua lay/out (relatief veel kleine ruimtes) en vermogen goed vergelijkbaar met de centrale in Dodewaard.

Het document behandelt de verandering van de verwijderingsmethode van de vaten. In eerste instantie was men voornemens de vaten in stukken te zagen, deels met "natte" methode, deels met "droge" methode. Hier is men van terug gekomen. Het waarom is beschreven in het document.

Let wel, er was in eerste instantie alleen vergunning voor het verwijderen van het vat in stukken. De Duitse vergunningverlener (!) is overtuigd geraakt van de voordelen van het verwijderen van het vat in één stuk. Uit het kostenvergelijk blijkt dat het ongeveer de helft goedkoper is dan verwijdering in stukken, en veel minder dosis voor de uitvoerders kost.
Natuurlijk is de methode niet 1 op 1 over te nemen voor Dodewaard. In Greifswald heeft men de internals uit het vat gehaald. Voor GKN zouden deze kunnen blijven zitten (voldoende ra verval na 40 jaar), mits het vat wordt gevuld met licht beton als afscherming, zoals in Jülich met de AVR is gedaan.

Een snelle berekening voor GKN met gebruikmaking van de NIS2009 studie levert het volgende:
Kosten uitvoer verwijderen internals : 10 1 c [redacted]
Kosten uitvoer verwijderen vat in stukken [redacted]
Kosten Mozaïk containers: [redacted]
De begrote uitvoeringskosten zijn [redacted]. Als daar een [redacted]% besparing te halen valt levert dat al [redacted]

Daarnaast zijn er kosten engineering, mankracht vullen Mozaïk, transport en opslag, maar die niet in detail uit de studie te halen. Maar deze kosten zijn aanzienlijk. Opslagkosten en transportkosten blijven natuurlijk aanwezig. Maar er gaan maar twee Mozaïk containers op een vrachtauto. Dat levert dus flink wat transporten.

Het zal duidelijk zijn dat er nog flink wat discussie te voeren is over de verwerking van het vat in Dodewaard evenals over de verwerking van een paar andere grote componenten zoals de koelers van reactorwaterzuiveringssysteem en reactor- en bassinafkoelsysteem.
Ik hoop dat de overheid bereid is om deze discussie te voeren. Stug vasthouden aan het standpunt "deze verwerkingsmethode past niet in het NL beleid", toont niet veel flexibiliteit of een open mind voor innovatie.

GKN is in ieder geval voornemens om bij de volgende update van de NIS studie weer te beginnen met het vaststellen van een TRF.
Daarin zullen wij als alternatieve verwerkingsroute het verwijderen van het vat als één stuk op laten nemen.

GKN heeft het al eerder aangeboden, maar het is wellicht een goed idee om eens te gaan kijken in Rheinsberg (al hoewel die al behoorlijk ver afgebroken is), of in Greifswald en daar eens verder te praten over de verwijdering van vaten en grote componenten in één stuk. Het kost wel wat tijd. Eén dag heen, één dag daar, en één dag terug. Wij hebben er contacten, en ik wil wel rijden. Het is net geen 700 km naar Greifswald, dus in 6 uurtjes ben je er al. Kort na de sluiting van Dodewaard heeft een aantal ambtenaren onder leiding van [redacted] met GKN een bezoek gebracht aan de oude centrale in Lingen, die toen nog volledig in Veilige Insluiting stond. Dat was voor de ambtenaren erg verhelderend en leerzaam.

GKN stelt het op prijs als je deze e-mail en bijlages ter informatie zou willen verspreiden onder je collega's bij de Ministeries van EZ en FIN.

Vriendelijke groet / Best regards,

BV Gemeenschappelijke Kernenergiecentrale Nederland (GKN)
(Joint Nuclear Power Plant of the Netherlands / Dodewaard NPP)

[redacted]

Mail: P.O. Box 40, 6669 ZG Dodewaard, The Netherlands.
Plant: Waalbandijk 112a, 6669 MG Dodewaard, The Netherlands. Phone plant: +31488418811.
Office: Wanraay 4, 6673 DN, Andelst, The Netherlands. Phone office: +31488470154. Fax office: +31488412128.

[redacted] Url: www.kcd.nl

20140220-1 - GKN

Taking apart Greifswald, two ways

Experience dismantling Germany's Greifswald nuclear power plant has shown that both the conventional cutting strategy and large component management strategy can be successful. However, the latter option is often favoured when considering economic and radiological factors.
By Ralf Borchardt

Eight Russian-designed VVER-440 pressurized water reactors were originally planned for the Greifswald Nuclear Power Plant (KGR) on Germany's northeastern Baltic Sea Coast. The first unit started operation in 1973, with the second a year later; and units 3&4 followed in 1978 and 1979. In 1990, after the reunification of Germany the operating units Greifswald 1-4 along with the 70 MW Soviet-designed Rheinsberg Nuclear Power Plant (KKR), about 140 km south, were shut down. The commissioning of Greifswald unit 5 as well as the construction work at units 6 to 8 was also stopped.

Today Energiewerke Nord GmbH is responsible for the decommissioning and dismantling of both Greifswald and Rheinsberg, along with a number of other nuclear facilities. EWN is the legal successor of the former 'Kombinat Kernkraftwerke,' and has been solely owned by the Federal Ministry of Finance since 2000.

Overall licences for the decommissioning and dismantling of Rheinsberg and Greifswald were both issued in 1995. The Greifswald licence, granted by the responsible Ministries of the Federal State of Mecklenburg/Western-Pomerania on 30 June 1995, covers the dismantling of reactor units 1-5 with part licences for the dismantling of the reactor components. EWN has since applied for additional licences needed for further dismantling of the plant.

Immediately after shutdown, dismantling strategies for reactors 1 to 5 on the Greifswald site (Figure 1) were investigated. It was quickly concluded two strategies should be used: a cutting strategy and a large component strategy.

The cutting strategy (Figure 2) was initially selected for Greifswald units 1-4 (and also Rheinsberg) due to the length of time they had been in operation (12-24 years). It involved cutting the reactor components into segments and packaging them into containers for subsequent interim and decay storage. The large component strategy, which involved transporting the whole reactor pressure vessel with appropriate shielding to an on-site Interim Storage North Facility (ISN), was selected for Greifswald 5 [1].

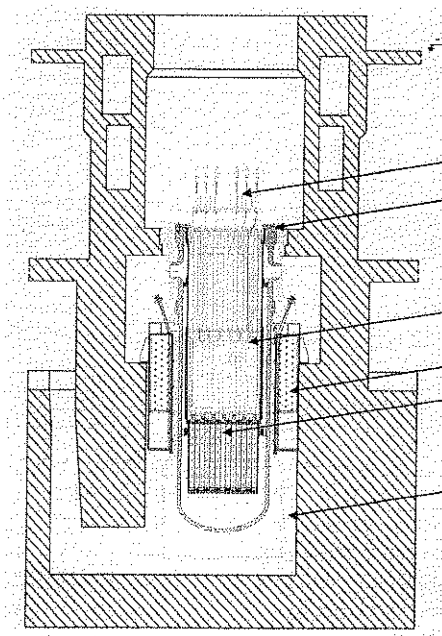
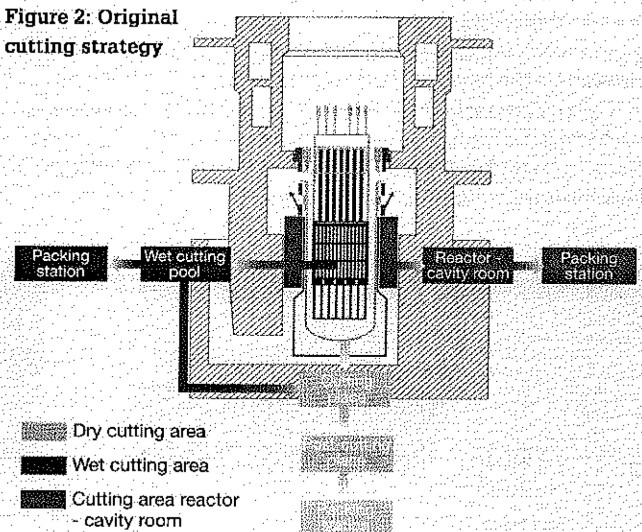


Figure 1: Diagram of RPV components

Figure 2: Original cutting strategy



Cutting strategy

Three cutting areas were installed for the remote dismantling of the reactor components from Greifswald 1-4: a dry cutting area and a wet cutting area located in the former steam generator rooms of units 2 and 4, and a cutting area in the reactor pit.

The dry cutting area was to be used to cut the reactor pressure vessel (RPV) and the low-activated parts of the reactor internals such as the reactor cavity and protective tube unit. The dry cutting area (Figure 3, p30) had two cutting places. In the first cutting place, rings were cut with horizontal cuts, and the reactor components were cut from bottom to top. To balance their weight and for lowering the reactor components after cutting, a flexible wire hoist was used. After the horizontal cut, the ring was taken by a transport vehicle with turntable to the post-cutting place where it was cut vertically into segments. Finally, a power manipulator was used to handle the segments and package them into the storage/transport container.

The wet cutting area was to be used for the cutting of the core basket, reactor cavity bottom, as well as the higher-activity parts of the reactor cavity and the protected tube unit. This area consists basically of a cutting pool with cutting devices, different transport and handling devices, a water cleaning system and a packing station. RPV components were cut from top to bottom. During the cutting, the components were fixed on the turntable in the cutting pool and covered with water (see Figure 4, p30).

The cutting area in the reactor pit was prepared for in-situ cutting of

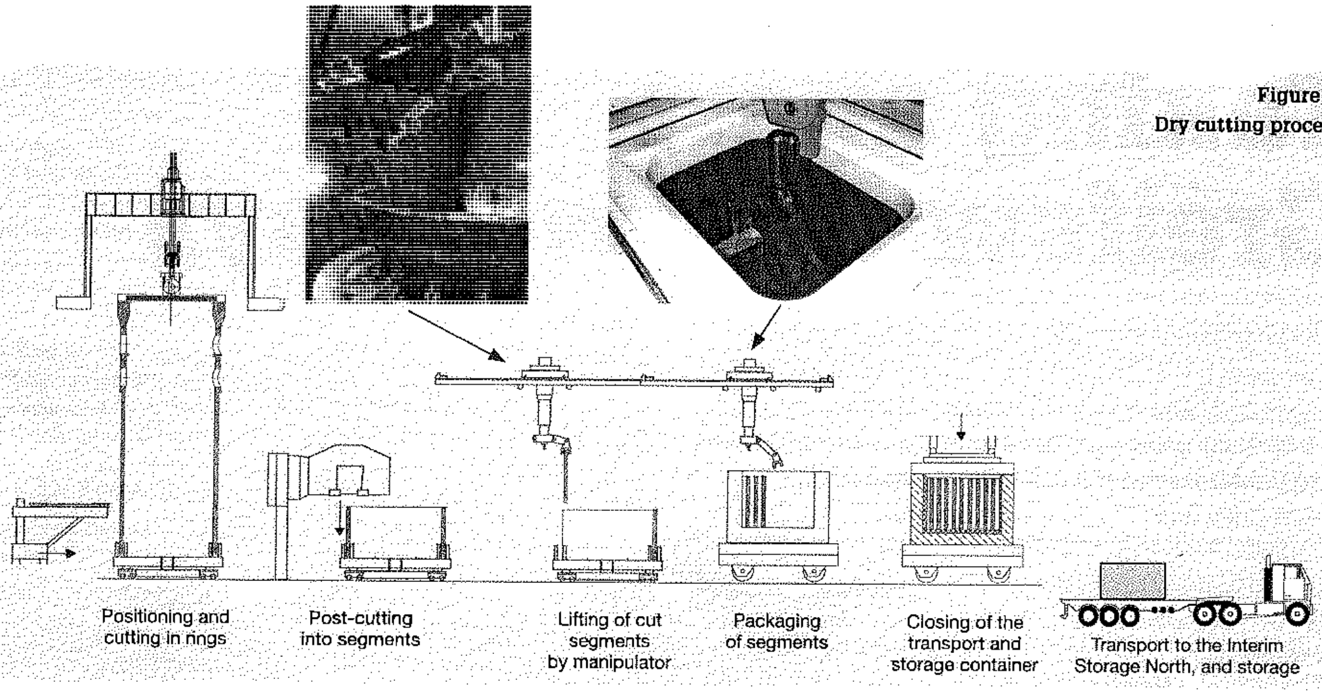


Figure 3: Dry cutting process

the corresponding annular water tanks (biological shield) and the RPV insulation.

The remote dismantling and packing of the RPV and internals was tested and optimized for the use with activated reactors in a long model-dismantling phase with non-activated reactor components from units 7 and 8 that ran from October 1999 to July 2003 [2]. The experience gained during planning and implementation of the model dismantling at Greifswald was also expected to form the basis for the remote dismantling of the Rheinsberg reactor.

Change of strategy

For Greifswald unit 5, EWN planned to transport the RPV as a whole component to the Interim Storage North Facility (ISN), on the same site. The four reactor internals were to be packed into shielded transport and storage devices and transported to the ISN for decay storage. In December 2003 the RPV of unit 5 was lifted and stored, without cutting, in the ISN.

Following an evaluation of its experience at unit 5, EWN considered a change in the disposal strategy for reactors 1-4 at Greifswald and the reactor at Rheinsberg (see Table 1, p31). Ultimately, it decided to continue with the cutting and packing of the reactor internals of Greifswald 1 and 2, which had started in August 2004, and also at Rheinsberg where dismantling activities started in September 2006 [3].

In parallel EWN also investigated a new decommissioning strategy (Figure 5, p31):

- The RPVs of units 1 to 4 and the reactor internals of units 3, 4 and 5 of Greifswald, as well as the Rheinsberg reactor pressure vessel to be stored as shielded large components in the ISN
- The reactor internals (core basket and protective tube unit) of units 3 and 4 to be packed into shielded transport and storage devices for decay storage
- The dismantling of the annular water tank and the RPV insulation is to be continued in the reactor pit.

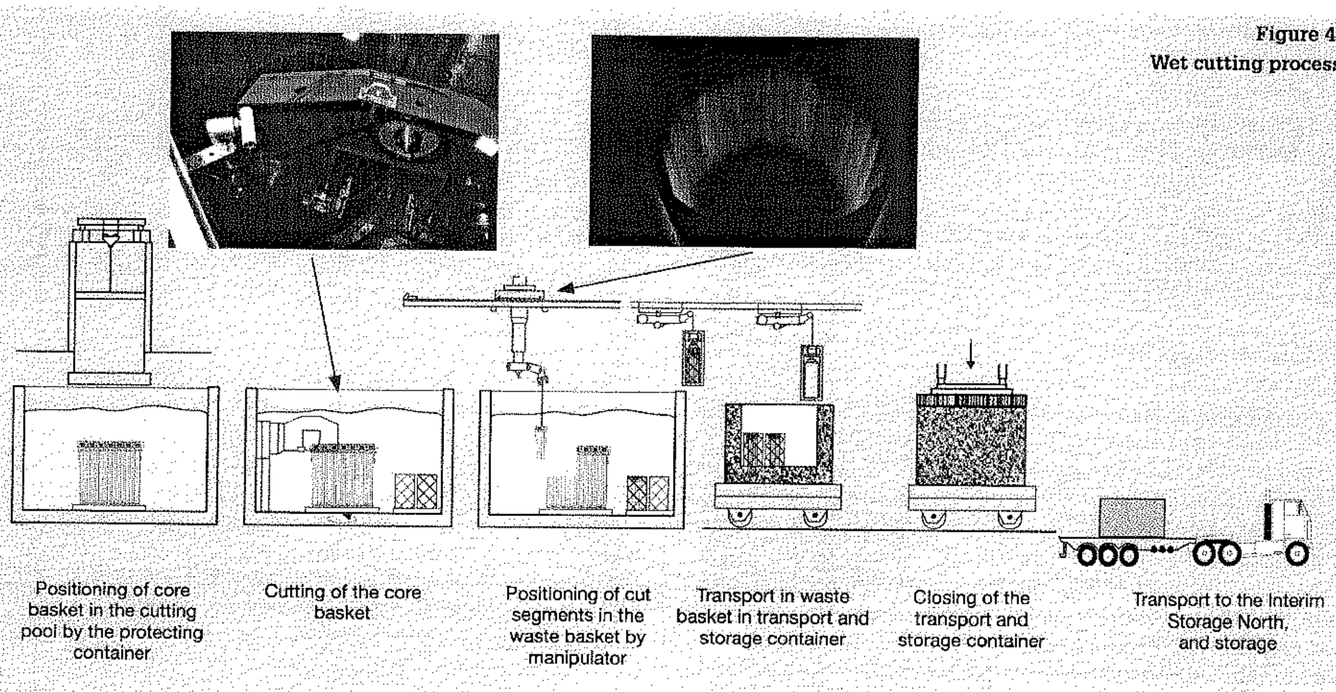


Figure 4: Wet cutting process

Table 1: Comparison of models for dismantling and transport of the unit 5 RPV

	Cutting strategy	Large component management
Project time	100%	
Engineering	100%	45-65%
Preparation	100%	35-55%
Execution	100%	8-12%
Waste management	100%	50-70%
Collective dose rate	100%	15-20%
Costs	100%	40-55%

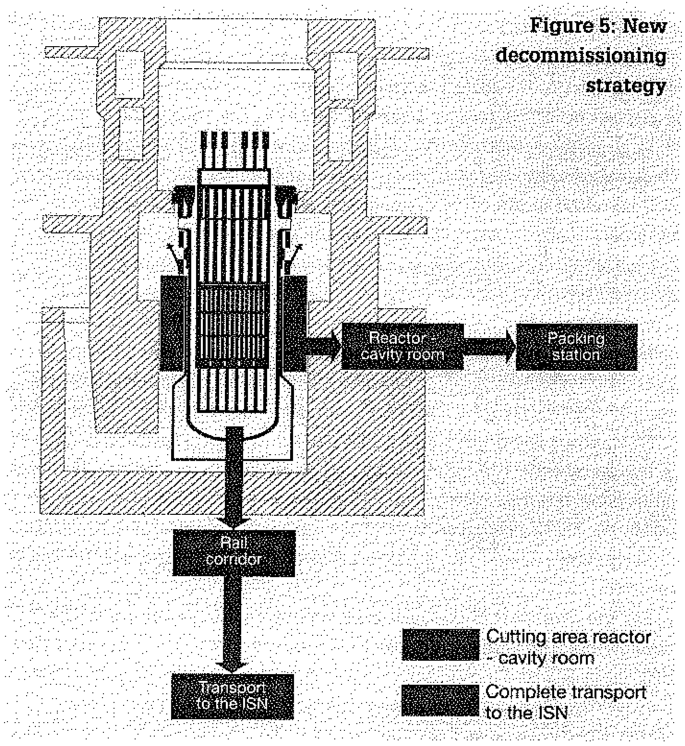


Figure 5: New decommissioning strategy

Dismantling the RPV internals

Units 1&2

Before hot operation could begin at Greifswald 1&2, a dismantling report had to be checked and approved by the authorities. The equipment used for the model dismantling in unit 5 also had to be installed in unit 2.

First, a milling machine was used to cut the nozzles (main coolant pipe connections) of the primary circulation pipe of the RPV. Dismantling of all 12 RPV nozzles was successfully completed in just 29.4 hours, around 2.5 hours per nozzle.

In parallel, the RPV internals were cut and packed within the wet and dry cutting areas. This work started in August 2004 and was successfully finished in July 2007. Overall, eight RPV internals with a total mass of 217.7 tons and a total activity of 2.15 x10^{16} Bq were remotely cut and packed into a total of 135 containers, six storage and transport casks and 20 waste drums. The applied collective dose was approximately 110 mSv, 40% below the expected collective dose [4].

The dismantling of the RPV internals at Rheinsberg was carried between September 2006 and September 2008, taking into account the experience from Greifswald. The wet cutting area was installed in a former spent fuel pond. Four RPV internals with a total mass of 41.22 tons and total activity 3.56 x10^{15} Bq were cut underwater and remotely packaged.

Units 3-5

The packing of the four RPV internals for each of the units 3, 4 and 5 at Greifswald into a shielding and transport container and their subsequent transport to and storage in the ISN was carried out from April until June 2006.

EWN decided to pack the reactor cavity/cavity bottom together with the RPV and to transport it into the ISN. For the reactor internals' protective tube unit and core basket, disposal in shielding and transport containers was preferred. However, since the reactors of units 3 and 4 operated for much longer than unit 5, these components were highly activated and new considerations had to be taken into account to ensure their safe handling and storage.

The complete process was therefore fully tested with the non-activated reserve core basket of plant 2 (units 3&4). During this cold test, all process steps, especially the remote ones, could be sufficiently tested and the personnel could be comprehensively trained.

Dismantling of the RPV

Units 1&2

The preparation of the transport of the reactors 1 to 4 started in 2005. At units 1 and 2 the transport of the RPVs inside the reactor building had to be carried out with the reactor hall crane. For this reason the processes had to be optimized and the amount of shielding minimized so that the maximum lift capacity of 250-ton of the reactor hall crane was not exceeded. This involved carrying out precise activation calculations of the RPV material, based on radiological measurements and samples taken in 2004, and conducting static investigations to find out the areas of the building (in particular the area of the rail corridor) that required reinforcement.

In 2005, the manufacturing and installation of the new facilities and equipment, as well as the heavy load transport from plant 1 (units 1 and 2) to the ISN was commissioned. Construction preparation work began at plant 1 and at the ISN in February and was finished end of May 2007. In August 2007, EWN received the licence for the strategy change. Transports of the RPVs of units 1 and 2 were carried out, on schedule, between 8 November and 23 November 2007.

Units 3&4

Once the unit 3&4 core baskets and protecting tube units had been transported to the ISN, EWN started intensive preparation works for the transport of their RPVs (plus inserted reactor cavity/cavity bottoms). Extensive safety analyses were of major importance during the preparation phase.

The static reinforcements required for units 3&4 were much more extensive than for units 1&2, as the total mass of the reactor with shielding was approx. 360 Mg and a force of 5270 MN was acting on the construction during the loading of the reactor cavity/cavity bottom into the RPV.

The following dismantling strategy was developed for units 3&4 on the basis of the experience made during the previous reactor transports:

- Dismantling of the cavity with cavity bottom from the RPV with the help of the reactor protection containers, as well as transport and parking in the maintenance pit
- Unshielded transport of the RPV from the installation position with the reactor hall crane and remote control to the rail corridor
- Placement of the RPV in a shielding cylinder (in vertical position)
- Transport of the cavity/cavity bottom with the help of the reactor protection container to the RPV in the rail corridor and placement in the RPV
- Closing of the RPV flange with a shielding plate with transport traverse
- Tilting of the reactor (using a carrying portal with wire hoist) into horizontal position in a transport unit.

- Moving the reactor in the rail corridor out of the reactor building
- Reloading of the reactor onto a heavy load transport unit
- Transport to the ISN (internal transport)
- Reloading of the reactor back onto a heavy transport unit
- Moving the reactor to the parking position in hall 7 of the ISN

To distribute the load during the tilting of the shielded RPV, a support was installed in the cable cellar below the rail corridor. For the transport of the reactor into the ISN, the reactor had to be tilted into the horizontal position. For this purpose a tilting device had to be installed below the northern rail corridor hatch. To move the tilted reactor in the rail corridor, a transport unit was installed. This device consists of an approx. 65m long double-tracked slide way built on a load distributing sub-construction, and two pairs of skidshoes which each are connected to a saddle and have an integrated hydraulic jack.

First, while the units 3 and 4 RPVs were in the installation position in the reactor pit, the reactor internals were removed and the RPV was emptied of residual water. The fixing elements of the RPV were also removed; all 12 reactor coolant pipes and instrumentation lines were disconnected, closed and shielded. The flange opening of the RPV was closed.

For the transport of the RPV from the installation position to the rail corridor, the same equipment was used as for the transport of the RPV units 1, 2 and 5, without shielding because of the crane's weight restrictions. Due to the maximum load capacity of the reactor hall (250t), the RPV was transported without the shielding cylinder for the core area, because the overall weight of RPV with shielding plate and RPV-traverse was already 225 Mg. The crane was operated remotely from behind radiological shielding to protect workers.

After the proper positioning of the reactor above the shielding cylinder, the reactor was lowered by the reactor hall crane and inserted into the shielding cylinder.

Once the shielding cylinder had been fixed the RPV, the reactor cavity with cavity bottom was inserted in the RPV. This was carried out with the help of a reactor protection container. Due to the weight of the reactor (RPV + reactor cavity with cavity bottom + shielding) now about 360 Mg, it was not possible to reload and tilt the reactor using the reactor-building crane. Therefore, a carrying portal with wire hoist was used for this task.

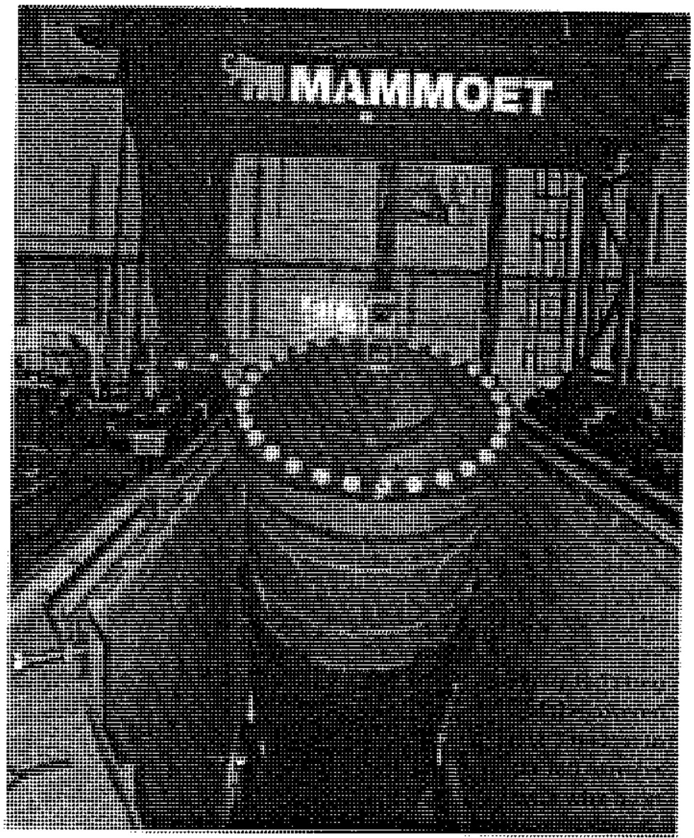
The tilting of the RPV into the horizontal position was realized just before transporting the reactor to the ISN. After having connected the flexible wire hoist with the transport-traverse, the reactor support could be unfastened. By alternating movement of the carrying portal and lowering of the flexible wire hoist hook the reactor was brought into a slanted position.

The shielded RPV was skidded outside to a hydraulic lifting unit with a lifting capacity of 1100 Mg and a lift height of 7.3 m was positioned. With the help of this lifting unit the complete reactor with shielding was lifted from the transport saddles and loaded on the heavy load transport vehicle. After load securing the reactor was transported to the ISN with a maximum speed of 3 km/h.

The transport of the reactor of unit 4 was realized immediately after finishing the transport of the reactor from unit 1 in November 2007.

Biological shield/ RPV insulation

After the removal of the RPV out of the reactor pit, the annular water tank and the RPV insulation were moved from inside the reactor pit. First the shielding plates above and below the former core zone were mounted. Thus it was possible to manually dismantle the lower part of the RPV insulation. As the RPV insulation contained asbestos, the work had to be carried out according to special regulations. Once the lower RPV insulation had been removed, an inner shielding ring was installed. The gap between the annular water tank and the shielding ring was filled with concrete to reduce the dose rate. With the help of a wire saw the annular water tank including RPV insulation was cut into 11 segments. These segments were lifted into the reactor hall and tilted into a horizontal position. Then, the segments were put into special 20-foot containers with shielding and transported to the ISN for decay storage and future conditioning.



Lessons

The dismantling of the reactors at Greifswald and Rheinsberg has now been completed. The project has shown that both the cutting and large component strategies can be successfully realized. The strategy chosen will depend on the priorities at a particular site. The conventional cutting strategy always seems to be reasonable when facilities for decay storage and future conditioning are not available. On the other hand if facilities are available, interim storage of large components is not only an alternative to cutting but a favourable option especially when considering economic and radiological aspects.

Following on from the Rheinsberg and Greifswald project, EWN has now started preparation work for dismantling the AVR, prototype pebble bed reactor at the Julicb Research Centre.

EWN has also been charged with the dismantling of the reactor of the Obrigheim Nuclear Power Plant. In 2005 this pressurized water reactor was shut down after more than 35 years of operation. The dismantling of the reactor is to be carried out by remote cutting and packing of the activated reactor components. Much of the equipment from the dismantling of the KGR and KKR will be used. ■

Ralf Borchardt (ralf.borchardt@ewn-gmbh.de), Energiewerke Nord GmbH, Latzower Straße 1, 17507 Rubenow, Germany.

This article is based on paper 13043 'Implemented Dismantling Strategies for the Reactors in the Greifswald and Rheinsberg Nuclear Power Plant,' presented at the Decommissioning Challenges – Industrial Reality and Prospects, 7-11 April 2013 in Avignon, France.

References are available on the online version of this article, www.tinyurl.com/greifsfull

20140220-2 - GKN

GKN

B.V. Gemeenschappelijke Kernenergiecentrale Nederland
Waalbandijk 112A, 6669 MG Dodewaard

Kostenreductie Ontmantelingsplan 2011 KCD als gevolg van innovatie en overige ontwikkelingen

Concept versie

Opgesteld door:
10 2 e [redacted]

Samenvatting

In 2009 en 2010 is een Ontmantelingsplan voor de kernenergiecentrale Dodewaard (KCD) opgesteld. De Minister van Economische Zaken heeft bij Besluit van 13 september 2011 gesteld dat dit plan genaamd “Ontmantelingsplan 2011 KCD”, voldoet aan de eisen die daaraan gesteld zijn in de artikelen 26, 1^e en 2^e lid van het Besluit kerninstallaties, splijtstoffen en ertsen en 3, 1^e en 2^e lid, van de Regeling buitengebruikstelling en ontmanteling van nucleaire inrichtingen.

Het Ontmantelingsplan 2011 KCD is in de jaren 2009 en 1010 opgesteld door INS Ingenieur-gesellschaft MbH met medewerking van GKN, Belgatom/Tractebel Engineering (de adviseurs van GKN), het (toenmalige) Ministerie van VROM en COVRA. De daarbij gehanteerde parameters zijn tot stand gekomen met inbreng en goedkeuring van alle betrokken partijen en verwoord in de door Belgatom/Tractebel Engineering opgestelde Technical Requisition File.
Als gevolg van innovatie en overige ontwikkelingen, vooral door de in afgelopen jaren in gang gezette ontmanteling van meerdere Amerikaanse en Duitse kernenergiecentrales, is het in 2009 en 2010 opgestelde Ontmantelingsplan voor de kernenergiecentrale Dodewaard, achterhaald. De eerstvolgende (wettelijke) evaluatie van het Ontmantelingsplan 2011 KCD is gepland in 2016. Echter gegeven de snelheid waarin de ontwikkelingen rond ontmanteling van nucleaire installaties plaatsvinden acht GKN het geboden een tussentijds rapport terzake op te stellen.

Dit rapport beschrijft een aantal kosten reducerende maatregelen waardoor het totaal aan kosten voor de ontmanteling van de kernenergiecentrale Dodewaard aanmerkelijk kunnen worden verminderd. De beschreven maatregelen zijn gebaseerd op de actuele praktijk betreffende ontmanteling van kernenergiecentrales in Europa. Een deel van deze maatregelen en technieken zijn thans niet uitvoerbaar omdat zij in strijd zijn met het Nederlandse Beleid op het gebied van de verwerking en opslag van radioactief afval. In de landen om Nederland zijn dergelijke technieken echter al meerdere malen toegepast. Het verdient aanbeveling om de Nederlandse regelgeving in lijn te brengen met de Europese ontwikkelingen op het gebied van verwerking van radioactief afval. De beschreven maatregelen en technieken zullen worden opgenomen in de volgende herziening van het Ontmantelingsplan voor de kernenergiecentrale Dodewaard, thans voorzien te worden opgesteld in 2016.

In het Ontmantelingsplan 2011 KCD zijn de kosten voor ontmanteling en eindberging van radioactief materiaal uit te voeren in de periode vanaf 2045, op basis van het prijspeil 2009/2010 berekend op 10 1 c [redacted]. Als gevolg van innovatie en overige ontwikkelingen zouden die kosten thans [redacted] bedragen, een besparing derhalve van [redacted].

Inhoudsopgave

1. Inleiding

GKN heeft in 2008 in samenwerking met vertegenwoordigers van het (toenmalige) Ministerie van VROM en van COVRA een Technical Requisition File (hierna: TRF) opgesteld, dat als uitgangspunt diende voor de Ontmantelingskostenberekening van de kernenergiecentrale Dodewaard (hierna: KCD). Dit TRF is formeel goedgekeurd door de directeur COVRA en de secretaris-generaal van het Ministerie van VROM. De resultaten van deze berekeningen zijn vermeld in de rapporten van NIS "Evaluation of Decommissioning of the Dodewaard NPP – New Decommissioning Cost Estimate".
De in april 2010 uitgebrachte studie staat bekend onder de naam NIS2009. De bij de opstelling van de studie betrokken vertegenwoordigers van het Ministerie van VROM, COVRA, NIS, Belgatom/ Tractebel Engineering en GKN hebben allen schriftelijk verklaard dat zij akkoord zijn met de resultaten van deze studie.
Het onderdeel Task 1, "Reference scenario - Starting date of decommissioning 2015" vormde de basis voor het door GKN bij de Minister van Economische Zaken & Innovatie ingediende aanvraag goedkeuring Ontmantelingsplan. De Minister heeft deze goedkeuring in september 2011 schriftelijk bevestigd. In 2013 heeft GKN een aanvraag "Goedkeuring Financiële Zekerstelling kosten Ontmanteling van de KCD" (hierna: FZO) ingediend bij de Minister van Economische Zaken en de Minister van Financiën. GKN heeft bij de Aanvraag FZO (in bijlage C.6) aangegeven dat de in de kostencalculaties te verwerken inflatie kan worden gecompenseerd door toepassing van actuele- en innovatieve technieken bij de ontmanteling van de KCD. Tijdens overleg terzake met vertegenwoordigers van de Ministeries van EZ en FIN is GKN verzocht het GKN standpunt nader te onderbouwen.

In de NIS2009 studie zijn de uitgangspunten gehanteerd zoals vastgelegd in het TRF. Ten tijde van het opstellen van dit TRF benaderden de parameters de "best practices" zoals deze wereldwijd werden toegepast. Deze waren tevens in lijn met het Nederlandse Beleid in zake verwerking en opslag van radioactief afval.
Inmiddels is het vijf jaar geleden dat het TRF is opgesteld en is er meer wereldwijde ervaring met de ontmanteling van nucleaire installaties opgedaan.
In voorliggend rapport worden een aantal van deze nieuwe inzichten en wereldwijde ontwikkelingen nader beschreven, inclusief hun kostenimpact.

Een aantal van deze inzichten waren al bekend bij het opstellen van het TRF in 2009. Zo is het niet volledig demonteren, maar als één stuk verwerken van grote componenten al door GKN in 2009 voorgesteld tijdens de derde voorbespreking van het TRF. Het opslaan van componenten in één stuk en het niet verder verwerken heeft als voordeel dat na een vervalperiode het metaal kan worden gerecycled. Dit is een besparing van grondstoffen. In 2009 werd door de toenmalige directeur COVRA gesteld dat dit (op dat moment) onbespreekbaar was, omdat dit niet in lijn was met het Nederlandse Beleid ten aanzien van radioactief afval. Alle afval moest volgens het toen (en nog) geldende Beleid worden verkleind en verpakt in zodanige pakketten dat opslag in de diepe ondergrond mogelijk was (REF 1, 2). Niet alleen leidt dit ertoe dat extra afscherming materiaal (en dus op te slaan volume) wordt geïntroduceerd, maar tevens moeten extra verwerkingshandelingen worden uitgevoerd (dosis voor medewerkers), terwijl het terughalen en hergebruiken van dergelijk materiaal na verval lastig is. Inmiddels is deze regel wereldwijd achterhaald. Het Nederlandse Beleid in zake radioactief afval dient te worden geëvalueerd en in lijn te worden gebracht met de laatste stand der techniek en de ontwikkelingen in landen om Nederland heen.

Bij de vijfjaarlijkse herevaluatie van het GKN Ontmantelingsplan in 2016 zullen de parameters in het TRF worden aangepast, gebaseerd op voortschrijdend inzicht en wereldwijde ontwikkelingen. Dit leidt tot een nieuwe kostenberekening van de Ontmantelingskosten.

Om goedkopere verwerking van radioactief afval mogelijk te maken dienen echter wel aanpassingen in het Nederlandse Beleid op het gebied van de verwerking van radioactief afval te worden doorgevoerd om aan te blijven sluiten bij de internationale ontwikkelingen. Indien dit niet is gebeurd voor het vaststellen van het TRF 2015/2016, zal het TRF zo worden ingericht dat naast een kostenberekening op basis van de dan vigerende regelgeving, er een tweede berekening kan worden uitgevoerd met alternatieve verwerking en verpakking.

Bij recente discussies over deze alternatieve verwerkingsvormen is door de medewerkers van de betrokken Ministeries geopperd om de voorgestelde aangepaste methodes van verwerking door een onafhankelijke partij te laten beschouwen op hun (on-)mogelijkheid en de hiermee gepaard gaande kosteneffecten. Ook werd geopperd dat de voorgestelde maatregelen en technieken nu al konden worden uitgewerkt en te zijner tijd ingepast in het Ontmantelingsplan 2016 KCD. Bij nadere beschouwing is GKN van mening dat dit niet verstandig is. Welke partij ook gevraagd wordt deze analyse uit te voeren, de uitkomsten van de analyse staan al vast. Alle partijen zullen aangeven dat dergelijke alternatieve verwerking- en verpakkingstechnieken zijn en worden toegepast. Hiervan zijn immers volop voorbeelden aanwezig. Daarnaast zullen zij stellen dat zonder verdere analyse het niet mogelijk is om een realistische kostenschatting te maken. Een deelstudie is bovendien niet uitvoerbaar omdat veel van de parameters worden beïnvloed door de uitgangspunten zoals loonkosten en vrijgavegrenzen. Juist die zijn weer onderwerp van discussie in een nieuw TRF. Een extra studie leidt bovendien tot extra kosten, wat weer ten koste gaat van de fondsen bestemt voor de amovering. Ter informatie: de IAEA waarschuwt in verschillende van haar publicaties over decommissioning voor het verlies van fondsen door het steeds maar weer uitvoeren van (aanvullende) studies. Daarnaast zal men constateren dat het Nederlandse Beleid in zake de verwerking van radioactief afval, de voorgestelde aanpassingen van verwerking en opslag van het afval niet toestaat. Daarom wordt deze exercitie niet zinvol geacht.

2. Verwerking van beton

Situatie

Een deel van het radioactief afval bestaat uit radioactief besmet en geactiveerd beton. De grootste hoeveelheid zal vrijkomen bij het ontmantelen van het biologisch schild. De radioactiviteit hiervan wordt voornamelijk veroorzaakt door activering van Europium tot Eu-152/154, aanwezig in de kiezels in het beton. Het cement is veelal niet radioactief en kan bij afscheiding vrij worden gestort.
Uit het jaarrapport van NIS over 2013 blijkt dat nog circa één zesde deel van het beton van het biologisch schild zal zijn geactiveerd in 2045. Het gaat dan om ongeveer 400 ton. Dit is gesitueerd in de binnenzijde van het biologisch schild.

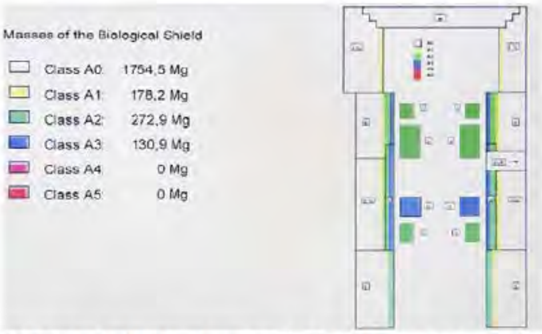


Foto 1. GKN-Dodewaard, NL: Als radioactief afval te verwerken deel van het biologisch schild.

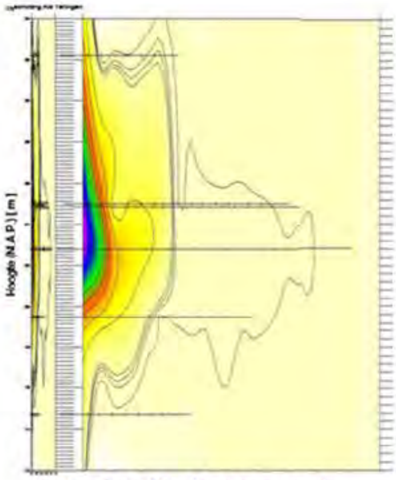


Foto 2. GKN-Dodewaard: Dwarsdoorsnede activering beton activering biologisch schild.

Huidige verwerking

Volgens de Nederlandse verpakkingseisen zou dit beton moeten worden vergruisd, gemengd met cement en vervolgens afgestort in vaten.

Alternatieven

1. *Verzagen en als blokken eeuwig opslaan.*

Het biologisch schild is op grond van vorm en locatie relatief eenvoudig als blokken te verzagen. Deze techniek wordt momenteel toegepast bij de ontmanteling van de AVR in Jülich, BRD.
De blokken kunnen worden ingepakt in geschikte containers en worden gecementeerd, waarna permanente opslag volgt.

Foto 3. AVR-Jülich, BRD: Plan uitzagen betonblokken biologisch schild.

Foto 4. AVR-Jülich, BRD: Uitnemen verzaagde betonblokken uit biologisch schild.

2. *Kiezels / cement scheiden*

In België is bij ontmantelingsprojecten in Mol/Dessel een installatie ontwikkeld welke na het vergruizen de kiezels uit het beton zeeft. De kiezels bevatten de radioactiviteit, door activering van de aanwezige sporenelementen. Het cement is vrij van radioactiviteit.
Deze methode vermindert de hoeveelheid op te slaan afval met circa 50%. De kiezels worden gecementeerd.

Foto 5. Eurochemie-Mol, België: kiezel-cement scheider voor beton.

Foto 6. Eurochemie-Mol, België: beton verwijderd uit wand voormalig bezinkbassin.

3. *Verzagen en op termijn vrijgeven.*

Een andere mogelijkheid is het radioactieve beton niet te vergruizen maar te verzagen en als blokken in (20 voet) containers of "big bags" tijdelijk op te slaan bij COVRA in het Verarmd uranium Opslag Gebouw (hierna: VOG) of in het Container Opslag Gebouw (hierna: COG), en de blokken op termijn vrij te meten (dus geen eindberging). Hierbij geldt dat na een opslagperiode de radioactiviteit zal zijn vervallen. Door op het moment van plaatsing van de blokken in de containers al het exposietempo en de nuclidevector te bepalen kan worden vastgesteld wanneer het materiaal vrijgegeven kan worden. Op deze manier hoeft alleen tijdelijk opslagvolume te worden gehuurd bij COVRA. De blokken kunnen na vrijgave, eventueel na vergruizing, worden gebruikt voor wegverharding of dijkverzwaring.

Alle genoemde alternatieven zijn (nog) niet in overeenstemming met het huidige Nederlandse Beleid, maar wel veel goedkoper.

<u>Impact volume/hoeveelheid afval</u>
Alternatief 1. Het afvoeren als blokken is een volume toename.
Alternatief 2. Het scheiden van kiezels en cement levert een volume reductie van 50% op.
Alternatief 3. Het opslaan en op termijn vrijgeven levert 100% volume reductie.

<u>Impact op de kosten bij minimaal volume</u>
Uitgaande van een soortelijke massa van het beton van 2500 kg.m3, levert de 400 ton biologisch schild een volume van 160 m3 beton. Volgens Nederlandse wetgeving het beton verwerken in 200L vaten, met een maximaal vulgewicht van 150L, geeft circa 1100 vaten (220 m3).
De opslag van een 200L vat bij COVRA in het Laag- en Middel radioactief afval Opslag Gebouw (hierna: LOG) met een exposietempo van minder dan 0,2 mSv/h kost momenteel [redacted]. Dit is dus een kostenpost van [redacted] , exclusief de kosten aan manuren van vullen en de vaten zelf.

Impact bij toepassing van alternatief 1:
Een standaard 20 voet zeecontainer heeft een volume van 33,2 m3. Dat impliceert dus 5 containers. Om eea hanteerbaar te houden wordt uitgegaan van het dubbele aantal. Het benodigde opslagvolume wordt hierdoor 320 m3. Voor 10 stuks 20 voet containers moet permanente opslag moet worden gehuurd. Aanlevering en opslag van een 20 voet container kost momenteel [redacted] per stuk (met terugname verplichting, berekening op basis van calcinaat, jaarverslag COVRA 2012). Kosten voor 10 containers is dan [redacted] Stel de aanschaf van de containers op [redacted] per stuk, dan zijn de kosten aan container aanschaf en opslag [redacted]. Totaal dus [redacted]. Kostenreductie is dan ongeveer [redacted]. Een lichte toeslag voor permanente opslag zal door COVRA worden toegepast. Opslag van dit afval in de diepe ondergrond is vanzelfsprekend onzin. Vandaar dat alternatief 1 bij nadere analyse logischer wijze over zal gaan in alternatief 3.

Impact bij toepassing van alternatief 2:
De volumereductie bedraagt 50%, waardoor het te verpakken volume 80 m3 bedraagt. Verwerking in een 200 L vat kost dan M€1,375. Als alternatief kan dit volume in 20 voet zeecontainers worden verpakt. Maar naar verwachting levert dit niet voldoende financiële winst.

Impact bij toepassing van alternatief 3
Dit is technisch gelijk aan alternatief 1, doch de opslag is niet oneindig
De kosten voor het ontmantelen van het schild zullen naar schatting met 30% afnemen bij opslag in blokken. Er hoeft immers niet te worden vergruisd, terwijl er voor 10 stuks 20 voet containers tijdelijke opslag moet worden gehuurd bij COVRA. Een extra periode van 50 jaar voldoet. Dit levert voor Eu-152 vier, en voor Eu-154 acht extra halfwaardetijden op. Omdat de containers goed uitgemeten in de opslag gaan, zullen de kosten bij finale vrijgave gering zijn. Aanlevering en opslag van een 20 voet container kost momenteel k€25 per stuk (met terugname verplichting, berekening op basis van calcinaat, jaarverslag COVRA 2012). Kosten voor 10 containers is dan k€250. Stel de aanschaf van de containers op [redacted] per stuk, dan zijn de kosten aan container aanschaf en opslag [redacted]. Totaal dus [redacted]. De kostenreductie is dan ongeveer [redacted].

<u>Impact kosten op de verwerking</u>
De verwerkingskosten van het schild zullen naast de opslagkosten van afval naar schatting ook nog met 30% afnemen bij opslag in blokken, door de mindere hoeveelheid arbeid. In blokken zagen en vervolgens afvoeren is minder arbeidsintensief dan het in kleine blokken zagen en aansluitend vergruizen.

Overwegin g

Op dit moment wordt naast calcinaat ook verarmd uranium opgeslagen in het VOG. Deze stoffen zijn niet overgedragen aan COVRA en blijven eigendom van de partij die aanlevert. En vergelijkbare methode van opslag is wordt thans bediscussieerd met eigenaren van cyclotrons. Bij de ontmanteling van cyclotrons komt veel licht geactiveerd staal vrij. In het COG wordt momenteel al (geringe) hoeveelheden zeer licht besmet staal opgeslagen Op termijn is eea voldoende vervallen om te worden vrijgegeven. Voor licht radioactief beton zou eenzelfde regeling opgezet kunnen worden. Dit vergt een aanpassing van het Nederlandse Beleid in zake de verwerking en opslag van radioactief afval.

Foto 7. COVRA-NL: Lossen containers met zeer licht radioactief materiaal bij COVRA-COG.

3. Omsmelten van radioactief metaal

<u>Situatie</u>
Licht radioactief materiaal kan worden omgesmolten waarbij de radioactieve stoffen in de slak terecht komen en het materiaal kan worden vrijgegeven, of worden hergebruikt als afschermingsmateriaal of radioactief afvalverpakking. De slak wordt als radioactief materiaal verwerkt en opgeslagen bij de afvalopslag in het land van de aanbieder van het materiaal. Er is dus een terug transport van radioactief materiaal. In Duitsland gebeurt het omsmelten bij de firma Siempelkamp in Krefeld. De normen voor de maximale hoeveelheid radioactiviteit in het materiaal zoals die door Siempelkamp worden gehanteerd, zijn erg laag. De firma Studsvik in Nyköping, Zweden hanteert veel hogere normen, omdat haar oven beter is geoutilleerd. Dit betekent dat veel meer materiaal kan worden omgesmolten. Ook heeft deze oven enkele malen grotere capaciteit dan die van Siempelkamp. Omsmelten van metaal is voordeliger dan het metaal als radioactief materiaal opslaan en is aan te merken als een hergebruik van grondstof.

<u>Overweging 1</u>
Gezien de te verwachten hoeveelheden potentieel om te smelten metaal welke zullen ontstaan bij de Duitse "Ausstieg" is het niet onmogelijk dat Siempelkamp een nieuwe oven zal bouwen. Wellicht zal deze oven ook hogere concentraties radioactiviteit kunnen accepteren en een grotere capaciteit hebben.

<u>Overweging 2</u>
Via de Belgische firma DDR is het mogelijk in de USA bij de firma Energy Solutions in Utah, metaal te laten omsmelten waarbij het eigendom van het metaal en de radioactieve slak overgaat in USA handen. De firma levert maatwerk. Deze werkwijze gaat in tegen het Nederlandse Beleid van het eigen afval opslaan in Nederland en niet exporteren. Diverse Europese landen, waaronder Duitsland, hebben dit wel toegestaan. Het materiaal wordt na omsmelten hergebruikt als afschermingsmateriaal, terwijl de radioactieve slak wordt verwerkt in een "burial site" op de zoutvlaktes van Utah. Er wordt dus geen radioactief afval teruggezonden.

Foto 8. Energy Solutions-Tennessee, USA: Oven voor ra besmet staal in Bear Creek, Oak Ridge.

Foto 9. Energy Solutions-Utah, USA: Burial site Clive nabij Salt Lake city.

Overweging 3
In al deze gevallen is sprake van een (gering) "transport risico" (het brengen en halen van de radioactieve stoffen). Ook is hier een potentiële discussie tav de hoeveelheden getransporteerde hoeveelheid radioactiviteit een risico ("even veel terug als gebracht").

Impact op de kosten.
Kwantificering is zonder nadere studie niet mogelijk. Energy Solutions geeft eerst prijzen af als hoeveelheden en radioactiviteit van het materiaal bekend zijn. Men neemt hogere activiteit aan en bepaalt de prijs mede op basis van de aanwezige nucliden.

4. Verwerking van de reactor en grote componenten in één stuk

<u>Situatie</u>

In de landen om Nederland heen (Duitsland, Verenigd Koninkrijk, Frankrijk) worden steeds meer grote radioactieve componenten opgeslagen in één stuk. Deze componenten worden NIET in de (diepe) ondergrond opgeborgen. Nederland/COVRA wil hier vooralsnog niet aan omdat dit niet in lijn is met het Nederlandse Beleid van opslag van alle afval in de (diepe) ondergrond. Daarom moet alle afval worden verkleind en geconditioneerd. Sommige grote componenten zoals warmtewisselaars en zelfs reactorvaten zijn echter technisch gezien zonder grote problemen als component af te voeren en op te slaan.

Juist deze componenten zijn na enkele tientallen jaren extra opslag door verval vrijwel geheel vrij van radioactiviteit. De reactorvaten van de vijf eenheden van de centrale Greifswald, de reactor van de centrale Rheinsberg (goed vergelijkbaar met Dodewaard), de stoomgeneratoren van de centrales Stade en Obrigheim en de reactor van de centrale Jülich zijn of worden in één stuk afgevoerd naar het Zwischen Lager Nord (ZLN) in Greifswald.

Foto 10. Rheinsberg-BRD: uithijsen reactor in één stuk.

Foto 11. Greifswald ZLN-BRD: Opslag reactorvaten grote componenten. Vat Rheinsberg ligt rechts.

In het Verenigd Koninkrijk worden stoomgeneratoren van Magnox reactoren afgevoerd als één component naar Studsvik, in Nyköping, Zweden, en hoog besmette warmtewisselaars van de opwerkingsinstallaties in Sellafield worden gecementeerd en als één blok opgeslagen in Drigg, Cumbria, Groot-Brittannië. Defecte Franse stoomgeneratoren worden als één component verwijderd en opgeslagen op de locatie van de (meestal multi-reactor) centrale voor verder radioactief verval. Eerst bij eindontmanteling van deze centrales zullen zij verder worden verwerkt. De doelstelling hierbij is het metaal van deze stoomgeneratoren zoveel mogelijk te hergebruiken.

Foto 12. Berkeley-UK:
Stoomgenerator wordt uitgehesen.

Foto 13. Berkeley-UK: Stoomgenerator op weg naar haven voor transport naar Studsvik, Nyköping, Zweden.

<u>Overweging</u>
De reactor van GKN en een aantal grote componenten zoals grote warmtewisselaars van RZS en RAS/SBK kunnen technisch zonder problemen als één component naar COVRA worden afgevoerd, mits wordt voldaan aan afschermingsvoorwaarden. De warmtewisselaars van GKN moeten volgens het Nederlandse afvalbeleid uit elkaar worden genomen (Ladder van Lansink), en zo veel als mogelijk worden gereinigd en hergebruikt. Dit is een minder gewenst verwerkingsconcept omdat dit een hoge stralingsbelasting voor de uitvoerders-, en veel meer verpakkingsafval oplevert .
Bij COVRA zijn deze componenten zonder technische problemen in "één stuk" op te slaan in bijvoorbeeld een nieuw te bouwen hal aan het LOG. Een dergelijke hal moet naar verwachting toch al worden gebouwd voor de opslag van het GKN afval .
De opslag als één component levert veel minder verpakkingen, een lagere stralingsbelasting, en zal sneller gaan dan verzagen en verpakken. Na voldoende verval kan worden besloten tot of alsnog verwerken en conditioneren of vrijmeten. De voorkeur hierbij is vrijmeten. Door vooraf goed de radioactiviteit en nuclidevector vast te leggen kan de feitelijke vrijmeting (en afvoer naar een verwerker / hoogoven) met weinig kosten worden gerealiseerd.

Foto 14. Big Rock Point-Michigan, USA: Verwijdering van het reactorvat in één stuk bij GKN' s zustercentrale.

Foto 15. Big Rock Point-Michigan, USA: Transport van de verpakte reactor in transportverpakking op 205 voet lange trailer.

Impact op de kosten

Volgens publicaties van EWN, de eigenaar van de reactoren in Rheinsberg en Greifswald, is het 50% goedkoper om de reactoren in één stuk te verwerken. Dit betreft zowel verwerking- als opslagkosten. De verwerking van de GKN reactor inclusief de internals kost [redacted] (WP 5 en 6 in de NIS2009 studie). Bij verwerking als één stuk wordt uitgegaan van het volstorten van de reactor met licht beton om de straling van de internals af te schermen. Een alternatief is het verwijderen van de internals met verpakking in Mozaïk containers. Rekening houdende met extra kosten voor transport naar COVRA mag op een kostenreductie van [redacted] [redacted] worden gerekend voor het verwerken van de reactor. De kostenreductie van verwerking van RZS-, RAS/SBK warmtewisselaars is hier niet berekend omdat deze in de huidige rapportage van NIS niet als zelfstandige items herkenbaar zijn.

5. Duitse tarieven en uurlonen

Situatie
In de NIS2009 studie zijn voornamelijk Duitse tarieven voor personeelskosten gehanteerd. Op het moment van opstellen van de studie leek dit logisch, omdat ervan uitgegaan werd dat kennis van ontmantelen in Nederland geheel zou ontbreken rond de tijd dat de centrale Dodewaard zou worden ontmanteld.

Overweging
De reactor in Borssele, de LFR, mogelijk de HFR en de HOR, de cyclotrons van VU Amsterdam en Eindhoven zijn voorzien eerder te worden ontmanteld dan de kernenergiecentrale Dodewaard. De LFR wordt volgens de huidige planning vanaf zomer 2014 ontmanteld. De ontmanteling en de verwerking van het radioactief afval van de beide cyclotrons vindt momenteel plaats. Bij al deze projecten zal kennis over ontmantelen worden opgedaan.
Momenteel werft NRG al personeel met kennis van ontmanteling, of de bereidheid deze kennis op te doen. Op basis van het bovenstaande mag worden aangenomen dat in Nederland in 2045 voldoende gekwalificeerd personeel beschikbaar zal zijn om de ontmanteling van GKN uit te voeren.

Impact op de kosten
De in de studie gehanteerde Duitse tarieven voor het in te huren personeel zijn tenminste 10% hoger dan die in Nederland gebruikelijk zijn. Ook is geen rekening gehouden met lagere uurtarieven voor medewerkers die gedurende een langere termijn worden ingehuurd (garantie van bezetting voor de uitlener).
Een nauwkeuriger schatting van de ontmantelingkosten is alleen mogelijk als de gehele studie NIS studie wordt overgedaan omdat de manuren overal in workpackages zijn verwerkt, en niet als aparte eenheid worden benoemd.

Een andere methode om de kostenreductie te bepalen bij het toepassen van Nederlandse in plaats van Duitse uurlonen, is uitgaan van de vuistregel dat ongeveer 70% van de totale kosten in een ontmantelingsproject worden toegeschreven aan manuren. Op een totaal van [redacted], het thans berekende totaal bedrag benodigd voor de ontmanteling van de KCD, levert het hanteren van Nederlandse uurtarieven een kostenreductie van [redacted] op.

6. Dubbele shift

<u>Situatie</u>
In de NIS 2009 studie wordt uitgegaan van enkele shift, in dagdienst. De periode waarin daadwerkelijk wordt gesloopt en afval verwerkt, is berekend op 7,5 jaar.

<u>Overweging</u>
Een verdere kostenreductie kan worden behaald door het feitelijke afbreken te laten uitvoeren in dubbele shift (vroege/late shift).
Dubbele shift zal de hiervoor genoemde periode niet geheel halveren. Er zijn logistieke zaken zoals opslag capaciteit en snelheid van afvoer van materiaal die dit verhinderen. Een reductie van deze periode met twee tot drie jaar is echter haalbaar.
Voor de manuren die de feitelijke sloop uitvoeren maakt dit niet uit, maar voor de site overhead wel.

<u>Impact op de kosten</u>
De kosten van de workpackages 15 (Project Management, Engineering, Site support, [redacted]) en 16 (Site security, Surveillance and Maintenance [redacted]) van de NIS2009 studie zullen aanzienlijk worden verminderd. Uitgaande van twee tot drie jaar reductie op 7,5 jaar lijkt realistisch. Dit levert een kostenreductie van [redacted].

7. Langere vervalperiode

Situatie

Op dit moment is de vrijgavegrens voor Co-60 1 Bq/g. In de praktijk echter is de vrijgavegrens de grens zoals deze is ingesteld aan de poortmonitor van de schroothandelaar. Deze is veelal ingesteld op waarden direct boven de achtergrond. Dit leidt ertoe dat materiaal wat formeel vrij gemeten is, niet wordt geaccepteerd door de schroothandelaren.
Over de reden van dit gedrag wordt hier niet verder ingegaan. Deze problematiek speelt voor alle nucleaire ontmantelingsprojecten.
Tijdens het Najaarssymposium van de Nederlandse Vereniging voor Stralingshygiëne in november 2013 is deze problematiek door drie sprekers genoemd (GKN, LFR, cyclotron Eindhoven). Het moge duidelijk zijn dat ter zake door de centrale Overheid moet worden ontwikkeld.

Overweging

Om het vrijgegeven maar niet als vrijgesteld geaccepteerd materiaal als radioactief materiaal aan te merken is natuurlijk onzin, maar het is een feit dat bij de ontmanteling van kernreactoren een hoeveelheid materiaal zal ontstaan die door de geschetste problematiek niet is af te voeren. Hierbij komen nog de problemen die bekend zijn van vrijmeten, speciaal die rond de vrijgavegrens.
Een oplossing van het geschetste probleem zou het invoeren van een vervalopslag bij COVRA kunnen zijn. Materiaal met een radioactiviteit (voor Co-60) van minder dan 1,5-2 Bq/g blijft bij COVRA (in 20 voet containers) ongeconditioneerd opgeslagen gedurende 11 jaar. Dan zijn twee halfwaardetijden voor Co-60 voorbij en is de radioactiviteit van het materiaal zeker tot onder de vrijgavegrens gedaald. Dit lijkt een kostenverhogende factor te introduceren, immers de opslagfaciliteit moet worden gebouwd en beheerd, doch deze zal tenminste opwegen tegen de kosten van de discussies en meetinspanningen welke moeten worden geleverd om exact de 1 Bq/g Co-60 aan te kunnen tonen. Ook wordt er winst behaald omdat een hoeveelheid materiaal welke een radioactiviteit (Co-60) van 1-2Bq/g heeft bij het moment van ontmantelen niet als radioactief materiaal behoeft te worden afgevoerd.

Impact op de kosten

Kwantificering van de precieze hoeveelheden en de financiële consequenties is alleen mogelijk als een groot deel van de NIS berekeningen worden overgedaan. Dit is een onderwerp wat moet worden opgenomen in de volgende NIS berekening, thans voorzien te worden uitgevoerd in 2016. Er zijn meerkosten omdat een opslag bij COVRA moet worden gerealiseerd, maar er zijn minderkosten omdat er veel minder nauwkeurig (tijd) hoeft te worden gemeten en minder afval moet worden geconditioneerd.

Overigens is de ultieme conclusie die uit deze werkwijze kan worden getrokken op zijn minst opmerkelijk: laat de Veilige Insluiting zolang staan totdat de operationele kosten op jaarbasis hoger zijn dan de kosten voor opslag van het radioactieve afval. Deze conclusie is niet nieuw. Ook bij IAEA speelt men met deze gedachten. De eerlijkheid gebied te vermelden dat hierbij meestal wordt uitgegaan van een multi-reactor site, waarbij de operationele kosten voor de Veilige Insluiting gering zijn als gevolg van de aanwezigheid van facilitaire diensten voor de in bedrijf zijnde units.

8. Verlenging van de Wachttijd

Situatie

Mocht ondanks alle inspanning, door wat voor oorzaak ook, in 2045 onvoldoende fondsen aanwezig zijn om de eindontmanteling te starten, dan kan besloten worden de eindontmanteling één of meerdere jaren uit te stellen.

Overweging

Omdat de Veilige Insluiting goed onderhouden is, het in de lijn der verwachting ligt dat dit beleid niet wijzigt en voornamelijk correctief onderhoud wordt gepleegd, zijn de operationele kosten goed in te schatten voor een verlengde bedrijfstijd van de Veilige Insluiting. Op basis van de ervaringen van de periode 2005-2014 is de stelling verdedigbaar dat de Veilige Insluiting, mits onderhouden op het niveau zoals dit thans gebeurd, na 40 jaar zeker niet uit elkaar zal zijn gevallen. Een verlenging van de Wachttijd met tien jaar behoort zeker tot de mogelijkheden.

Impact op de kosten

Bij de aanvraag voor Financiële zekerheid (bijlage C7) is al aangetoond dat verlenging van de fase Wachttijd bij het niet op tijd verkrijgen van de vergunning voor Ontmanteling, een jaar vertraging financieel voordeel brengt. De kosten van een jaar extra Veilige Insluiting van de KCD zijn ondergeschikt aan de rentebaten.

9. De actuele situatie in Duitsland

Situatie

Hoewel er alweer stemmen opgaan om de versnelde sluiting van de Duitse kernenergiecentrales ongedaan te maken, wegens de enorme kosten welke de "Energiewende" met zich meebrengt, lijkt de kans dat dit gebeurt vrijwel nihil.
Dat impliceert dat de komende decennia een groot aantal ontmantelingsprojecten in Duitsland worden uitgevoerd.

Overweging

De vele ontmantelingsprojecten zullen zeker leiden tot de ontwikkeling van nieuwe technieken en apparatuur welke de ontmanteling efficiënter en goedkoper zullen doen verlopen.

Impact op de kosten

De kostenreductie ten gevolge van de ontwikkeling van nieuwe technieken kwantificeren is vanzelfsprekend onmogelijk.

10. Kwantificering

Situatie
Volledige kwantificering van alle genoemde zaken is onmogelijk zonder een complete NIS studie opnieuw uit te voeren. Dit omdat in het rekenmodel veel aspecten met elkaar verbonden zijn. Om dezelfde reden is het moeilijk om met een aantal gerichte vragen door NIS een schatting te laten maken van de mogelijke reducties. Bovendien kost dit geld, en het steeds maar weer extra berekeningen laten uitvoeren ten koste van het ontmantelingsfonds is (ook volgens IAEA) één van de snelste manieren om die fondsen kwijt te raken.

Overweging
Bij de volgende herziening van het Ontmantelingsplan GKN, thans voorzien in 2016, dient nadrukkelijk in het dan voor aanvang van de berekeningen op te stellen TRF, te worden aangegeven dat een extra berekening moet worden uitgevoerd naar de "winst" welke wordt behaald c.q. wat de gevolgen en effecten zijn van:
- het uitnemen van reactorvat en overige grote componenten in één stuk,
- het hanteren van Nederlandse uurlonen,
- dubbele shift tijdens de afbraak.

Bovendien zal dan van de Overheid worden gevraagd om de mogelijkheid van opslag van grote componenten in één stuk na te gaan en eventuele knelpunten hierbij te onderzoeken.

Thans is de verwachte planning voor het opstellen van het Ontmantelingsplan 2016 KCD:
-Najaar 2015-voorjaar 2016 opstellen TRF,
-Voorjaar 2016 uitvoer berekeningen door NIS,
-Zomer 2016 opstellen Ontmantelingsplan (waarschijnlijk als een addendum op het al goedgekeurde plan van 2011, maar in ieder geval met gebruikmaking van grote delen van de algemene teksten van het plan 2011),
-Najaar 2016 goedkeuring door Minister.

Impact op de kosten
Niet van toepassing.

11. Conclusies.

Op basis van een aantal aanpassingen aan het goedgekeurde Ontmantelingsplan voor de kernenergiecentrale Dodewaard is het mogelijk aanzienlijke kostenbesparingen te realiseren ten opzichte van de huidige NIS2009/Ontmantelingsplan 2011 KCD calculatie.
Niet al deze kostenreducties zijn thans uitvoerbaar omdat deze aanpassingen van het Nederlandse Beleid op het gebied van verwerking en opslag van radioactief afval vragen. Ook zijn niet alle kosten op dit moment kwantificeerbaar, omdat hiervoor specialistische berekeningen dienen te worden uitgevoerd. Het uitvoeren van dergelijke berekeningen is relatief kostbaar en zal eerst worden uitgevoerd bij de herziening van het huidige Ontmantelingsplan 2011 KCD in 2016, waarbij vooraf in overleg met alle stakeholders een nieuw TRF zal worden opgesteld.

Het overzicht van de mogelijke kostenreductie in M€ is als volgt:
- aanpassing verwerking beton [redacted]
- meer staal omsmelten
- reactor verwijderen als één stuk
- Nederlandse uurtarieven
- toepassen van dubbele shifts
- langere vervalperiode
- ervaringen in Duitsland

De totaal mogelijke besparing bedraagt [redacted]

12. Referenties

(1) Tractebel Engineering, GKN - Evaluation of Decommissioning of the Dodewaard NPP, New decommissioning cost estimate- Technical Requisition File paragraaf 3.3, *"The removal, in one peace, of the Reactor Pressure Vessel (with its internals) will not be considered as this is not an option compatible with the size of the waste packages acceptable for disposal in a deep geological repository"*.

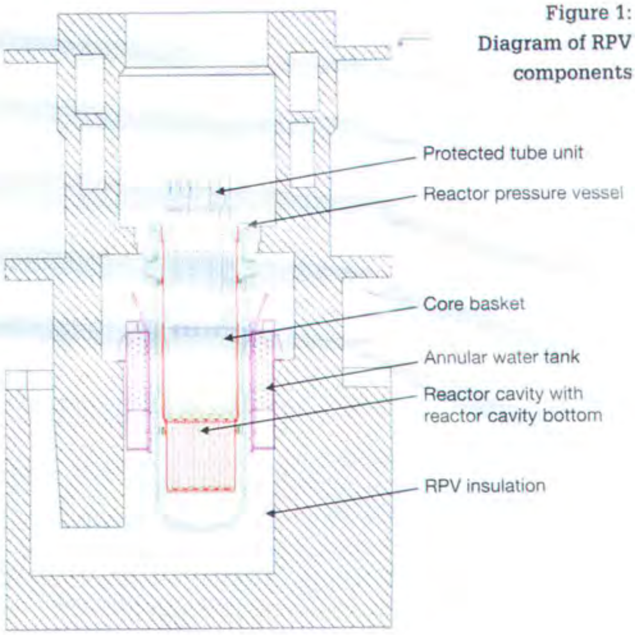
(2) Verslag van de derde bespreking over "Kosten Ontmanteling KCD" met COVRA en ministerie van VROM (16.07.2008).
*"De huidige COVRA-vergunning voorziet alleen in het accepteren van verpakkingen welke opgeslagen kunnen worden in een eindberging. "Grote" verpakkingen, zoals ook de KONRAD verpakkingen van 1,5*1,5*1,5m, vallen daar momenteel niet binnen. Hierdoor vervalt het scenario "verwijdering van het reactorvat in één stuk". COVRA stelt dat de geschiktheid voor eindberging NL beleid is, en ziet ook problemen met de opslag van het vat als één geheel in een nieuw te bouwen loods bij COVRA, en het transport van KCD-Dodewaard naar COVRA-Borsele. GKN is het met de zienswijze niet eens maar heeft op dit moment geen ander alternatief dan dit te accepteren".*
(Deze uitspraak werd gedaan door de directeur COVRA. In een latere vergadering werd vastgesteld dat de genoemde KONRAD containers wel acceptabel waren).

20140220-3 - GKN

Taking apart Greifswald, two ways

Experience dismantling Germany's Greifswald nuclear power plant has shown that both the conventional cutting strategy and large component management strategy can be successful. However, the latter option is often favoured when considering economic and radiological factors.
By Ralf Borchardt

Figure 1: Diagram of RPV components



Eight Russian-designed VVER-440 pressurized water reactors were originally planned for the Greifswald Nuclear Power Plant (KGR) on Germany's northeastern Baltic Sea Coast. The first unit started operation in 1973, with the second a year later; and units 3&4 followed in 1978 and 1979. In 1990, after the reunification of Germany the operating units Greifswald 1-4 along with the 70 MW Soviet-designed Rheinsberg Nuclear Power Plant (KKR), about 140 km south, were shut down. The commissioning of Greifswald unit 5 as well as the construction work at units 6 to 8 was also stopped.

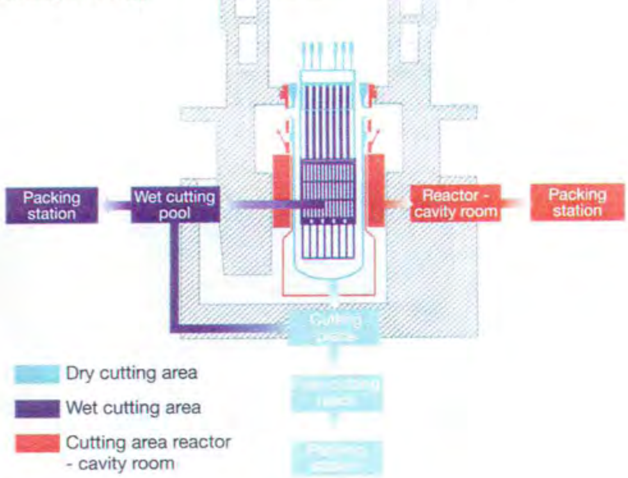
Today Energiewerke Nord GmbH is responsible for the decommissioning and dismantling of both Greifswald and Rheinsberg, along with a number of other nuclear facilities. EWN is the legal successor of the former 'Kombinat Kernkraftwerke,' and has been solely owned by the Federal Ministry of Finance since 2000.

Overall licences for the decommissioning and dismantling of Rheinsberg and Greifswald were both issued in 1995. The Greifswald licence, granted by the responsible Ministries of the Federal State of Mecklenburg/Western-Pomerania on 30 June 1995, covers the dismantling of reactor units 1-5 with part licences for the dismantling of the reactor components. EWN has since applied for additional licences needed for further dismantling of the plant.

Immediately after shutdown, dismantling strategies for reactors 1 to 5 on the Greifswald site (Figure 1) were investigated. It was quickly concluded two strategies should be used: a cutting strategy and a large component strategy.

The cutting strategy (Figure 2) was initially selected for Greifswald units 1-4 (and also Rheinsberg) due to the length of time they had been in operation (12-24 years). It involved cutting the reactor components into segments and packaging them into containers for subsequent interim and decay storage. The large component strategy, which involved transporting the whole reactor pressure vessel with appropriate shielding to an on-site Interim Storage North Facility (ISN), was selected for Greifswald 5 [1].

Figure 2: Original cutting strategy



Cutting strategy

Three cutting areas were installed for the remote dismantling of the reactor components from Greifswald 1-4: a dry cutting area and a wet cutting area located in the former steam generator rooms of units 2 and 4, and a cutting area in the reactor pit.

The dry cutting area was to be used to cut the reactor pressure vessel (RPV) and the low-activated parts of the reactor internals such as the reactor cavity and protective tube unit. The dry cutting area (Figure 3, p30) had two cutting places. In the first cutting place, rings were cut with horizontal cuts, and the reactor components were cut from bottom to top. To balance their weight and for lowering the reactor components after cutting, a flexible wire hoist was used. After the horizontal cut, the ring was taken by a transport vehicle with turntable to the post-cutting place where it was cut vertically into segments. Finally, a power manipulator was used to handle the segments and package them into the storage/transport container.

The wet cutting area was to be used for the cutting of the core basket, reactor cavity bottom, as well as the higher-activity parts of the reactor cavity and the protected tube unit. This area consists basically of a cutting pool with cutting devices, different transport and handling devices, a water cleaning system and a packing station. RPV components were cut from top to bottom. During the cutting, the components were fixed on the turntable in the cutting pool and covered with water (see Figure 4, p30).

The cutting area in the reactor pit was prepared for in-situ cutting of

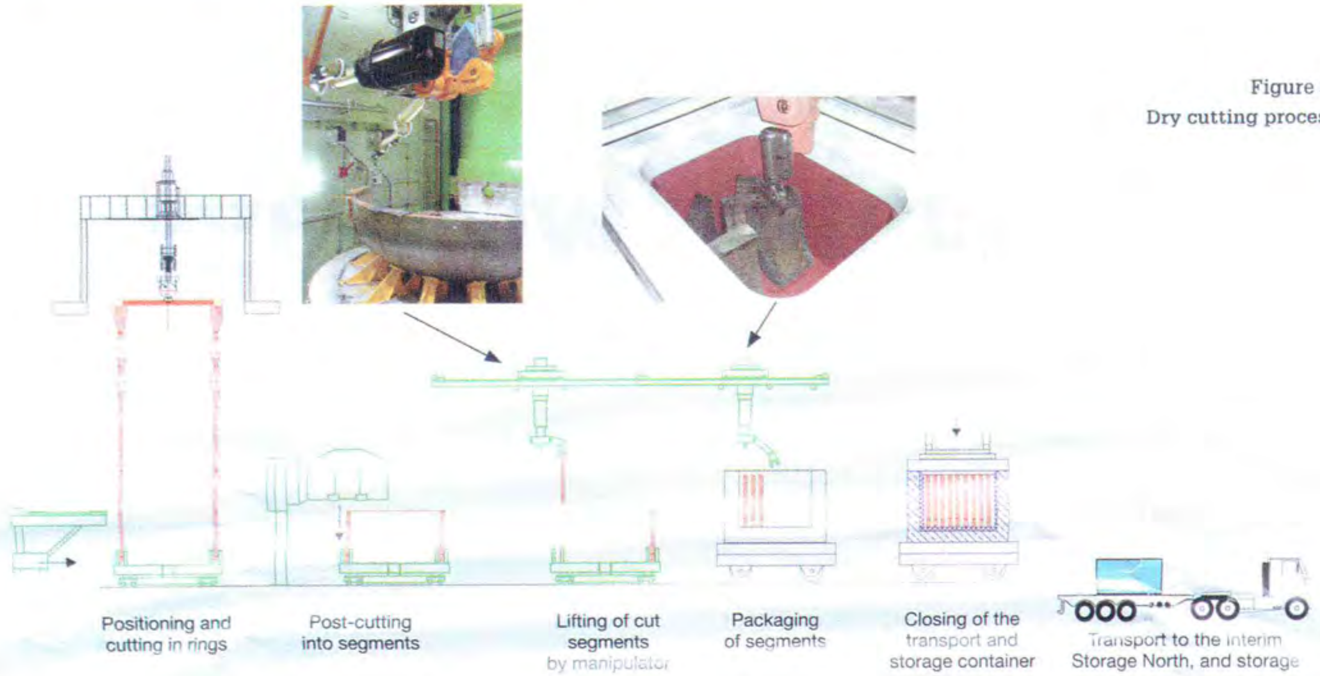


Figure 3: Dry cutting process

the corresponding annular water tanks (biological shield) and the RPV insulation.

The remote dismantling and packing of the RPV and internals was tested and optimized for the use with activated reactors in a long model-dismantling phase with non-activated reactor components from units 7 and 8 that ran from October 1999 to July 2003 [2]. The experience gained during planning and implementation of the model dismantling at Greifswald was also expected to form the basis for the remote dismantling of the Rheinsberg reactor.

Change of strategy

For Greifswald unit 5, EWN planned to transport the RPV as a whole component to the Interim Storage North Facility (ISN), on the same site. The four reactor internals were to be packed into shielded transport and storage devices and transported to the ISN for decay storage. In December 2003 the RPV of unit 5 was lifted and stored, without cutting, in the ISN.

Following an evaluation of its experience at unit 5, EWN considered a change in the disposal strategy for reactors 1-4 at Greifswald and the reactor at Rheinsberg (see Table 1, p31). Ultimately, it decided to continue with the cutting and packing of the reactor internals of Greifswald 1 and 2, which had started in August 2004, and also at Rheinsberg where dismantling activities started in September 2006 [3].

In parallel EWN also investigated a new decommissioning strategy (Figure 5, p31):

- The RPVs of units 1 to 4 and the reactor internals of units 3, 4 and 5 of Greifswald, as well as the Rheinsberg reactor pressure vessel to be stored as shielded large components in the ISN
- The reactor internals (core basket and protective tube unit) of units 3 and 4 to be packed into shielded transport and storage devices for decay storage
- The dismantling of the annular water tank and the RPV insulation is to be continued in the reactor pit.

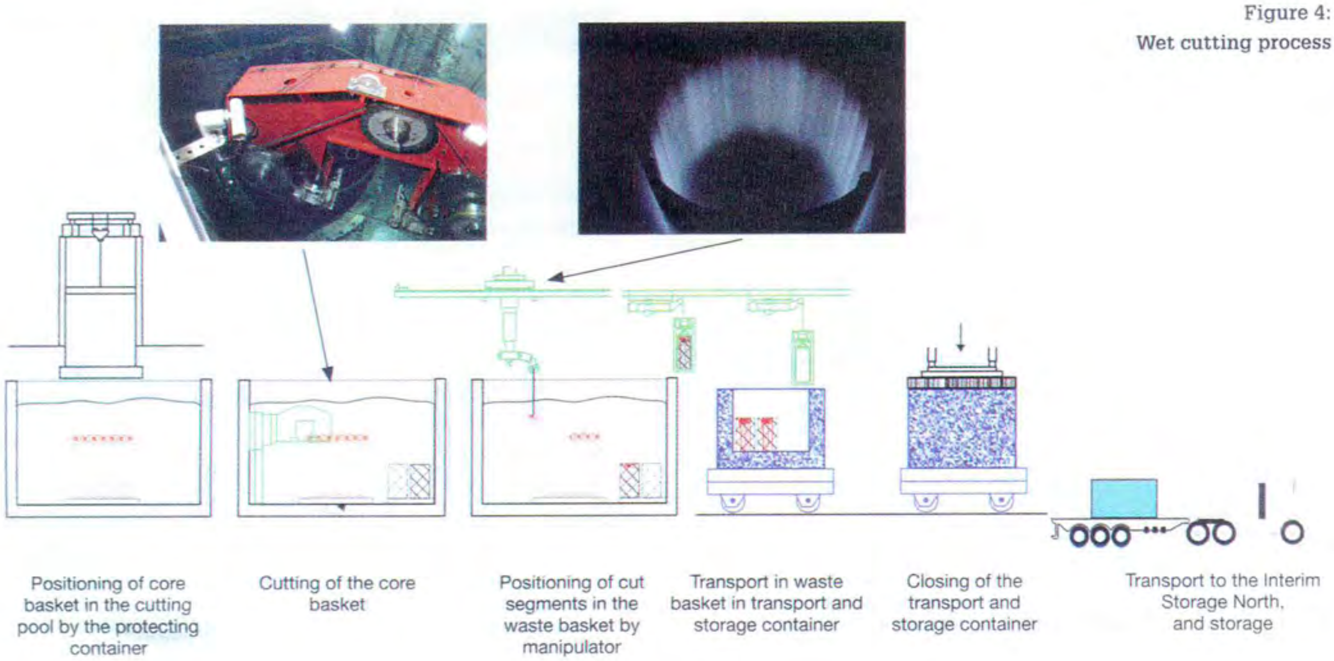


Figure 4: Wet cutting process

Table 1: Comparison of models for dismantling and transport of the unit 5 RPV		
	Cutting strategy	Large component management
Project time	100%	
Engineering	100%	45-65%
Preparation	100%	35-55%
Execution	100%	8-12%
Waste management	100%	50-70%
Collective dose rate	100%	15-20%
Costs	100%	40-55%

Dismantling the RPV internals

Units 1&2

Before hot operation could begin at Greifswald 1&2, a dismantling report had to be checked and approved by the authorities. The equipment used for the model dismantling in unit 5 also had to be installed in unit 2.

First, a milling machine was used to cut the nozzles (main coolant pipe connections) of the primary circulation pipe of the RPV. Dismantling of all 12 RPV nozzles was successfully completed in just 29.4 hours, around 2.5 hours per nozzle.

In parallel, the RPV internals were cut and packed within the wet and dry cutting areas. This work started in August 2004 and was successfully finished in July 2007. Overall, eight RPV internals with a total mass of 217.7 tons and a total activity of 2.15 $\times 10^{16}$ Bq were remotely cut and packed into a total of 135 containers, six storage and transport casks and 20 waste drums. The applied collective dose was approximately 110 mSv, 40% below the expected collective dose [4].

The dismantling of the RPV internals at Rheinsberg was carried between September 2006 and September 2008, taking into account the experience from Greifswald. The wet cutting area was installed in a former spent fuel pond. Four RPV internals with a total mass of 41.22 tons and total activity 3.56 $\times 10^{15}$ Bq were cut underwater and remotely packaged.

Units 3-5

The packing of the four RPV internals for each of the units 3, 4 and 5 at Greifswald into a shielding and transport container and their subsequent transport to and storage in the ISN was carried out from April until June 2006.

EWN decided to pack the reactor cavity/cavity bottom together with the RPV and to transport it into the ISN. For the reactor internals' protective tube unit and core basket, disposal in shielding and transport containers was preferred. However, since the reactors of units 3 and 4 operated for much longer than unit 5, these components were highly activated and new considerations had to be taken into account to ensure their safe handling and storage.

The complete process was therefore fully tested with the non-activated reserve core basket of plant 2 (units 3&4). During this cold test, all process steps, especially the remote ones, could be sufficiently tested and the personnel could be comprehensively trained.

Dismantling of the RPV

Units 1&2

The preparation of the transport of the reactors 1 to 4 started in 2005. At units 1 and 2 the transport of the RPVs inside the reactor building had to be carried out with the reactor hall crane. For this reason the processes had to be optimized and the amount of shielding minimized so that the maximum lift capacity of 250-ton of the reactor hall crane was not exceeded. This involved carrying out precise activation calculations of the RPV material, based on radiological measurements and samples taken in 2004, and conducting static investigations to find out the areas of the building (in particular the area of the rail corridor) that required reinforcement.

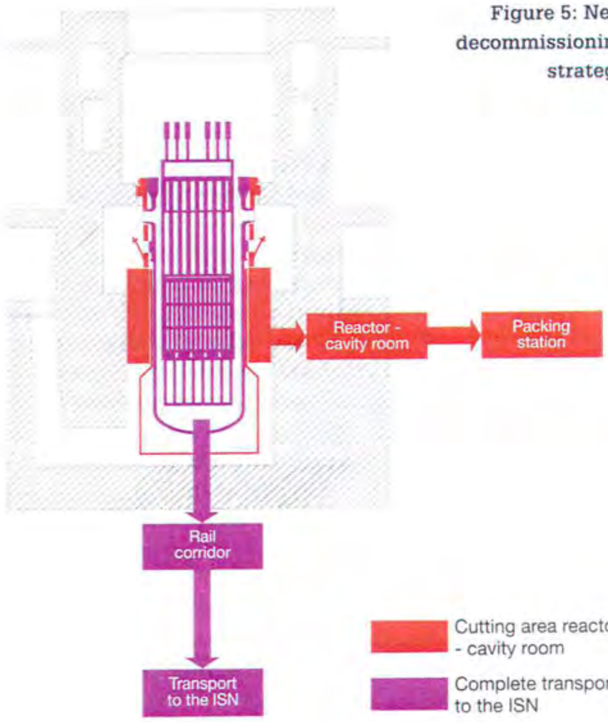


Figure 5: New decommissioning strategy

In 2005, the manufacturing and installation of the new facilities and equipment, as well as the heavy load transport from plant 1 (units 1 and 2) to the ISN was commissioned. Construction preparation work began at plant 1 and at the ISN in February and was finished end of May 2007. In August 2007, EWN received the licence for the strategy change. Transports of the RPVs of units 1 and 2 were carried out, on schedule, between 8 November and 23 November 2007.

Units 3&4

Once the unit 3&4 core baskets and protecting tube units had been transported to the ISN, EWN started intensive preparation works for the transport of their RPVs (plus inserted reactor cavity/cavity bottoms). Extensive safety analyses were of major importance during the preparation phase.

The static reinforcements required for units 3&4 were much more extensive than for units 1&2, as the total mass of the reactor with shielding was approx. 360 Mg and a force of 5270 MN was acting on the construction during the loading of the reactor cavity/cavity bottom into the RPV.

The following dismantling strategy was developed for units 3&4 on the basis of the experience made during the previous reactor transports:

- Dismantling of the cavity with cavity bottom from the RPV with the help of the reactor protection containers, as well as transport and parking in the maintenance pit
- Unshielded transport of the RPV from the installation position with the reactor hall crane and remote control to the rail corridor
- Placement of the RPV in a shielding cylinder (in vertical position)
- Transport of the cavity/cavity bottom with the help of the reactor protection container to the RPV in the rail corridor and placement in the RPV
- Closing of the RPV flange with a shielding plate with transport traverse
- Tilting of the reactor (using a carrying portal with wire hoist) into horizontal position in a transport unit.

- Moving the reactor in the rail corridor out of the reactor building
- Reloading of the reactor onto a heavy load transport unit
- Transport to the ISN (internal transport)
- Reloading of the reactor back onto a heavy transport unit
- Moving the reactor to the parking position in hall 7 of the ISN

To distribute the load during the tilting of the shielded RPV, a support was installed in the cable cellar below the rail corridor. For the transport of the reactor into the ISN, the reactor had to be tilted into the horizontal position. For this purpose a tilting device had to be installed below the northern rail corridor hatch. To move the tilted reactor in the rail corridor, a transport unit was installed. This device consists of an approx. 65m long double-tracked slide way built on a load distributing sub-construction, and two pairs of skidshoes which each are connected to a saddle and have an integrated hydraulic jack.

First, while the units 3 and 4 RPVs were in the installation position in the reactor pit, the reactor internals were removed and the RPV was emptied of residual water. The fixing elements of the RPV were also removed; all 12 reactor coolant pipes and instrumentation lines were disconnected, closed and shielded. The flange opening of the RPV was closed.

For the transport of the RPV from the installation position to the rail corridor, the same equipment was used as for the transport of the RPV units 1, 2 and 5, without shielding because of the crane's weight restrictions. Due to the maximum load capacity of the reactor hall (250t), the RPV was transported without the shielding cylinder for the core area, because the overall weight of RPV with shielding plate and RPV-traverse was already 225 Mg. The crane was operated remotely from behind radiological shielding to protect workers.

After the proper positioning of the reactor above the shielding cylinder, the reactor was lowered by the reactor hall crane and inserted into the shielding cylinder.

Once the shielding cylinder had been fixed the RPV, the reactor cavity with cavity bottom was inserted in the RPV. This was carried out with the help of a reactor protection container. Due to the weight of the reactor (RPV + reactor cavity with cavity bottom + shielding) now about 360 Mg, it was not possible to reload and tilt the reactor using the reactor-building crane. Therefore, a carrying portal with wire hoist was used for this task.

The tilting of the RPV into the horizontal position was realized just before transporting the reactor to the ISN. After having connected the flexible wire hoist with the transport-traverse, the reactor support could be unfastened. By alternating movement of the carrying portal and lowering of the flexible wire hoist hook the reactor was brought into a slanted position.

The shielded RPV was skidded outside to a hydraulic lifting unit with a lifting capacity of 1100 Mg and a lift height of 7.3 m was positioned. With the help of this lifting unit the complete reactor with shielding was lifted from the transport saddles and loaded on the heavy load transport vehicle. After load securing the reactor was transported to the ISN with a maximum speed of 3 km/h.

The transport of the reactor of unit 4 was realized immediately after finishing the transport of the reactor from unit 1 in November 2007.

Biological shield/ RPV insulation

After the removal of the RPV out of the reactor pit, the annular water tank and the RPV insulation were moved from inside the reactor pit. First the shielding plates above and below the former core zone were mounted. Thus it was possible to manually dismantle the lower part of the RPV insulation. As the RPV insulation contained asbestos, the work had to be carried out according to special regulations. Once the lower RPV insulation had been removed, an inner shielding ring was installed. The gap between the annular water tank and the shielding ring was filled with concrete to reduce the dose rate. With the help of a wire saw the annular water tank including RPV insulation was cut into 11 segments. These segments were lifted into the reactor hall and tilted into a horizontal position. Then, the segments were put into special 20-foot containers with shielding and transported to the ISN for decay storage and future conditioning.

Figure 6: Tilting of the covered unit 3 reactor in the rail corridor with wire hoist

Lessons

The dismantling of the reactors at Greifswald and Rheinsberg has now been completed. The project has shown that both the cutting and large component strategies can be successfully realized. The strategy chosen will depend on the priorities at a particular site. The conventional cutting strategy always seems to be reasonable when facilities for decay storage and future conditioning are not available. On the other hand if facilities are available, interim storage of large components is not only an alternative to cutting but a favourable option especially when considering economic and radiological aspects.

Following on from the Rheinsberg and Greifswald project, EWN has now started preparation work for dismantling the AVR, prototype pebble bed reactor at the Julich Research Centre.

EWN has also been charged with the dismantling of the reactor of the Obrigheim Nuclear Power Plant. In 2005 this pressurized water reactor was shut down after more than 35 years of operation. The dismantling of the reactor is to be carried out by remote cutting and packing of the activated reactor components. Much of the equipment from the dismantling of the KGR and KKR will be used.

Ralf Borchardt (ralf.borchardt@ewn-gmbh.de), Energiewerke Nord GmbH, Latzower Straße 1, 17507 Rubenow, Germany.

This article is based on paper 13043 'Implemented Dismantling Strategies for the Reactors in the Greifswald and Rheinsberg Nuclear Power Plant,' presented at the Decommissioning Challenges – Industrial Reality and Prospects, 7-11 April 2013 in Avignon, France.

References are available on the online version of this article, www.tinyurl.com/greifsfull

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10 2 e [redacted]

Van: [redacted]
Verzonden: donderdag 20 februari 2014 16:51
Aan: [redacted]
Onderwerp: FW: Rapport "Kostenreductie Ontmantelingsplan 2011 KCD als gevolg van innovatie en overige ontwikkelingen"
Bijlagen: DR 14-004 brief aan minEZ-[redacted]-Kostenreductie Ontmantelingsplan 2011 KCD agv innovatie en ov. ontw..pdf; DR-14-003 Kostenreductie Ontmantelingsplan 2011 KCD - concept versie.docx

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Van: [redacted]
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Onderwerp: Rapport "Kostenreductie Ontmantelingsplan 2011 KCD als gevolg van innovatie en overige ontwikkelingen"

Geachte [redacted]

Bijgaand doe ik u de digitale versie van het rapport "Kostenreductie Ontmantelingsplan 2011 KCD als gevolg van innovatie en overige ontwikkelingen" toekomen als mede de digitale versie van de aanbiedingsbrief. Beide documenten spreken voor zichzelf. De hard copy exemplaren zijn heden 20 februari 2014 per normale post verzonden .

Ik vraag u vriendelijk zelf voor interne verspreiding zorg te dragen.

Met vriendelijke groeten,
[redacted]

20140324 - GKN

Ministerie van Economische Zaken

> Retouradres Postbus 20401 2500 EK Den Haag

B.V. Gemeenschappelijke Kernenergiecentrale Nederland (GKN)
[redacted]
B.V. Nederlands Elektriciteit Administratiekantoor, directie GKN
Postbus 40
6669 ZG Dodewaard

Directoraat-generaal Bedrijfsleven & Innovatie
Directie Innovatie en Kennis

Bezoekadres
Bezuidenhoutseweg 73
2594 AC Den Haag

Postadres
Postbus 20401
2500 EK Den Haag

Factuuradres
Postbus 16180
2500 BD Den Haag

Overheidsidentificatienr
00000001003214369000

T 070 379 8911 (algemeen)
www.rijksoverheid.nl/ez

Behandeld door
10 2 e [redacted]

Ons kenmerk
DGBI-I&K / 14042149

Uw kenmerk

Bijlage(n)
1. verslag overleg 6 feb. 2014

Datum - 10 MAART 2014 -
Betreft Reactie op uw rapport Kostenreductie Ontmantelingsplan 2011 KCD

Geachte 10 2 e [redacted]

Wij hebben uw brief van 20 februari jl. en het rapport "Kostenreductie Ontmantelingsplan 2011 KCD als gevolg van innovatie en overige ontwikkelingen" (hierna: het rapport) in goede orde ontvangen.

Bij uw aanvraag, ontvangen d.d. 8 juli 2013, heeft u rekening gehouden met de kosten van ontmanteling exclusief inflatie, met als argument dat nieuwe innovatieve technieken zullen compenseren voor de inflatie.

Op 27 januari jl. heeft GKN van de Staat het verzoek ontvangen onder meer dit onderdeel van de aanvraag nader te onderbouwen. Tijdens de bespreking van 6 februari 2014 tussen de Staat en GKN is dit nader toegelicht en besproken. Ik constateer dat het bovengenoemde rapport de verzochte onderbouwing niet biedt, omdat:

- in het rapport niet wordt ingegaan op de inflatiecomponent en de hoogte hiervan. Dit maakt het voor de Staat niet mogelijk te beoordelen of innovatieve technieken inderdaad het effect van inflatie teniet doen.
- Het rapport gaat wel in op innovatieve technieken die gebruikt zouden kunnen worden bij de ontmanteling van Kerncentrale Dodewaard (KCD) en een kostenbesparing opleveren. GKN maakt daarbij echter twee kanttekeningen. Ten eerste wordt aangegeven dat niet alle beschreven kostenreducties uitvoerbaar zijn, omdat deze aanpassing van het Nederlandse beleid op het gebied van verwerking en opslag van radioactief afval vergen. Ten tweede wordt gesteld dat niet alle kostenreducties kwantificeerbaar zijn, omdat hiervoor specialistische berekeningen dienen te worden uitgevoerd. Deze beide kanttekeningen leiden ertoe dat ook in dit opzicht niet de verzochte onderbouwing wordt gegeven dat innovatieve technieken de kosten van inflatie zullen compenseren.

U heeft aangegeven uiterlijk 24 maart 2014 de brief van 27 januari jl. met aanvullende vragen te beantwoorden. Bijgevoegd vindt u tevens een verslag van ons overleg van 6 februari 2014.

Directoraat-generaal
Bedrijfsleven & Innovatie
Directie Innovatie en Kennis

DGBI-I&K / 14042149

Hoogachtend,
De Minister van Economische Zaken,
namens deze:
10 2 e
[redacted]

Bijgevoegd:

1. Verslag bespreking GKN - Ministerie van Economische Zaken - Ministerie van Financiën d.d. 6 februari 2014

Directoraat-generaal Bedrijfsleven & Innovatie
Directie Innovatie en Kennis

Behandeld door
[redacted]

Datum
7 maart 2014

Kenmerk
DGBI-I&K / 14042199

Kopie aan

Bijlage(n)

verslag

Omschrijving	Verslag bespreking GKN - Ministerie van Economische Zaken - Ministerie van Financiën
Voorzitter	[redacted]
Vergaderdatum en -tijd	6 februari 2014
Locatie	Ministerie van Economische Zaken
Aanwezig	[redacted]
Afwezig	

Agendapunten

- Inflatie/innovatie
- Vragen GKN naar aanleiding van brief van EZ/FIN met kenmerk DGETM-ED/13214630
- Relatie GKN-NEA

Inflatie/innovatie

- [redacted] licht toe dat de aanname van GKN inzake de effecten van inflatie en de effecten van innovatie in diens aanvraag d.d. 1 juli 2013 zonder nadere onderbouwing niet kan worden beoordeeld. [redacted] geeft aan dat GKN diens aanname de afgelopen periode verder heeft onderbouwd. [redacted] stelt voor dat GKN diens aanname en onderbouwing kwalitatief en financieel laat toetsen door een onafhankelijk deskundige. De uitkomst van deze toetsing kan GKN verwerken in diens aanvraag zodat EZ en FIN de aanname van GKN over de effecten van innovatie en de effecten van inflatie kunnen beoordelen. Bij een toetsing door een onafhankelijk deskundige geldt de huidige wet- en regelgeving als kader, maar de deskundige heeft de ruimte om te onderzoeken in hoeverre binnen internationale standaarden innovatieve technieken mogelijk zijn die tot concrete kostenbesparing kunnen leiden. GKN is van plan om in 2015 diens ontmantelingsplan conform de wettelijke verplichting te actualiseren. [redacted] geeft aan dat het beoogde onderzoek als basis kan dienen voor het toekomstige ontmantelingsplan, zodat daarmee dubbel werk kan worden vermeden. Afgesproken wordt dat GKN binnen een termijn van twee weken EZ en FIN zal informeren over de onafhankelijk deskundige(n) die de vergunninghouder wil inschakelen voor het onderzoek. GKN zal het onderzoek laten uitvoeren in samenspraak met EZ en FIN.

- [redacted] vraagt aandacht voor het feit dat in het onderzoek inflatie-indexaties gebruikt moeten worden die als referentie kunnen dienen voor de inschatting van de hoogte van de ontmantelingskosten van kernenergiecentrale Dodewaard.
- [redacted] merkt op dat de beslistermijn is opgeschort tot uiterlijk 24 maart 2014, dit is de uiterlijke reactietermijn voor GKN ten aanzien van de brief met aanvullende vragen die GKN van EZ en FIN heeft ontvangen. [redacted] is daarnaast akkoord met het verlengen van de opschorting van de beslistermijn tot na het onderzoek naar inflatie en innovatie, onder de voorwaarde dat GKN instemt met dit onderzoek.

<u>Vragen GKN n.a.v. brief met kenmerk DGETM-ED/13214630</u>

- [redacted] stelt dat de discussie met de Belastingdienst over de verrekening van BTW inzake de ontmantelingskosten is afgerond: De belastinginspecteur gaat akkoord met de aftrekbaarheid van BTW over de kosten voor ontmanteling na 2045.
- [redacted] licht toe dat de voorziening inzake het sociaal plan van toepassing is op 6 personen die 62 jaar of ouder zijn. [redacted] gaat er daarom vanuit dat GKN geen rekening hoeft te houden met de mogelijkheid dat de betrokken personen elders werk zullen vinden. Desgevraagd bevestigt [redacted] dat de contante waarde van de verwachte uitgaven in verband met de uitvoering van het sociaal plan [redacted] bedragen. [redacted] benoemt dat de jaarrekening 2012 een voorziening meldt 10 1 c [redacted] licht toe dat in de jaarrekening over 2013 een herschikking van de voorzieningen zal plaatsvinden.
- Naar aanleiding van de hiervoor genoemde voorziening vraagt [redacted] naar de voorziening inzake de opwerking van splijtstof. GKN heeft het ministerie van Economische Zaken schriftelijk geïnformeerd (DR 13-035 van 31 oktober 2013), waarin GKN stelt dat zij als gevolg van een overeenkomst met de Britse Nuclear Decommissioning Authority geen verplichtingen meer heeft ten aanzien van de nucleaire brandstoffen die in het verleden zijn gebruikt bij de opwekking van elektriciteit. [redacted] bevestigt op basis van deze overeenkomst dat GKN geen financiële risico's meer loopt op dit terrein en dat de voorziening opwerking splijtstof dus niet meer nodig is. Desgevraagd geeft [redacted] aan dat in de overeenkomst slechts één vrijwaring is opgenomen van GKN ten aanzien van NDA, die erop neer komt dat GKN de verplichting heeft om de inhoud van het contract niet te delen met derden (met uitzondering van de Nederlandse overheid) op straffe van een boete. Verder zitten in het contract volgens [redacted] geen clausules die nog tot toekomstige uitgaven voor GKN kunnen leiden.
- [redacted] stelt twee vragen over het onderwerp vertraging en beleggingsrendement. Besloten wordt om beide onderwerpen buiten de vergadering verder te bespreken.
- [redacted] bevestigt dat GKN de interpretatie deelt dat de kosten voor eindberging onderdeel vormen van de kosten van het buiten gebruik stellen en de ontmanteling van kernenergiecentrale Dodewaard en dat artikel 15f van de Kew hierop betrekking heeft. [redacted] wil echter benadrukken dat de onderbouwing van de kosten voor eindberging voor GKN niet transparant zijn,

omdat de vergunninghouder hierbij dient uit te gaan van de informatie die van Covra is ontvangen. Deze prijsinformatie is volgens [redacted] niet duidelijk onderbouwd.

- Afgesproken wordt dat GKN een en ander toelicht in de schriftelijke beantwoording van de vragen.

Relatie GKN-NEA

- [redacted]

20141120 - GKN

B.V. Gemeenschappelijke Kernenergiecentrale Nederland
Waalbandijk 112A, 6669 MG Dodewaard

Kostenreductie Ontmantelingsplan 2011 KCD als gevolg van innovatie en overige ontwikkelingen

24 maart 2014

Opgesteld door:

10 2 e [redacted]

Samenvatting

In 2009 en 2010 is een Ontmantelingsplan voor de kernenergiecentrale Dodewaard (KCD) opgesteld. De Minister van Economische Zaken heeft bij Besluit van 13 september 2011 gesteld dat dit plan genaamd "Ontmantelingsplan 2011 KCD", voldoet aan de eisen die daaraan gesteld zijn in de artikelen 26, 1^e en 2^e lid van het Besluit kerninstallaties, splijtstoffen en ertsen en 3, 1^e en 2^e lid, van de Regeling buitengebruikstelling en ontmanteling van nucleaire inrichtingen.

Het Ontmantelingsplan 2011 KCD is in de jaren 2009 en 1010 opgesteld door INS Ingenieur-gesellschaft MbH met medewerking van GKN, Belgatom/Tractebel Engineering (de adviseurs van GKN), het (toenmalige) Ministerie van VROM en COVRA. De daarbij gehanteerde parameters zijn tot stand gekomen met inbreng en goedkeuring van alle betrokken partijen en verwoord in de door Belgatom/Tractebel Engineering opgestelde Technical Requisition File.
Als gevolg van innovatie en overige ontwikkelingen, vooral door de in afgelopen jaren in gang gezette ontmanteling van meerdere Amerikaanse en Duitse kernenergiecentrales, is het in 2009 en 2010 opgestelde Ontmantelingsplan voor de kernenergiecentrale Dodewaard, achterhaald. De eerstvolgende (wettelijke) evaluatie van het Ontmantelingsplan 2011 KCD is gepland in 2016. Echter gegeven de snelheid waarin de ontwikkelingen rond ontmanteling van nucleaire installaties plaatsvinden acht GKN het geboden een tussentijds rapport terzake op te stellen.

Dit rapport beschrijft een aantal kosten reducerende maatregelen waardoor het totaal aan kosten voor de ontmanteling van de kernenergiecentrale Dodewaard aanmerkelijk kunnen worden verminderd. De beschreven maatregelen zijn gebaseerd op de actuele praktijk betreffende ontmanteling van kernenergiecentrales in Europa. Een deel van deze maatregelen en technieken zijn thans niet uitvoerbaar omdat zij in strijd zijn met het Nederlandse Beleid op het gebied van de verwerking en opslag van radioactief afval, en de Nederlandse Wet- en Regelgeving . In de landen rondom Nederland zijn dergelijke technieken echter al meerdere malen toegepast. Het verdient aanbeveling om het Nederlandse Beleid en de Wet- en Regelgeving op het gebeid van verwerking en opslag van radioactief afval in lijn te brengen met de Europese ontwikkelingen op dit gebied. De beschreven maatregelen en technieken zullen worden opgenomen in de volgende herziening van het Ontmantelingsplan voor de kernenergiecentrale Dodewaard, thans voorzien te worden opgesteld in 2016.

In het Ontmantelingsplan 2011 KCD zijn de kosten voor ontmanteling en eindberging van radioactief materiaal uit te voeren in de periode vanaf 2045, op basis van het prijspeil 2009/2010 berekend op 10 1 c [redacted] Als gevolg van innovatie en overige ontwikkelingen zouden die kosten thans [redacted] bedragen, een besparing derhalve van [redacted]

Inhoudsopgave

1. Inleiding

GKN heeft in 2008 in samenwerking met vertegenwoordigers van het (toenmalige) Ministerie van VROM en van COVRA een Technical Requisition File (hierna: TRF) opgesteld, dat als uitgangspunt diende voor de Ontmantelingskostenberekening van de kernenergiecentrale Dodewaard (hierna: KCD). Dit TRF is formeel goedgekeurd door de directeur COVRA en de secretaris-generaal van het Ministerie van VROM. De resultaten van deze berekeningen zijn vermeld in de rapporten van NIS "Evaluation of Decommissioning of the Dodewaard NPP – New Decommissioning Cost Estimate".
De in april 2010 uitgebrachte studie staat bekend onder de naam NIS2009. De bij de opstelling van de studie betrokken vertegenwoordigers van het Ministerie van VROM, COVRA, NIS, Belgatom/ Tractebel Engineering en GKN hebben allen schriftelijk verklaard dat zij akkoord zijn met de resultaten van deze studie.
Het onderdeel Task 1, "Reference scenario - Starting date of decommissioning 2015" vormde de basis voor het door GKN bij de Minister van Economische Zaken & Innovatie ingediende aanvraag goedkeuring Ontmantelingsplan. De Minister heeft deze goedkeuring in september 2011 schriftelijk bevestigd. In 2013 heeft GKN een aanvraag "Goedkeuring Financiële Zekerstelling kosten Ontmanteling van de KCD" (hierna: FZO) ingediend bij de Minister van Economische Zaken en de Minister van Financiën. GKN heeft bij de Aanvraag FZO (in bijlage C.6) aangegeven dat de in de kostencalculaties te verwerken inflatie kan worden gecompenseerd door toepassing van actuele- en innovatieve technieken bij de ontmanteling van de KCD. Tijdens overleg terzake met vertegenwoordigers van de Ministeries van EZ en FIN is GKN verzocht het GKN standpunt nader te onderbouwen.

In de NIS2009 studie zijn de uitgangspunten gehanteerd zoals vastgelegd in het TRF. Ten tijde van het opstellen van dit TRF benaderden de parameters de "best practices" zoals deze wereldwijd werden toegepast. Deze waren tevens in lijn, of konden in lijn worden gebracht met het Nederlandse Beleid in zake verwerking en opslag van radioactief afval. Een voorbeeld hiervan is het toepassen van Duitse afvalverpakkingen.
Inmiddels is het vijf jaar geleden dat het TRF is opgesteld en is er meer wereldwijde ervaring met de ontmanteling van nucleaire installaties opgedaan.
In voorliggend rapport worden een aantal van deze nieuwe inzichten en wereldwijde ontwikkelingen nader beschreven, inclusief hun kostenimpact.

Een aantal van deze inzichten waren al bekend bij het opstellen van het TRF in 2009. Zo is het niet volledig demonteren, maar als één stuk verwerken van grote componenten al door GKN in 2009 voorgesteld tijdens de derde voorbespreking van het TRF. Het opslaan van componenten in één stuk en het niet verder verwerken heeft als voordeel dat na een vervalperiode het metaal kan worden gerecycled. Dit is een besparing van grondstoffen. In 2009 werd door de toenmalige directeur COVRA gesteld dat dit (op dat moment) onbespreekbaar was, omdat dit niet in lijn was met het Nederlandse Beleid ten aanzien van radioactief afval. Alle afval moest volgens het toen (en nog) geldende Beleid worden verkleind en verpakt in zodanige pakketten dat opslag in de diepe ondergrond mogelijk was (REF 1, 2). Niet alleen leidt dit ertoe dat extra afscherming materiaal (en dus op te slaan volume) wordt geïntroduceerd, maar tevens moeten extra verwerkingshandelingen worden uitgevoerd (dosis voor medewerkers), terwijl het terughalen en hergebruiken van dergelijk materiaal na verval lastig is. Inmiddels is deze regel wereldwijd achterhaald. Het Nederlandse Beleid in zake radioactief afval dient te worden geëvalueerd en in lijn te worden gebracht met de laatste stand der techniek en de ontwikkelingen in landen om Nederland heen.

Bij de vijfjaarlijkse herevaluatie van het GKN Ontmantelingsplan in 2016 zullen de parameters in het TRF worden aangepast, gebaseerd op voortschrijdend inzicht en wereldwijde ontwikkelingen. Dit leidt tot een nieuwe kostenberekening van de Ontmantelingskosten.

Om goedkopere verwerking van radioactief afval mogelijk te maken dienen echter wel aanpassingen in het Nederlandse Beleid op het gebied van de verwerking van radioactief afval te worden doorgevoerd om aan te blijven sluiten bij de internationale ontwikkelingen. Indien dit niet is gebeurd voor het vaststellen van het TRF 2015/2016, zal het TRF zo worden ingericht dat naast een kostenberekening op basis van de dan vigerende regelgeving, er een tweede berekening kan worden uitgevoerd met alternatieve verwerking en verpakking.

Bij recente discussies over deze alternatieve verwerkingsvormen is door de medewerkers van de betrokken Ministeries geopperd om de voorgestelde aangepaste methodes van verwerking door een onafhankelijke partij te laten beschouwen op hun (on-)mogelijkheid en de hiermee gepaard gaande kosteneffecten. Ook werd geopperd dat de voorgestelde maatregelen en technieken nu al konden worden uitgewerkt en te zijner tijd ingepast in het Ontmantelingsplan 2016 KCD. Bij nadere beschouwing is GKN van mening dat dit niet verstandig is. Welke partij ook gevraagd wordt deze analyse uit te voeren, de uitkomsten van de analyse staan al vast. Alle partijen zullen aangeven dat dergelijke alternatieve verwerking- en verpakkingstechnieken zijn en worden toegepast. Hiervan zijn immers volop voorbeelden aanwezig. Daarnaast zullen zij stellen dat zonder verdere analyse het niet mogelijk is om een realistische kostenschatting te maken. Een deelstudie is bovendien niet uitvoerbaar omdat veel van de parameters worden beïnvloed door de uitgangspunten zoals loonkosten en vrijgavegrenzen. Juist die zijn weer onderwerp van discussie in een nieuw TRF. Een extra studie leidt bovendien tot extra kosten, wat weer ten koste gaat van de fondsen bestemt voor de amovering. Ter informatie: de IAEA waarschuwt in verschillende van haar publicaties over decommissioning voor het verlies van fondsen door het steeds maar weer uitvoeren van (aanvullende) studies. Daarnaast zal men constateren dat het Nederlandse Beleid in zake de verwerking van radioactief afval, de voorgestelde aanpassingen van verwerking en opslag van het afval niet toestaat. Daarom wordt deze exercitie niet zinvol geacht.

2. Verwerking van beton

Situatie
Een deel van het radioactief afval bestaat uit radioactief besmet en geactiveerd beton. De grootste hoeveelheid zal vrijkomen bij het ontmantelen van het biologisch schild. De radioactiviteit hiervan wordt voornamelijk veroorzaakt door activering van Europium tot Eu-152/154, aanwezig in de kiezels in het beton. Het cement is veelal niet radioactief en kan bij afscheiding vrij worden gestort.
Uit het jaarrapport van NIS over 2013 blijkt dat nog circa één zesde deel van het beton van het biologisch schild zal zijn geactiveerd in 2045. Het gaat dan om ongeveer 400 ton. Dit is gesitueerd in de binnenzijde van het biologisch schild.

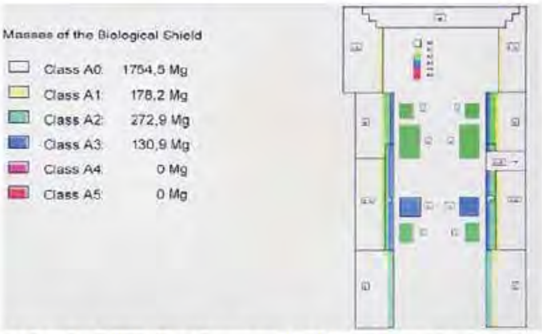

Foto 1. GKN-Dodewaard, NL: Als radioactief afval te verwerken deel van het biologisch schild.

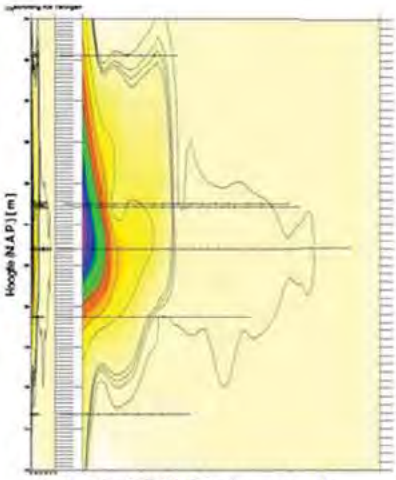

Foto 2. GKN-Dodewaard: Dwarsdoorsnede activering beton activering biologisch schild.

Huidige verwerking
Volgens de Nederlandse verpakkingseisen zou dit beton moeten worden vergruisd, gemengd met cement en vervolgens afgestort in vaten.

Alternatieven

1. *Verzagen en als blokken eeuwig opslaan.*

Het biologisch schild is op grond van vorm en locatie relatief eenvoudig als blokken te verzagen. Deze techniek wordt momenteel toegepast bij de ontmanteling van de AVR in Jülich, BRD.
De blokken kunnen worden ingepakt in geschikte containers en worden gecementeerd, waarna permanente opslag volgt.

Foto 3. AVR-Jülich, BRD: Plan uitzagen betonblokken biologisch schild.

Foto 4. AVR-Jülich, BRD: Uitnemen verzaagde betonblokken uit biologisch schild.

2. *Kiezels / cement scheiden*

In België is bij ontmantelingsprojecten in Mol/Dessel een installatie ontwikkeld welke na het vergruizen de kiezels uit het beton zeeft. De kiezels bevatten de radioactiviteit, door activering van de aanwezige sporenelementen. Het cement is vrij van radioactiviteit.
Deze methode vermindert de hoeveelheid op te slaan afval met circa 50%. De kiezels worden gecementeerd.

Foto 5. Eurochemie-Mol, België: kiezel-cement scheider voor beton.

Foto 6. Eurochemie-Mol, België: beton verwijderd uit wand voormalig bezinkbassin.

3. *Verzagen en op termijn vrijgeven.*

Een andere mogelijkheid is het radioactieve beton niet te vergruizen maar te verzagen en als blokken in (20 voet) containers of "big bags" tijdelijk op te slaan bij COVRA in het Verarmd uranium Opslag Gebouw (hierna: VOG) of in het Container Opslag Gebouw (hierna: COG), en de blokken op termijn vrij te meten (dus geen eindberging). Hierbij geldt dat na een opslagperiode de radioactiviteit zal zijn vervallen. Door op het moment van plaatsing van de blokken in de containers al het exposietempo en de nuclidevector te bepalen kan worden vastgesteld wanneer het materiaal vrijgegeven kan worden. Op deze manier hoeft alleen tijdelijk opslagvolume te worden gehuurd bij COVRA. De blokken kunnen na vrijgave, eventueel na vergruizing, worden gebruikt voor wegverharding of dijkverzwaring.

Alle genoemde alternatieven zijn (nog) niet in overeenstemming met het huidige Nederlandse Beleid, maar wel veel goedkoper.

<u>Impact volume/hoeveelheid afval</u>
Alternatief 1. Het afvoeren als blokken is een volume toename.
Alternatief 2. Het scheiden van kiezels en cement levert een volume reductie van 50% op.
Alternatief 3. Het opslaan en op termijn vrijgeven levert 100% volume reductie.

<u>Impact op de kosten bij minimaal volume</u>
Uitgaande van een soortelijke massa van het beton van 2500 kg.m3, levert de 400 ton biologisch schild een volume van 160 m3 beton. Volgens Nederlandse wetgeving het beton verwerken in 200L vaten, met een maximaal vulgewicht van 150L, geeft circa 1100 vaten (220 m3).
De opslag van een 200L vat bij COVRA in het Laag- en Middel radioactief afval Opslag Gebouw (hierna: LOG) met een exposietempo van minder dan 0,2 mSv/h kost momenteel [redacted] Dit is dus een kostenpost van [redacted] exclusief de kosten aan manuren van vullen en de vaten zelf.

Impact bij toepassing van alternatief 1:
Een standaard 20 voet zeecontainer heeft een volume van 33,2 m3. Dat impliceert dus 5 containers. Om eea hanteerbaar te houden wordt uitgegaan van het dubbele aantal. Het benodigde opslagvolume wordt hierdoor 320 m3. Voor 10 stuks 20 voet containers moet permanente opslag moet worden gehuurd. Aanlevering en opslag van een 20 voet container kost momentee[redacted]per stuk (met terugname verplichting, berekening op basis van calcinaat, jaarverslag COVRA 2012). Kosten voor 10 containers is dan [redacted] Stel de aanschaf van de containers op [redacted] per stuk, dan zijn de kosten aan container aanschaf en opslag [redacted]. Totaal dus [redacted]. Kostenreductie is dan ongeveer [redacted]. Een lichte toeslag voor permanente opslag zal door COVRA worden toegepast. Opslag van dit afval in de diepe ondergrond is vanzelfsprekend onzin. Vandaar dat alternatief 1 bij nadere analyse logischer wijze over zal gaan in alternatief 3.

Impact bij toepassing van alternatief 2:
De volumereductie bedraagt 50%, waardoor het te verpakken volume 80 m3 bedraagt. Verwerking in een 200 L vat kost dan [redacted]. Als alternatief kan dit volume in 20 voet zeecontainers worden verpakt. Maar naar verwachting levert dit niet voldoende financiële winst.

Impact bij toepassing van alternatief 3
Dit is technisch gelijk aan alternatief 1, doch de opslag is niet oneindig
De kosten voor het ontmantelen van het schild zullen naar schatting met 30% afnemen bij opslag in blokken. Er hoeft immers niet te worden vergruisd, terwijl er voor 10 stuks 20 voet containers tijdelijke opslag moet worden gehuurd bij COVRA. Een extra periode van 50 jaar voldoet. Dit levert voor Eu-152 vier, en voor Eu-154 acht extra halfwaardetijden op. Omdat de containers goed uitgemeten in de opslag gaan, zullen de kosten bij finale vrijgave gering zijn. Aanlevering en opslag van een 20 voet container kost momenteel [redacted]per stuk (met terugname verplichting, berekening op basis van calcinaat, jaarverslag COVRA 2012). Kosten voor 10 containers is dan [redacted] Stel de aanschaf van de containers op [redacted] per stuk, dan zijn de kosten aan container aanschaf en opslag [redacted] Totaal dus [redacted]. De kostenreductie is dan ongeveer [redacted].

<u>Impact kosten op de verwerking</u>
De verwerkingskosten van het schild zullen naast de opslagkosten van afval naar schatting ook nog met 30% afnemen bij opslag in blokken, door de mindere hoeveelheid arbeid. In blokken zagen en vervolgens afvoeren is minder arbeidsintensief dan het in kleine blokken zagen en aansluitend vergruizen.

Overweging
Op dit moment wordt naast calcinaat ook verarmd uranium opgeslagen in het VOG. Deze stoffen zijn niet overgedragen aan COVRA en blijven eigendom van de partij die aanlevert. En vergelijkbare methode van opslag is wordt thans bediscussieerd met eigenaren van cyclotrons. Bij de ontmanteling van cyclotrons komt veel licht geactiveerd staal vrij. In het COG wordt momenteel al (geringe) hoeveelheden zeer licht besmet staal opgeslagen Op termijn is eea voldoende vervallen om te worden vrijgegeven. Voor licht radioactief beton zou eenzelfde regeling opgezet kunnen worden. Dit vergt een aanpassing van het Nederlandse Beleid in zake de verwerking en opslag van radioactief afval.

Foto 7. COVRA-NL: Container Opslag Gebouw (COG), containers gevuld met zeer licht radioactief materiaal.

3. Omsmelten van radioactief metaal

<u>Situatie</u>
Licht radioactief materiaal kan worden omgesmolten waarbij de radioactieve stoffen in de slak terecht komen en het materiaal kan worden vrijgegeven, of worden hergebruikt als afschermingsmateriaal of radioactief afvalverpakking. De slak wordt als radioactief materiaal verwerkt en opgeslagen bij de afvalopslag in het land van de aanbieder van het materiaal. Er is dus een terug transport van radioactief materiaal. In Duitsland gebeurt het omsmelten bij de firma Siempelkamp in Krefeld. De normen voor de maximale hoeveelheid radioactiviteit in het materiaal zoals die door Siempelkamp worden gehanteerd, zijn erg laag. De firma Studsvik in Nyköping, Zweden hanteert veel hogere normen, omdat haar oven beter is geoutilleerd. Dit betekent dat veel meer materiaal kan worden omgesmolten. Ook heeft deze oven enkele malen grotere capaciteit dan die van Siempelkamp. Omsmelten van metaal is voordeliger dan het metaal als radioactief materiaal opslaan en is aan te merken als een hergebruik van grondstof.

<u>Overweging 1</u>
Gezien de te verwachten hoeveelheden potentieel om te smelten metaal welke zullen ontstaan bij de Duitse "Ausstieg" is het niet onwaarschijnlijk dat Siempelkamp de komende jaren een tweede oven zal bouwen. Wellicht zal deze oven ook hogere concentraties radioactiviteit kunnen accepteren en een grotere capaciteit hebben.

<u>Overweging 2</u>
Via de Belgische firma DDR is het mogelijk in de USA bij de firma Energy Solutions in Utah, metaal te laten omsmelten waarbij het eigendom van het metaal en de radioactieve slak overgaat in USA handen. De firma levert maatwerk. Deze werkwijze gaat in tegen het Nederlandse Beleid van het eigen afval opslaan in Nederland en niet exporteren. Diverse Europese landen, waaronder Duitsland, hebben dit wel toegestaan. Het materiaal wordt na omsmelten hergebruikt als afschermingsmateriaal, terwijl de radioactieve slak wordt verwerkt in een "burial site" op de zoutvlaktes van Utah. Er wordt dus geen radioactief afval teruggezonden.

Foto 8. Energy Solutions-Tennessee, USA: Oven voor ra besmet staal in Bear Creek, Oak Ridge.

Foto 9. Energy Solutions-Utah, USA: Burial site Clive nabij Salt Lake city.

Overweging 3
In al deze gevallen is sprake van een (gering) "transport risico" (het brengen en halen van de radioactieve stoffen). Ook is hier een potentiële discussie tav de hoeveelheden getransporteerde hoeveelheid radioactiviteit een risico ("even veel terug als gebracht").

Impact op de kosten.
Kwantificering is zonder nadere studie niet mogelijk. Energy Solutions geeft eerst prijzen af als hoeveelheden en radioactiviteit van het materiaal bekend zijn. Men neemt hogere activiteit aan en bepaalt de prijs mede op basis van de aanwezige nucliden.

4. Ver werking van de reactor en grote co nponenten in één stuk

Situatie

In de la nden om Nederland hee n (Duitsland, Verenigd K oninkrijk, Frankrijk) wor len steeds neer grote radioactieve componente n opgeslagen in één stuk. Deze componenten worden NIET i n de (diepe) ondergrond opgeborgen. Nederland/COVRA wil hier vooralsnog niet aan omdat dit niet in lijn is met het Nederlandse Beleid van opslag van alle afval in de (diepe) ondergrond. Daarom moet alle afval w rden verkleind en geco ditioneerd. Sommige grote componenten zoals warmtewisselaars en zelfs reactorvaten zijn echter te :hnisch gezien zonder grote problemen als component af te voeren en op te slaan.

Juist de :e componenten zijn na enkele tientallen jaren extra opslag door verval vrijwel gehe el vrij van radioactiviteit. De reactorvaten van de vijf eenheden va n de centrale Greifswald, de reactor van de centrale Rheinsberg (goed vergelijkbaar met Dodewaard), de stoomgeneratoren van de centrales Stade e n Obrigheim en de react or van de centrale Jülich zijn of worden in één stuk afgevoer d naar het Zwi chen Lager Nord (ZLN) in Greifswald, Mecklenb urg-Vorpommern.

Foto 10. Rheinsberg-BRD: uithijsen reactor in één stuk.

Foto 11. Greifswald ZLN-BRD: Opslag reactorvaten grote co nponenten. Vat Rheinsberg ligt rechts.

In het Verenigd Koninkrijk worden stoomge neratoren van Magnox reactoren afgevoerd als één component naar Studsvik, in Nyköping, Zweden, en hoo g besmette warmtewisselaars van d e opwerkingsinstallaties in Sellafield worden gecementee d en als één blok opgeslagen in Drigg, Cumbri a, Groot-Brittannië. Defecte Franse stoomgeneratoren worden als één component v erwijderd en opgeslagen op de locatie van de (meestal multi-reactor) centrale voor verder radioactief verval. Eerst bij eindontmanteling van deze central es zullen zij verder word en verwerkt. De doelstelling hierbij i s het metaal van deze st oomgeneratoren zoveel mogelijk te hergebruike n.

Foto 12. Berkeley-UK:
Stoomgenerator wordt uitgehesen.

Foto 13. Berkeley-UK: Stoomgenerator op weg naar haven voor transport naar Studsvik, Nyköping, Zweden.

Overweging

De reactor van GKN en een aantal grote componenten zoals grote warmtewisselaars van RZS en RAS/SBK kunnen technisch zonder problemen als één component naar COVRA worden afgevoerd, mits wordt voldaan aan afschermingsvoorwaarden. De warmtewisselaars van GKN moeten volgens het Nederlandse afvalbeleid uit elkaar worden genomen (Ladder van Lansink), en zo veel als mogelijk worden gereinigd en hergebruikt. Dit is een minder gewenst verwerkingsconcept omdat dit een hoge stralingsbelasting voor de uitvoerders-, en veel verpakkingsafval oplevert.
Bij COVRA zijn deze componenten zonder technische problemen in "één stuk" op te slaan in bijvoorbeeld een nieuw te bouwen hal aan het LOG. Een dergelijke hal moet toch al worden gebouwd voor de opslag van het GKN afval.
De opslag als één component levert veel minder verpakkingen, een lagere stralingsbelasting, en zal sneller verlopen dan verzagen en verpakken. Na voldoende verval kan worden besloten tot of alsnog verwerken en conditioneren of vrijmeten. De voorkeur hierbij is vrijmeten voor hergebruik / omsmelten. Door vooraf gedetailleerd de radioactiviteit en nuclidevector vast te leggen kan de feitelijke vrijmeting (en afvoer naar een verwerker / hoogoven) met weinig kosten worden gerealiseerd.

Foto 14. Big Rock Point-Michigan, USA: Verwijdering van het reactorvat in één stuk bij GKN' s zustercentrale.

Foto 15. Big Rock Point-Michigan, USA: Transport van de verpakte reactor in transportverpakking op 205 voet lange trailer.

Impact op de kosten

Volgens publicaties van EWN, de eigenaar van de reactoren in Rheinsberg en Greifswald, is het 50% goedkoper om de reactoren in één stuk te verwerken. Dit betreft zowel verwerking- als opslagkosten. De verwerking van de GKN reactor inclusief de internals kost circa [redacted] (WP 5 en 6 in de NIS2009 studie). Bij verwerking als één stuk wordt uitgegaan van het volstorten van de reactor met licht beton om de straling van de internals af te schermen. Een alternatief is het verwijderen van de internals met verpakking in Mozaïk containers. Rekening houdende met extra kosten voor transport naar COVRA mag op een kostenreductie van [redacted] [redacted] worden gerekend voor het verwerken van de reactor. De kostenreductie van verwerking van RZS-, RAS/SBK warmtewisselaars is hier niet berekend omdat deze in de huidige rapportage van NIS niet als zelfstandige items herkenbaar zijn.

5. Duitse tarieven en uurlonen

<u>Situatie</u>
In de NIS2009 studie zijn voornamelijk Duitse tarieven voor personeelskosten gehanteerd. Op het moment van opstellen van de studie leek dit logisch, omdat ervan uitgegaan werd dat kennis van ontmantelen in Nederland geheel zou ontbreken rond de tijd dat de centrale Dodewaard zou worden ontmanteld.

<u>Overweging</u>
De reactor in Borssele, de LFR, mogelijk de HFR en de HOR, de cyclotrons van VU Amsterdam en Eindhoven zijn voorzien eerder te worden ontmanteld dan de kernenergiecentrale Dodewaard. De LFR wordt volgens de huidige planning vanaf zomer 2014 ontmanteld. De ontmanteling en de verwerking van het radioactief afval van de beide cyclotrons vindt momenteel plaats. Bij al deze projecten zal kennis over ontmantelen worden opgedaan.
Momenteel werft NRG al personeel met kennis van ontmanteling, of de bereidheid deze kennis op te doen. Op basis van het bovenstaande mag worden aangenomen dat in Nederland in 2045 voldoende gekwalificeerd personeel beschikbaar zal zijn om de ontmanteling van GKN uit te voeren.

<u>Impact op de kosten</u>
De in de studie gehanteerde Duitse tarieven voor het in te huren personeel zijn tenminste 10% hoger dan die in Nederland gebruikelijk zijn. Ook is geen rekening gehouden met lagere uurtarieven voor medewerkers die gedurende een langere termijn worden ingehuurd (garantie van bezetting voor de uitlener).
Een nauwkeuriger schatting van de ontmantelingkosten is alleen mogelijk als de gehele studie NIS studie wordt overgedaan omdat de manuren overal in workpackages zijn verwerkt, en niet als aparte eenheid worden benoemd.

Een andere methode om de kostenreductie te bepalen bij het toepassen van Nederlandse in plaats van Duitse uurlonen, is uitgaan van de vuistregel dat ongeveer 70% van de totale kosten in een ontmantelingsproject worden toegeschreven aan manuren. Op een totaal van [redacted], het thans berekende totaal bedrag benodigd voor de ontmanteling van de KCD, levert het hanteren van Nederlandse uurtarieven een kostenreductie van ongeveer [redacted] op.

6. Dubbele shift

<u>Situatie</u>
In de NIS 2009 studie wordt uitgegaan van enkele shift, in dagdienst. De periode waarin daadwerkelijk wordt gesloopt en afval verwerkt, is berekend op 7,5 jaar.

<u>Overweging</u>
Een verdere kostenreductie kan worden behaald door het feitelijke afbreken te laten uitvoeren in dubbele shift (vroege/late shift).
Dubbele shift zal de hiervoor genoemde periode niet geheel halveren. Er zijn logistieke zaken zoals opslag capaciteit en snelheid van afvoer van materiaal die dit verhinderen. Een reductie van deze periode met twee tot drie jaar is echter haalbaar.
Voor de manuren die de feitelijke sloop uitvoeren maakt dit niet uit, maar voor de site overhead wel.

<u>Impact op de kosten</u>
De kosten van de workpackages 15 (Project Management, Engineering, Site support, [redacted]) en 16 (Site security, Surveillance and Maintenance [redacted]) van de NIS2009 studie zullen aanzienlijk worden verminderd. Uitgaande van twee tot drie jaar reductie op 7,5 jaar lijkt realistisch. Dit levert een kostenreductie van [redacted] zijnde [redacted].

7. Langere vervalperiode

Situatie

Op dit moment is de vrijgavegrens voor Co-60 1 Bq/g. In de praktijk echter is de vrijgavegrens de grens zoals deze is ingesteld aan de poortmonitor van de schroothandelaar. Deze is veelal ingesteld op waarden direct boven de achtergrond. Dit leidt ertoe dat materiaal wat formeel vrij gemeten is, niet wordt geaccepteerd door de schroothandelaren.
Over de reden van dit gedrag wordt hier niet verder ingegaan. Deze problematiek speelt voor alle nucleaire ontmantelingsprojecten.
Tijdens het Najaarssymposium van de Nederlandse Vereniging voor Stralingshygiëne in november 2013 is deze problematiek door drie sprekers genoemd (GKN, LFR, cyclotron Eindhoven). Het moge duidelijk zijn dat ter zake door de centrale Overheid moet worden ontwikkeld.

Overweging

Om het vrijgegeven maar niet als vrijgesteld geaccepteerd materiaal als radioactief materiaal aan te merken is natuurlijk onzin, maar het is een feit dat bij de ontmanteling van kernreactoren een hoeveelheid materiaal zal ontstaan die door de geschetste problematiek niet is af te voeren. Hierbij komen nog de problemen die bekend zijn van vrijmeten, speciaal die rond de vrijgavegrens.
Een oplossing van het geschetste probleem zou het invoeren van een vervalopslag bij COVRA kunnen zijn. Materiaal met een radioactiviteit (voor Co-60) van minder dan 1,5-2 Bq/g blijft bij COVRA (in 20 voet containers) ongeconditioneerd opgeslagen gedurende 11 jaar. Dan zijn twee halfwaardetijden voor Co-60 voorbij en is de radioactiviteit van het materiaal zeker tot onder de vrijgavegrens gedaald.
Dit lijkt een kostenverhogende factor te introduceren, immers de opslagfaciliteit moet worden gebouwd en beheerd, doch deze zal tenminste opwegen tegen de kosten van de discussies en meetinspanningen welke moeten worden geleverd om exact de 1 Bq/g Co-60 aan te kunnen tonen.
Ook wordt er winst behaald omdat een hoeveelheid materiaal welke een radioactiviteit (Co-60) van 1-2Bq/g heeft bij het moment van ontmantelen niet als radioactief materiaal behoeft te worden afgevoerd.

Impact op de kosten

Kwantificering van de precieze hoeveelheden en de financiële consequenties is alleen mogelijk als een groot deel van de NIS berekeningen worden overgedaan. Dit is een onderwerp wat moet worden opgenomen in de volgende NIS berekening, thans voorzien te worden uitgevoerd in 2016. Er zijn meerkosten omdat een opslag bij COVRA moet worden gerealiseerd, maar er zijn minderkosten omdat er veel minder nauwkeurig (tijd) hoeft te worden gemeten en minder afval moet worden geconditioneerd.

Overigens is de ultieme conclusie die uit deze werkwijze kan worden getrokken op zijn minst opmerkelijk: laat de Veilige Insluiting zolang staan totdat de operationele kosten op jaarbasis hoger zijn dan de kosten voor opslag van het radioactieve afval. Deze conclusie is niet nieuw. Ook bij IAEA speelt men met deze gedachten. De eerlijkheid gebied te vermelden dat hierbij meestal wordt uitgegaan van een multi-reactor site, waarbij de operationele kosten voor de Veilige Insluiting gering zijn als gevolg van de aanwezigheid van facilitaire diensten voor de in bedrijf zijnde units.

8. Verlenging van de Wachttijd

Situatie
Mocht ondanks alle inspanning, door wat voor oorzaak ook, in 2045 onvoldoende fondsen aanwezig zijn om de eindontmanteling te starten, dan kan besloten worden de eindontmanteling één of meerdere jaren uit te stellen.

Overweging
Omdat de Veilige Insluiting goed onderhouden is, het in de lijn der verwachting ligt dat dit beleid niet wijzigt en voornamelijk correctief onderhoud wordt gepleegd, zijn de operationele kosten goed in te schatten voor een verlengde bedrijfstijd van de Veilige Insluiting. Op basis van de ervaringen van de periode 2005-2014 is de stelling verdedigbaar dat de Veilige Insluiting, mits onderhouden op het niveau zoals dit thans gebeurd, na 40 jaar zeker niet uit elkaar zal zijn gevallen. Een verlenging van de Wachttijd met tien jaar behoort zeker tot de mogelijkheden.

Impact op de kosten
Bij de aanvraag voor Financiële zekerheid (bijlage C7) is al aangetoond dat verlenging van de fase Wachttijd bij het niet op tijd verkrijgen van de vergunning voor Ontmanteling, een jaar vertraging financieel voordeel brengt. De kosten van een jaar extra Veilige Insluiting van de KCD zijn ondergeschikt aan de rentebaten.

9. De actuele situatie in Duitsland

Situatie
Hoewel er alweer stemmen opgaan om de versnelde sluiting van de Duitse kernenergiecentrales ongedaan te maken, wegens de enorme kosten welke de "Energiewende" met zich meebrengt, lijkt de kans dat dit gebeurt vrijwel nihil.
Dat impliceert dat de komende decennia een groot aantal ontmantelingsprojecten in Duitsland worden uitgevoerd.

Overweging
De vele ontmantelingsprojecten zullen zeker leiden tot de ontwikkeling van nieuwe technieken en apparatuur welke de ontmanteling efficiënter en goedkoper zullen doen verlopen.

Impact op de kosten
De kostenreductie ten gevolge van de ontwikkeling van nieuwe technieken kwantificeren is vanzelfsprekend onmogelijk.

10. Kwantificering

Situatie
Volledige kwantificering van alle genoemde zaken is onmogelijk zonder een complete NIS studie opnieuw uit te voeren. Dit omdat in het rekenmodel veel aspecten met elkaar verbonden zijn. Om dezelfde reden is het moeilijk om met een aantal gerichte vragen door NIS een schatting te laten maken van de mogelijke reducties. Bovendien kost dit geld, en het steeds maar weer extra berekeningen laten uitvoeren ten koste van het ontmantelingsfonds is (ook volgens IAEA) één van de snelste manieren om die fondsen kwijt te raken.

Overweging
Bij de volgende herziening van het Ontmantelingsplan GKN, thans voorzien in 2016, dient nadrukkelijk in het dan voor aanvang van de berekeningen op te stellen TRF, te worden aangegeven dat een extra berekening moet worden uitgevoerd naar de "winst" welke wordt behaald c.q. wat de gevolgen en effecten zijn van:
- het uitnemen van reactorvat en overige grote componenten in één stuk,
- het hanteren van Nederlandse uurlonen,
- dubbele shift tijdens de afbraak.

Bovendien zal dan van de Overheid worden gevraagd om de mogelijkheid van opslag van grote componenten in één stuk na te gaan en eventuele knelpunten hierbij te onderzoeken.

Thans is de verwachte planning voor het opstellen van het Ontmantelingsplan 2016 KCD:
-Najaar 2015-voorjaar 2016 opstellen TRF,
-Voorjaar 2016 uitvoer berekeningen door NIS,
-Zomer 2016 opstellen Ontmantelingsplan (waarschijnlijk als een addendum op het al goedgekeurde plan van 2011, maar in ieder geval met gebruikmaking van grote delen van de algemene teksten van het plan 2011),
-Najaar 2016 goedkeuring door Minister.

Impact op de kosten
Niet van toepassing.

11. Conclusies.

Op basis van een aantal aanpassingen aan het goedgekeurde Ontmantelingsplan voor de kernenergiecentrale Dodewaard is het mogelijk aanzienlijke kostenbesparingen te realiseren ten opzichte van de huidige NIS2009/Ontmantelingsplan 2011 KCD calculatie.
Niet al deze kostenreducties zijn thans uitvoerbaar omdat deze aanpassingen van het Nederlandse Beleid op het gebied van verwerking en opslag van radioactief afval vragen. Ook zijn niet alle kosten op dit moment kwantificeerbaar, omdat hiervoor specialistische berekeningen dienen te worden uitgevoerd. Het uitvoeren van dergelijke berekeningen is relatief kostbaar en zal eerst worden uitgevoerd bij de herziening van het huidige Ontmantelingsplan 2011 KCD in 2016, waarbij vooraf in overleg met alle stakeholders een nieuw TRF zal worden opgesteld.

Het overzicht van de mogelijke kostenreductie in M€ is als volgt:
- aanpassing verwerking beton [redacted]
- meer staal omsmelten
- reactor verwijderen als één stuk
- Nederlandse uurtarieven
- toepassen van dubbele shifts
- langere vervalperiode
- ervaringen in Duitsland

De totaal mogelijke besparing bedraagt [redacted].

12. Referenties

(1) Tractebel Engineering, GKN - Evaluation of Decommissioning of the Dodewaard NPP, New decommissioning cost estimate- Technical Requisition File paragraaf 3.3, *"The removal, in one peace, of the Reactor Pressure Vessel (with its internals) will not be considered as this is not an option compatible with the size of the waste packages acceptable for disposal in a deep geological repository"*.

(2) Verslag van de derde bespreking over "Kosten Ontmanteling KCD" met COVRA en ministerie van VROM (16.07.2008).
*"De huidige COVRA-vergunning voorziet alleen in het accepteren van verpakkingen welke opgeslagen kunnen worden in een eindberging. "Grote" verpakkingen, zoals ook de KONRAD verpakkingen van 1,5*1,5*1,5m, vallen daar momenteel niet binnen. Hierdoor vervalt het scenario "verwijdering van het reactorvat in één stuk". COVRA stelt dat de geschiktheid voor eindberging NL beleid is, en ziet ook problemen met de opslag van het vat als één geheel in een nieuw te bouwen loods bij COVRA, en het transport van KCD-Dodewaard naar COVRA-Borsele. GKN is het met de zienswijze niet eens maar heeft op dit moment geen ander alternatief dan dit te accepteren".*
(Deze uitspraak werd gedaan door de directeur COVRA. In een latere vergadering werd vastgesteld dat de genoemde KONRAD containers wel acceptabel waren).