



# Standardised Costs Elements (Items) for Decommissioning

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# Contents

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**1) Introduction**

**2) Review of sections 1 to 11**



# Structure

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- **Facility shutdown activities**
- **Procurement of general equipment and material**
- **Dismantling activities**
- **Waste treatment and disposal**
- **Security, surveillance and maintenance**
- **Site cleanup and landscaping**
- **Pre-decommissioning actions**
- **Project management, engineering and support**
- **Research and development**
- **Fuel**
- **Other costs**



# 1 - Pre-decommissioning actions

Section 1 covers all activities carried out in preparation of the actual decommissioning

- 01.0100** Decommissioning planning
  - 01.0101** Strategic studies
  - 01.0102** Conceptual planning
  - 01.0103** Detailed planning
  - 01.0104** Safety and environmental studies

Typical engineering activities needed for preparing the decommissioning plan from the preliminary plan, through selecting and reasoning the strategy up to detailed level. The facility characterization at various levels. The results of item 01.0300 and 01.0400 are used too.

**Cost drivers:** mostly engineering work force, duration of period dependent activities, expenses typical for office work

- 01.0200** Authorisation
  - 01.0201** License applications and license approvals
  - 01.0202** Public consultation and public inquiry

Engineering and management activities for development of documents and activities for obtaining the decommissioning license. Supporting documents for gaining the regulator relief for issuing the license. Work with the public.

**Cost drivers:** mostly engineering/management work force, duration of period dependent activities, expenses typical for office work, financial expenses related for issuing the license.



# 1 - Pre-decommissioning actions

## ~~01.0300 Radiological surveys for planning and licensing~~

### 01.0400 Hazardous-material surveys and analysis

**Engineering activities for organizing the facility characterization, developing the equipment and material categories for costs calculation, managing and organization of the radiological and material surveys in facilities. Determination of release criteria and its impact on decontamination methods and decommissioning options**

**Cost drivers:** engineering and qualified workers work force, duration of period dependent activities, number/unit factors of rooms, work in controlled area, office expenses

### 01.0500 Prime contracting selection

**Mostly work of the management, supported by engineering activities**

**Cost drivers:** mostly engineering/management work force, duration of period dependent activities, financial expenses related to tendering process

**The activities of the chapter 1 are performed normally by specialized decommissioning departments of the facility, by specialized companies and only partially by operating personnel.**



## 2 - Plant shutdown and inspection

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**Section 2 covers all activities relating to shutdown operations of the facility.**

**02.0100 Plant shutdown and inspection**

**02.0101 Termination of operation, plant stabilisation, isolation, inspection**

**02.0102 Facility reuse**

**02.0200 Removal of fuel and/or nuclear-fuel materials**

**02.0201 Defuelling and transfer of fuel to temporary spent-fuel storage**

**02.0202 Nuclear-fuel material inventory recovery**

**02.0300 Drainage and drying or blowdown of all systems not in operation**

**Activities of the operating personnel. Include the fuel cool-down period, transport of the spent fuel outside the facility, management of the unused fuel, nuclear materials from operation phase. The systems are phase by phase reduced and isolated.**

**Cost drivers:** shift and supporting operating personnel, duration of fuel cooling down period, operational costs for systems in operation. **Caution** – there are **different concepts** for including the costs for 02.0100 and 02.0200 into the decommissioning or operational costs. The costs for the item 02.0100 can be significant.

## 2 - Plant shutdown and inspection



**02.0400** Sampling for radiological inventory characterisation after plant shutdown, defuelling and drainage and drying or blowdown of systems

**02.0401** Sampling for radiological inventory characterisation in the installations after plant shutdown, defuelling and drainage and drying or blowdown of systems

**02.0402** Subgrade soil sampling and monitoring wells to map contamination plumes

**Non-destructive and destructive sampling for radiological characterisation of equipment and surfaces in the facilities, in-situ measurements of samples, modelling, using design codes, according to reactor operating parameters (flux curves, operating time, etc.)**

**Cost drivers:** mostly engineering work force, duration of period dependent activities, expenses typical for office work, expenses for sophisticated software or services

**02.0500** Removal of system fluids (water, oils, etc.)

**02.0600** Removal of special system fluids (D2O, sodium, etc.)

**02.0700** Decontamination of systems for dose reduction

**02.0800** Removal of waste from decontamination

**02.0900** Removal of combustible material

**02.1000** Removal of spent resins

**02.1100** Removal of other waste from facility operations

**Activities of the operating personnel for removal of waste and transport.**

**Cost drivers:** standard operating personnel work force, duration of activities, operational costs for systems in operation. **Costs for treatment of the waste are not included.**



## 3 – Procurement of general equipment and material

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**Section 3 covers all activities relating to the purchasing of general equipment and materials at site level.**

**03.0100 General site dismantling equipment**

**Lifting and transporting equipment, cranes**

**03.0200 General equipment for personnel/tooling**

**Additional equipment for personnel and/or tooling decontamination**

**03.0300 General radiation protection and health physics equipment**

**General radiation protection equipment – portal systems , Portable monitoring equipment for dose rate measurements and/or contamination measurements, monitoring equipment for decommissioning operations and/or material release measurements, additional health physics equipment for personnel dose-uptake follow-up,**

**03.0400 General security and maintenance equipment for long-term storage**

**Equipment required for the surveillance of facilities, security fencing**

**Work force of technical support departments, technical departments**

**Cost drivers:** Investment or hiring and maintenance, including installation, testing, licensing. Operational costs are included in decommissioning activities





## 4 – Dismantling activities

**Section 4 covers all activities relating to the different actual dismantling operations. Depending on the selected option, dismantling activities and related cost items in view of a dormancy period or in view of other “standard” or specific decommissioning stages can be applicable.**

### **04.0100 Decontamination of areas and equipment in buildings to facilitate dismantling**

**Chemical (including use of the closed decontamination circuits), electrochemical and other methods for pre-dismantling decontamination of technological systems and building surfaces, use of specialized techniques, systems modification, shielding**

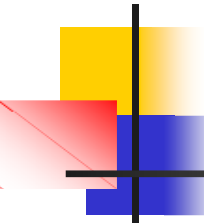
### **04.0200 Drainage of spent-fuel pool and decontamination of linings**

**Drainage, water cleaning, removal of contaminants, decontamination of the pool.**

**Cost drivers:** specialized decommissioning personnel work force, duration of activities, operational costs for decontamination systems in operation, development, construction, mobilisation and demobilisation of specialised systems for decontamination.

**For defining of the extent of the pre-dismantling in the cost calculation structure, the inventory database of equipment can be used.**

## 4 – Dismantling activities

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- 04.0400 Dismantling and transfer of contaminated equipment and material to containment structure for long-term storage**
  - 04.0500 Sampling for radiological inventory characterisation in the installations after zoning and in view of dormancy**
  - 04.0600 Site reconfiguration, isolating and securing structures**
    - 04.0601 Reconfiguration and maintenance of essential services and facilities to support long-term storage and/or decommissioning operations**
    - 04.0602 Site boundary reconfiguration**
    - 04.0603 Construction of temporary enclosures, storing, structural enhancements, etc. to support site remediation**
    - 04.0604 Stabilisation of radioactive and hazardous waste pending remediation**
  - 04.0700 Facility (controlled area) hardening, isolation or entombment**

**Standard activities for preparing the long-term storage period. Work performed mostly inside the controlled area. No major decommissioning activities are performed. The resulted waste is mostly re-stored and the cost for waste treatment are minimal.**

**Cost drivers:** standard decommissioning personnel work force, duration of activities,

## 4 – Dismantling activities



- 04.0800 Radiological inventory characterisation for decommissioning**  
Establishing decommissioning **criteria** for decontamination, recycling, controlled disposal, unrestricted release;  
Measurement of the facility to be decommissioned as well as the surrounding environment, by **radionuclide modelling, direct surveys, sampling and radiochemical analysis**  
Characterisation for **decontamination of dismantled materials**  
Characterisation of dismantling activities as needed for **exposure control (ALARA)**  
Characterisation for **waste packaging, disposal and storage**

Work of specialized departments or contracted work for specialised companies.  
Requires high qualification and experience and sophisticated instrumentation, software and services.

**Cost drivers:** highly qualified engineering work force, number and duration of specialised tasks, specialised instrumentation, software and services.

- 04.0900 Preparation of temporary waste storage area**  
Preparation of temporary waste storage yard by removing materials and zoning  
**Cost drivers:** standard decommissioning personnel work force, duration of activities,



## 4 – Dismantling activities

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### **04.1000 Removal of fuel handling equipment**

**Removal and extraction of fuel handling equipment and associated components from a temporary storage area, pool, canal, hot cell, etc.**

**Cost drivers:** specialized decommissioning personnel work force, duration of activities, operational costs for systems in operation.

For defining the extent of calculation items, the inventory database is used. The standardised calculation structure is of the type “complex technological systems”.



## 4 – Dismantling activities

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### **04.1100 Design, procurement, and testing of special tooling/equipment for remote dismantling**

#### **04.1101 Design and procurement of special tools for dismantling the reactor vessel and internals**

- **Studies of dismantling alternatives for the reactor vessel and internals, working conditions and waste transport and management**
- **Design of tooling, including 3-D modelling, simulations, R&D, consultants, mock-ups, scale models and demonstrations, adaptation of existing tooling, manufacturing processes or related applications**
- **Generation of design specifications, including operating and maintenance procedures, hardware and software, installation, testing, performance measurement**
- **Procurement/adaptation of tooling for remote disassembly/segmentation**

#### **04.1102 Design and procurement of special tools for dismantling other components or structures (design, adaptation, modification, procurement, leasing)**

**Work of specialized constructional departments or contracted work for specialised companies. Requires high qualification and experience and sophisticated instrumentation, software and services.**

**Cost drivers: highly qualified engineering/designing work force, number and duration of specialised tasks, specialised instrumentation, software and services, costs for specialised equipment and tools, cost for specialized projects for design, testing**



## 4 – Dismantling activities

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### 04.1200 Dismantling operations on reactor vessel and internals

- Preparation of the work area for dismantling, extracting and packaging the waste for disposal
- Construction enabling the underwater operations
- Installation of handling devices and protection systems
- Dismantling of reactor vessel and internals
- Monitoring of the disassembly
- Operation of the segmentation tooling
- Maintenance and change-out of support equipment (purification and ventilation filters)
- Accepting, preparation and loading of the disposal containers
- Removal of handling devices and protection systems

**Work of specialised decommissioning personnel. Requires specialized training for work with remote controlled equipment and with sophisticated instrumentation and software.**

**Cost drivers:** specialized decommissioning operating personnel work force, duration of activities, operational costs for systems in operation.

For defining the extent of calculation items, the inventory database is used. The standardised calculation structure is of the type “complex technological systems”. The inventory database is developed according the constructional design of the reactor and should reflect the dismantling procedure.



## 4 – Dismantling activities

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**04.1400**      **Removal of biological/thermal shield**

**Dismantling of the activated portion of the biological/thermal or sacrificial shield**

**04.1500**      **Removal of other material/equipment from containment structure and all other facilities, or removal of entire contaminated facilities**

**Removal of contaminated and activated materials, contaminated components that can only be dismantled at the end of the removal process, removal of non-contaminated ancillary equipment in support of the final release survey**

**04.1600**      **Removal and disposal of asbestos**

**04.1700**      **Removal of pool linings**

**Dismantling of equipment and materials is organised on the room-oriented principle, similar like in dismantling item 04.1300.**

**Cost drivers:** specialized decommissioning operating personnel work force, duration of activities, operational costs for systems in operation.

**For defining the extent of calculation items, the inventory database is used. The standardised calculation structure is of the type "room oriented".**



## 4 – Dismantling activities

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### 04.1300 Removal of primary and auxiliary systems

04.1301 Removal of primary and auxiliary systems in reactor facilities

04.1302 Dismantling and removal of contaminated equipment, piping, liners and internal systems in non-reactor nuclear

Dismantling of equipment in the individual rooms of the facility in the reactor building or in the auxiliary nuclear buildings. The dismantling is **room-oriented organised** and includes a set of preparatory activities, dismantling of the equipment in the room according their categories and a set of finishing and cleaning activities.

**Cost drivers:** specialized decommissioning operating personnel work force, duration of activities calculated for hands-on activities and for period dependent activities, operational costs for systems in operation, costs for tools.

For defining the extent of calculation items, the inventory database of equipment in the rooms is used and the database of rooms for defining the extent of preparatory and finishing activities.





## 4 – Dismantling activities

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**04.1800 Building decontamination**

**04.1801 Removal of contamination from areas and structures in all buildings and stacks**

**04.1802 Removal of embedded pipes in buildings**

**04.1803 Removal of structures/facilities to gain access to radionuclides that may have breached design boundaries**

**04.1900 Environmental cleanup**

**04.1901 Removal of embedded pipes outside buildings**

**04.1902 Removal of structures/facilities to gain access to radionuclides that may have breached design boundaries**

**04.1903 Removal of contamination from areas and structures outside all buildings and stacks**

**04.2000 Final radioactivity survey**

**04.2100 Characterisation of radioactive materials**

**04.2101 Characterisation of radioactive materials for recycling and reuse**

**04.2102 Characterisation of radioactive materials for final disposal**

**04.2200 Decontamination for recycling and reuse**

**04.2300 Personnel training**

**04.2400 Asset recovery: Sale/transfer of metal or materials, and salvaged equipment or components for recycling or reuse**



## 5 - Waste processing, storage and disposal

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**Section 5 comprises a large number of activities aiming at preparing the dismantled components either for final disposal as radioactive waste, or for release for restricted or unrestricted recycle or reuse**

- 05.0100 Waste processing, storage and disposal safety analysis**
- 05.0200 Waste-transport feasibility studies**
- 05.0300 Special permits, packaging and transport requirements**

**Typical activities of the period dependent type for evaluating the issues of the waste processing. Work of specialized departments or contracted work for specialised companies. Requires specific qualification and experience and sophisticated software and services.**

**Cost drivers: qualified engineering work force, number and duration of specialised tasks, specialised software and services.**

- 05.0400 Processing of system fluids (water, oils, etc.) from facility operations**
- 05.0500 Processing of special system fluids (D<sub>2</sub>O, sodium, etc.) from facility operations**
- 05.0600 Processing of waste from decontamination during facility operations**
- 05.0700 Processing of combustible material from facility operations**
- 05.0800 Processing of spent resins from facility operations**
- 05.0900 Processing of other nuclear and hazardous materials from facility operations**

**Each items 05.0400 to 05.0900 include sub-items for processing, packaging and transporting.**



## 5 - Waste processing, storage and disposal

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- 05.1000 Storage of waste from facility operations**
  - 05.1001 Preparation of storage facility**
  - 05.1002 Waste storage**
  - 05.1003 Storage of radioactive waste from facility operations**
  - 05.1004 Decontamination of storage facility**
  - 05.1005 Dismantling/disposal of storage facility**
- 05.1100 Disposal of waste from facility operations**
  - 05.1101 Preparation of disposal site**
  - 05.1102 Waste disposal**
  - 05.1103 Disposal of radioactive waste from facility operations**
  - 05.1104 Disposal of non-radioactive waste from facility operations**

**The costs for activities of the section 05.0400 to 05.1100 are not included into the costs of a decommissioning project for a standard shutdown facility. The facility at the start of decommissioning should be without the operation waste.**



## 5 - Waste processing, storage and disposal

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### **05.1200 Processing of decommissioning waste**

**05.1201 Processing of radioactive decommissioning waste**

**05.1202 Processing of non-radioactive decommissioning waste**

**05.1203 Waste containers**

### **05.1300 Packaging of decommissioning waste**

**05.1301 Packaging of radioactive decommissioning waste**

**05.1302 Packaging of non-radioactive decommissioning waste**

### **05.1400 Transport of decommissioning waste**

**05.1401 Transport of radioactive decommissioning waste**

**05.1402 Transport of non-radioactive decommissioning waste**



## 5 - Waste processing, storage and disposal

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### **05.1500 Storage of decommissioning waste**

**05.1501 Preparation of storage facility**

**05.1502 Waste storage**

**05.1503 Storage of radioactive decommissioning waste.**

**05.1504 Decontamination of storage facility**

**05.1505 Dismantling/disposal of storage facility**

### **05.1600 Disposal of decommissioning waste**

**05.1601 Preparation of disposal site**

**05.1602 Decommissioning waste disposal**

**05.1603 Disposal of radioactive decommissioning waste on disposal site**

**05.1604 Disposal of non-radioactive decommissioning waste**



## 6 - Site security, surveillance and maintenance

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**Section 6 mainly covers site protection, control and maintenance activities**

**06.0100 Site security operation and surveillance**

**06.0200 Inspection and maintenance of buildings and systems in operation**

**06.0300 Site upkeep**

**06.0400 Energy and water**

**06.0500 Periodic radiation and environmental survey**



## 7 - Site restoration, cleanup and landscaping

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**general, Section 7 considers the non-radiological portions of plant decommissioning**

**07.0100 Demolition or restoration of buildings**

**07.0101 Dismantling of “balance-of-plant” systems and building components**

**07.0102 Dismantling of the structure**

**07.0103 Dismantling of the stack**

**07.0200 Final cleanup and landscaping**

**07.0300 Independent compliance verification with cleanup and/or site-reuse standards**

**07.0400 Perpetuity funding/surveillance for limited or restricted release of property**



## 8 – Project management, engineering and site support

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**Section 8 covers project management and site support services during decommissioning operations**

**08.0100 Mobilisation and preparatory work**

**08.0101 Mobilisation of construction equipment and facilities**

**08.0102 Mobilisation of personnel**

**08.0103 Set-up/construction of temporary facilities**

**08.0104 Construction of temporary utilities**

**08.0105 Temporary relocations**

**08.0200 Project management and engineering services**

**08.0201 Project manager and his staff**

**08.0202 Planning and cost control**

**08.0203 Quality assurance and quality surveillance**

**08.0204 Procurement, warehousing, and materials handling**

**08.0205 General/subcontractor administration**

**08.0206 Documentation and records control**

**08.0207 Engineering support**

**08.0300 Public relations**





## 8 – Project management, engineering and site support

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- 08.0400 Support services**
  - 08.0401 Housing, office equipment, site services**
  - 08.0402 Computer support**
  - 08.0403 Decommissioning support including chemistry, decontamination and field supervision**
  - 08.0404 Waste-management support**
- 08.0500 Health and safety**
  - 08.0501 Health physics**
  - 08.0502 Radiation protection and monitoring**
  - 08.0503 Industrial safety**
- 08.0600 Demobilisation**
  - 08.0601 Removal of temporary facilities**
  - 08.0602 Removal of temporary utilities**
  - 08.0603 Demobilisation of construction equipment and facilities**
  - 08.0604 Demobilisation of personnel**

**Typical activities of the period dependent type. Various professions of the support activities and of management up to the top management level are included.**

**Cost drivers: management, engineering and technical work force, number and duration of specialised tasks, costs for operation of facilities and services.**



## 9 - Research and development

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**09.0100**            **Research and development of decontamination, radiation measurement and dismantling processes, tools and equipment**

**09.0200**            **Simulation of complicated work on**

**Work of specialized R&D departments or contracted work for specialised companies. Requires high qualification and experience and sophisticated instrumentation, software and services.**

**Cost drivers: highly qualified engineering/designing work force, number and duration of specialised tasks, costs for specialised instrumentation, software and services, costs for specialised equipment and tools, cost for specialized projects for design, testing**



## 10 - Fuel and nuclear material

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**10.0100 Transfer of fuel or nuclear material from facility or from temporary storage to intermediate storage**

**10.0200 Intermediate storage**

**10.0201 Wet intermediate storage**

**10.0202 Dry intermediate storage and containers**

**10.0300 Dismantling/disposal of temporary storage facility**

**10.0301 Decontamination of temporary storage facility**

**10.0302 Dismantling/disposal of temporary storage facility**

**10.0400 Preparation of transfer of fuel or nuclear material from intermediate storage to final disposition**

**10.0500 Dismantling/disposal of intermediate storage facility**

**10.0501 Decontamination of intermediate storage facility**

**10.0502 Dismantling/disposal of intermediate storage**



## 11 – Other costs

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### **11.0100 Owner costs**

#### **11.0101 Implementation of transition plan**

#### **11.0102 Capital expenditures**

### **11.0200 General, overall (not specific) consulting costs**

### **11.0300 General, overall (not specific) regulatory fees, inspections, certifications, reviews, etc.**

### **11.0400 Taxes**

### **11.0500 Insurances**

### **11.0600 Overheads and general administration**

### **11.0700 Contingency**

#### **11.0701 Risk, financial assurance versus inherent uncertainties**

#### **11.0702 Escalation of high-risk cost elements**

### **11.0800 Interest on borrowed money**

### **11.0900 Asset recovery: Resale/transfer of general equipment and material**