Standardised Costs Elements (Items) for Decommissioning

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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.
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.**
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

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,
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

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

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

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

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

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
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 (D₂O, 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

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

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

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
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
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
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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<td>08.0604</td>
<td>Demobilisation of personnel</td>
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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.
Research and development

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 workforce, 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

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 facility
11 – Other costs

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