DECOMMISSIONING OF THE ASTRA RESEARCH REACTOR – PLANNING, EXECUTING AND SUMMARIZING THE PROJECT

by

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The decommissioning of the ASTRA research reactor at the Austrian Research Centres Seibersdorf was described within three technical papers already released in *Nuclear Technology & Radiation Protection* throughout the years 2003, 2006, and 2008. Following a suggestion from IAEA the project was investigated well after the files were closed regarding rather administrative than technical matters starting with the project mission, explaining the project structure and identifying the key factors and the key performance indicators. The continuous documentary and reporting system as implemented to fulfil the informational needs of stakeholders, management, and project staff alike is described. Finally the project is summarized in relationship to the performance indicators.

Key words: decommissioning, ASTRA research reactor, key factors, performance indicators, documentation

INTRODUCTION

Successful project delivery requires the systematic application of the practice and tools of project management [1-3]. An important aspect of project implementation is to ensure that information is available to manage and understand performance. Performance Indicators are one of the principal means of providing this information to those parties with an interest or influence on the project – whether internal or external to the project organization (see ref. 4, IAEA, Introduction to "Selection & Use of Performance Indicators in Decommissioning").

Austria, at the time of the ASTRA-MTR research reactor decommissioning at the site Seibersdorf, had no experience regarding to the dismantling of nuclear facilities. The document starts with a short reflection on the history of the reactor and the goals, the structure and the implementation of the decommissioning project. A suitable framework of performance indicators as it was actually developed and applied during the process is identified. The structure of the accompanying reporting system is explained and the results obtained in terms of schedule, materials, manpower, and budget relative to the performance indicators are analyzed.

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THE HISTORY OF THE REACTOR

In 1958 a federal agreement was reached in Austria to construct a 10 MW MTR multi purpose research reactor of the American Machinery and Foundry (AMF) design at a site approximately 30 km southeast of Vienna near the village of Seibersdorf. On September 29th 1960, the ASTRA reactor (Adapted Swimming Tank Reactor Austria) reached first criticality. After a period of initial operation, the average extent of operation per year from 1966 on was in the range of 500 and 900 MWd.

After a people's referendum held in Austria in November 1978, generally rejecting the use of nuclear power in Austria and preventing the already built nuclear power plant at Zwentendorf from becoming critical, the scientific use of the reactor subsequently decreased. After several modifications the commercial possibilities of the reactor were extended. Nevertheless the income of the reactor by commercial use hardly exceeded 50% of the ever rising operating costs of roughly EURO 1.300.000 per year in the late 1990's.

In 1997 the management of the Austrian Research Centres Seibersdorf (ARCS), responsible for the operation of the reactor decided because of political and financial reasons, to shut down the reactor permanently at the earliest possible date. A first deadline for the shut down was communicated with January 1st, 1998. Due to commitments and obligations to the users of the reactor and the date confirmed by the US Department of Energy (DOE) to accept ASTRA's spent fuel by the end of 2000 at the earliest, this deadline was extended to January 1st, 1999. The shut-down of the reactor finally occurred on July 29th, 1999.

GOALS, STRUCTURE AND IMPLEMENTATION OF THE PROJECT

The goals of the project

Since the ASTRA reactor was the first of the three research reactors in Austria undergoing decommissioning, no particular experience and regulations in decommissioning of those facilities were established. On the other hand, throughout reactor operations, the personnel of the reactor was directly responsible for the modifications to the facility with an outstanding experience in technical requirements and handling procedures under operating conditions and were familiar with the features of the reactor and the necessary safety procedures.

In general, different strategies have been applied for the decommissioning of research reactors, ranging from immediate dismantling to defer dismantling in stages separated by a few months and up to several decades. Between April 1998 and April 1999 on behalf of the Austrian government as the key-owner of the ARCS and the facility, a comprehensive study was prepared by ARCS to give a clear picture of the possibilities in decommissioning. Advantages and disadvantages were compared under ASTRA circumstances leading to a decision for immediate dismantling. The remaining operating time was partly dedicated to establish empirical data related to *e. g.* the activation of the pool-alumina-liner, the shielding concrete and of other major components.

The goals for the decommissioning with reference to buildings, structures, and funds were defined to:
– remove activated and contaminated materials from the reactor,
– keep the amount of radioactive waste to a reasonable minimum,
– keep the costs of the decommissioning as low as possible, and
– clear and preserve the building for further unrestricted re-use.

The goals for the decommissioning with reference to people and the environment were defined to:
– apply the necessary physical surveillance to personnel and environment,
– protect the staff from unnecessary exposure (ALARA-principle),
– take appropriate measures to prevent contaminations and the spreading of contaminations, and
– protect the environment from hazards implemented by the decommissioning process

The structure of the project

For reasons of licensing, legalization and administration the project was structured into four phases:

Phase 0	removal and disposition of the fuel elements preparation of data	Aug. 1999-Dec. 2000
Phase 1	recovering and treating of remote handled waste (RHW), recovering and treatment of RHW from the vicinity of the core, handling and conditioning of neutron exposed graphite, phase-1 conditioning work at Hot-Cell-Laboratory continued until	Jan. 2001-Jan. 2003 Dec. 2005
Phase 2	recovering and treating of contact handled waste, "fingerprinting" contamination of the primary water systems, dismantling of the primary water systems, processing of contaminated and activated metals, "fingerprinting" activation of Barite concrete, dismantling of the biological shield, radiological clearance of the surface of the concrete	Feb. 2003-Jan. 2005
Phase 3	radiological clearance of the reactor building	Feb. 2005-Dec. 2005

The implementation of the project

Based on the obtained data of the comprehensive study a rather clear picture of the tasks to be performed, the timetable of the project and the costs to be expected could be drawn with the following results.
– First possible shipping date for the transfer of the 54 spent fuel elements was established with DOE in the fall of 2000. To cover the costs of the disposition, EUR 1,800,000 were accumulated over years of operation for this purpose.
– Estimated 160 tons activated and contaminated materials had to be expected at estimated averaging costs of EUR 4,000,000 for the conditioning and intermediate storage.
– The work should be performed with remaining qualified reactor staff but with the option to use external labour when applying specialized techniques.
– 90 years of manpower for dismantling including the conditioning of the intermediate and low level waste, the establishment of the necessary radiological parameters, clearance of the buildings, radiation protection measures and documentation were calculated.

– Based on an average of 15 operational staff members that amounted to 6 years of project duration with estimated costs of EUR 9,000,000, not taking into account unforeseen delays.

Total costs of the decommissioning were therefore estimated with EUR 13,000,000 covering all expenses including the conditioning and temporary storage of the waste but with the exemption of the costs for the disposition of the spent fuel and the considerable reserve funds which are requested under Austrian law for an eventual later final storage of radioactive waste.

According to Austrian legislation, the operation of nuclear facilities is under federal supervision. Tasks similar to those already performed during the operational period of the reactor, *e. g.* disposition of the spent fuel or modifications to the reactor internals and experiments were therefore considered operational work and could be performed on already established rules. The return of the spent fuel elements to DOE and the removal and conditioning of remote handled waste (RHW) from the vicinity of the core and beam-tube internals was therefore permitted under the operational license (phase 0 and phase 1).

The decommissioning of nuclear facilities on the other hand is under supervision of the federal state of Lower Austria. To continue the project into phase 2 and phase 3 a decommissioning license by way of an Environmental Impact Assessment (EIA) had to be obtained while performing the work up to phase 1. In advance to the EIA, EURATOM had to be informed according Article 37 about the intentions to decommission the ASTRA.

After discussions of the implements of the comprehensive Decommissioning study with the responsible stakeholders, the project was finally presented to Parliament and appropriated in June 1999. The funding to run the project was granted in six equal parts over the years 2000 to 2005. In December 1999 the budget was formally approved by the Austrian federal ministry of finance. Now with the necessary funds guaranteed and the expectation of a positive statement according Article 37, EURATOM and by obtaining a decommissioning license following an EIA in due course, work on the project could commence immediately in January 2000.

IDENTIFICATION OF THE KEY FACTORS

Stakeholders

Facility owner	ARCS (until March 2003) Nuclear Engineering Seibersdorf Ltd - NES (from April 2003)
Government	represented by the ministry of science
Fund provider	represented by the federal ministry of finance
Regulators	represented by the federal ministry of environment, work under operating license, represented by the government of Lower Austria, work under decommissioning license
Neighbouring countries	via EURATOM according to the Article 37 procedure
General public	via Environmental Impact Assessment (EIA)
Project management	ARCS, division Nuclear Services (until March 2003); NES, Decommissioning Department (from April 2003)
Radioactive waste	NES, Radioactive Waste Management Department (RWMD)
Special materials	NES, Hot Cell Department (HZL)

Radioactive inventory

The majority of the radionuclides identified for the ASTRA possessed half-lives up to 80 days decaying sufficiently fast to allow immediate dismantling after the unavoidable time needed for the fuel disposition, or half-lives of more than 50 years until a substantial reduction of dose rates were achieved. Immediate dismantling with traces of *e. g.* Co-60 still present even in low level activated or contaminated areas assisted in the definition of reliable radionuclide relationships and simplified detection and clearance procedures.

The conditioning of contact handled materials and special materials (*e. g.* the annealing of the graphite and the remote handled sealing of the Beryllium elements) had to be carried out by the project staff supported by the colleagues and facilities of the Hot Cell Department in order to fulfil the acceptance criteria at the storage facility.

Available manpower and experience

The experience of the reactor operators in handling and cutting procedures under operating conditions and it's familiarity with the technical features of the reactor and the necessary safety procedures. Due to the experience, personal exposure has always been at comparably very low levels.

Safety and environment

Since decommissioning work could be performed within the closed containment of the reactor building with ventilation, under pressure and drainage still fully in operation, sufficient safety standards could be guaranteed. Virtually no possibility for a release of activity to the environment during the whole decommissioning process would exist.

Based on the radioactive inventory, the available manpower and experience and with a maximum priority to safety and environmental compatibility the immediate dismantling was recommended as the most viable option.

Estimation of the costs

A table of the different tasks necessary to dismantle the ASTRA was prepared. The work was divided into legal procedures, preliminary efforts, actual undertakings, the establishment of radiological data, and the conditioning and documentation. In comparison to other tasks performed at the reactor under operation, work-times were estimated. All single tasks were drawn against the available manpower. An overall period for the decommissioning could be calculated and the costs estimated.

A comprehensive catalogue of all significant parts of the reactor was prepared, including technical data like materials, weight, size of contaminated surface and calculated levels of contamination or activation with a basic characterization of possible nuclides. The amount of radioactive waste and of materials with potential clearance probabilities was defined and again the costs calculated. Contacts with other known decommissioning projects in Europe were established and estimated and actual data were compared with the figures of the ASTRA.

IDENTIFICATION OF THE PERFORMANCE INDICATORS

Timescale

Within the structure of the project, progress over the time was defined via the four phases (see structure of the project). Each of the phases was detailed into tasks with estimated working times attached. Due to the release of the money in equal batches over the years, it was essential to plan the tasks and apply manpower accordantly.

Tasks and materials flow

The comprehensive catalogue of parts was providing data on a continuous basis. Interlocking this data with the list of tasks allowed for a follow up of the progress and the definition of milestones.

Cost analysis

The implemented SAP system in ARCS facilitated the necessary means. Due to the fact that the budget was distributed on a constant yearly basis it was essential, that by the planning of tasks *e. g.* involving additional costs like employing external contractors, the financial possibilities had to be kept in view.

THE DOCUMENTARY SYSTEM

The scope of the project, the decommissioning strategies and tasks defined and the calculated costs established on the one side and the stakeholders with their responsibilities on the other side can be seen as a network connected via documented information drawn from the actual progress within the project. The strict obligation to identify each part/component, active or inactive, from the dismantling procedures until the final disposition as radioactive waste or to the release for re-use or disposal was also calling for extensive documentation.

Due to limited management resources the reporting system had to be easy for handling, but informative enough to fulfil the needs of stakeholders at different levels (*e. g.* government, regulators, experts, management, staff). Therefore a bottom up system was conceived, interconnecting the incoming data with the framework of the related tasks and matching the data against the guidelines as defined during the planning and legalising of the project (top-down documentation system). The procedures were handled flexible with possibilities for extensions and alterations when needed. Usually the project was reviewed on a yearly basis.

The bottom-up reporting system

To relay information to the stakeholders on a regular basis and to gain data suitable for reviewing the project, a reporting system was initiated. As overall indicator on project performance and project delivery the information was based on key-performance indicators. Reasons for changes in the planning and consequences due to the changes and due to unforeseen matters were analyzed. The regular bottom-up reporting system consisted of eight items.

Daily journal

Data usually established by project members on a handwritten daily basis. The main tasks performed were continuously added into an Excel-table stating date, component- or task number, and task performed.

Monthly reports

Compiled from the daily data and the data on materials flow and connected to the tasks- and timetable. The reported tasks were linked to the personnel involved and statements about difficulties or advancement added. The report was extended to cover topical matters and included the planning of the forthcoming month(s). The next monthly report was based on the previous, so current matters could be followed up. The

Word-file was made available to the directors of the Nuclear Services (NS), later to the executives of Nuclear Engineering Seibersdorf (NES) as well as to every staff member.

Quarterly reports

Compilation of the monthly reports: It emphasized on the timetable and the current costs and dealt with irregularities. The report was also extended to cover topical matters and difficulties and included the planning of the forthcoming period. The following quarterly report was again based on the previous for reasons of follow up. The Word-file was made available to the directors of the NS/NES, the contents included into the obligatory quarterly reports from NS/NES to the directors on the board of the ARCS and the scientific board.

Yearly reports

Based on the monthly and quarterly reports with extensive reflections on status-quo, review and statistics in reference to the key-performance indicators, cost-development and development in personnel and planning. Distribution was similar to the quarterly reports.

Materials flow

Basic data provided by project members, continuously extended by the documentation of transfer to the RWMD, acting as central facility for the collection, conditioning and intermediate storage of radioactive wastes arising in the country, or the final release. Excel file based on the component number with basic identifications of the parts, links to the original documents stemming either from the transfer to the RWMD or to the documents arising throughout the clearance procedures.

Waste-, clearance- and release reports

Precise data were obtained while material and components were handled. Each item from the moment of disassembling to either the place in the ready conditioned barrel in the intermediate storage or the way of cleared items to re-use, recycling, or disposal had to be followed at all times. The established number-based overall identification system was duly extended throughout the process. Via this system all data as for example within the daily journal, the probes and samples, the CAD-drawings, the extensive photo-documentation and the legal clarification documents were interlocking. Hard-copies were collected into a filing system.

Health and safety reports

A standardized monthly data collection following radiation protection is a general routine within all departments of the ARCS dealing with radioactivity. Additionally personnel on the job were equipped with electronic dosimeters providing instant information for the worker. The readings of the electronic dosimeters were regularly collected on a daily basis. In the case readings above the expected levels, the daily journal covering the undertakings allowed for immediate identification of tasks responsible. Official health and safety reports comparing actual and calculated values were usually prepared on a yearly basis or on request.

Status reports

Apart from the regular reports, status reports had to be prepared on request.

The top-down documentation system

The top-down communication covering technical, administrative and legal matters at different levels.

Decommissioning study

Before the initiation of the project a comprehensive Decommissioning study was prepared. The authorization of the project and the tasks as well as the legalization of the work was based and linked on the contents.

Reactor decommissioning meetings

During the planning stages of the project and throughout the operational phases 0 and 1 of the project, meetings with responsible stakeholders were held on regular schedules. The meetings were documented, decisions authorized, and continuing steps agreed with. In the later stages of the project after the granting of the decommissioning license following the EIA the meetings were held on occasion, usually to co-ordinate work within the departments RWMD and HZL of NES.

Application for the environmental impact assessment (EIA)

Extension of the Decommissioning study emphasizing on tasks to dismantle the reactor further, *e. g.* bioshield, cooling system and clearance of the building (decommissioning license).

Information of EURATOM according article 37 of the treaty

Information contents similar to the application for the EIA, but restructured to meet EURATOM-preferences.

Working instructions

Since the working instructions for the reactor in operation including work during phase 0 and phase 1 were not applicable for the work under the decommissioning license, new working instructions had to be established, authorized, and released. Alterations in the course of the decommissioning work were usually also put into working instructions before applying to the regulators.

Final report

After the successful clearance of the reactor building and in order to terminate the project a final report with a description of the tasks performed was requested by the authorities. The report included a copy of the daily journal and of the Excel-file on materials flow. The final report serves also as a key to the extensive overall hard-copy documentation of the reactor during decommissioning.

The overall project documentation

Since there is no guarantee, that digital copies are still usable/readable after long years of storage (for some items 30 years and more) it was decided to collect important information and originals preferably in hard copy. To accommodate the extensive documentation from the decommissioning period as well as from the operating period of the reactor, a room on the top-floor of the NES administration building was adopted. It was furnished with steel cabinets for long-time preservation of the documents.

The documentation on the subject of decommissioning contains:
- complete documentation of the decommissioning process, planning, operating, evaluation,
- monthly, quarterly an yearly reports on decommissioning,
- technical and legal documentation on decommissioning,
- extensive documentation about radiological clearance measurement and materials flow,
- the extensive photo-documentation,
- collection of working instructions valid for decommissioning, and
- papers, publications, and books released in connection with the decommissioning

The documentation on the subject of 40 years of reactor operation contains:
- detailed information about the fuel cycle and disposal over the full operating period,
- reactor operating logbooks and the logbooks of radiological surveillance,
- continuous records on exhaust air and surveillance of the surrounding,
- operating handbook and records of continuous survey by the regulators,
- theoretical and technical information concerning experiments,
- a complete set of technical drawings of the reactor,
- administrative communication and picture documentation during reactor operation, and
- personal documentation of the former reactor management

SUMMERIZING THE PROJECT IN RELATIONSHIP TO THE PERFORMANCE INDICATORS

The final goal of the project was the release of the buildings for re-use. Immediate dismantling was chosen to be the optimum decommissioning strategy. Decommissioning work started with the disposition of spent fuel. It was immediately continued with the removal of remote handled waste, followed by the removal of contact handled waste and finalized with the decontamination of the reactor building to achieve the clearance level for unrestricted re-use. With the release of the reactor building from regulatory control the decommissioning of the ASTRA was terminated in October 2006, approximately 10 months behind schedule. In the following the development of the project along the timescale, the materials flow, and the actual costs in relationship to the performance indicators on a task-related basis are analyzed.

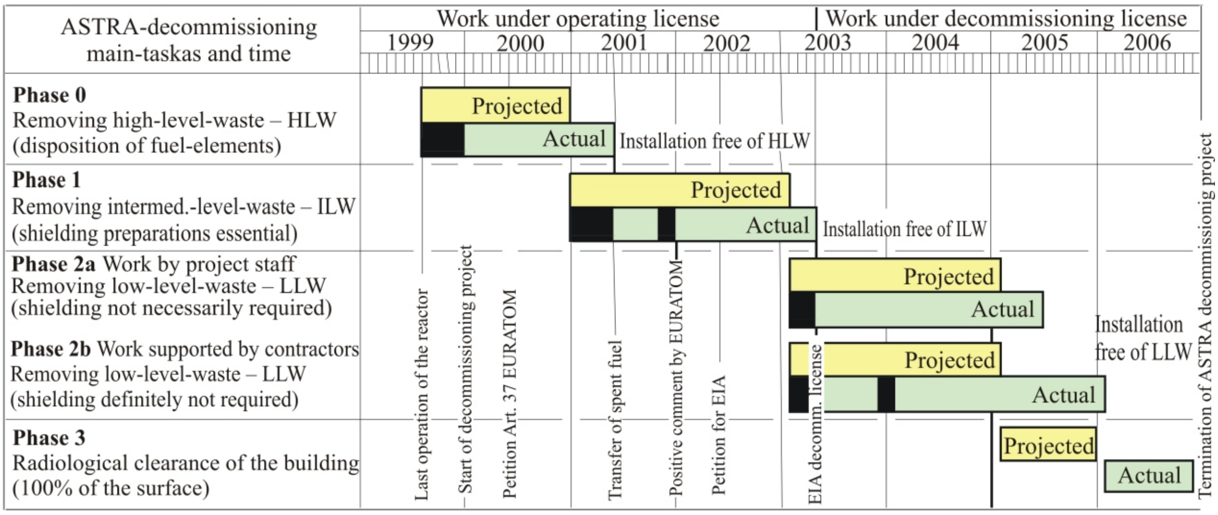
Analyzing the performance of the project with reference to the timescale

In order to cope with delays usually caused by administrative difficulties outside the competence of the decommissioning management, *e. g.* unexpected waiting for licenses, it was decided to enforce the project-team by co-workers leased from an outside company and to run tasks parallel where possible (dismantling the biological shield in the reactor building and the primary water-systems in the independent underground pump-room). To engage external labour for specialized tasks, *e. g.* the cutting of concrete, was already decided during the planning for decommissioning. Table 1 summarizes the ASTRA project by detailing main tasks over time.

Analyzing the materials flow in relationship with the tasks

The obligation to reduce radioactive waste has been followed ambitiously. For example, under Austrian conditions there are no established routes to introduce metals into the market, even though the radionuclide content is well below the clearance levels for unrestricted re-use. Such metals would have had to be considered "radioactive" waste. Germany has established routes for the recycling of cleared metals. In co-operation with a German company licensed for the melting of those metals, 42 metric tons of cleared ASTRA metals were recycled for re-use. Further assets were the extensive characterization efforts and the introduction of diamond wire cutting to dismantle the biological shield. It resulted in a considerable reduction of radioactive waste in comparison to the original

Table 1. ASTRA decommissioning – tasks and time



Note: Dark hatched areas indicate times lost through delays outside the power of the project management

planning (83 tons actually *vs*. 160 tons estimated), see tab. 2 for details.

Analyzing the costs in relationship with the tasks and the budget

After the decision to dismantle the reactor immediately after the final shut down, using the expertise of the reactor staff, a swift continuation of the work was essential (time is money!). Due to retirement only two out of ten members of the original staff remained until the end of the project. Replacements had to be contracted.

The costs of manpower (project staff, personnel leased and specialists employed) are dominating the budget with 72% of the total costs. The costs for conditioning and storage of radioactive waste amounted to 18% of the total costs. The considerable costs of an eventual final storage of the waste were not part of the projects budget.

Realistic early planning, preventing delays and flexibility in the implementation of the project were crucial. In order to keep the project within the financial limits it was necessary to apply a continuous trade off between decontamination efforts (expenditures in terms of man-hours) *vs*. minimization of radioactive waste (savings in storage and disposal costs).

The preparations of the fuel transfer and the loading of the transport containers with the 54 spent fuel elements were within the projects cost. The costs of the disposition of the spent fuel were expected to be entirely covered by funds collected on a continuous rate during reactor operation. Due to unfavourable exchange rates between the US-$ and the EUR around 2001 an additional 0.207 million EUR were needed to cover the disposition. The costs exceeding the provisions as well as the purchase of a whole-body monitor were subject to special approval by the authorities but covered out of project-funds at the time. The money was reimbursed in 2006 when additional funds were needed to close the project. Table 3 highlights costs associated with the phases of ASTRA decommissioning. Note: The figures in tab. 3 are represented under a different point of view compared to the similar figures within the cost analysis as presented in 2008; see tab. 4 of ref. 3.

The estimated costs of the decommissioning project were calculated based on the price-index of 1999 with a budget of 13.080 million EUR. The money was equally distributed at a rate of 2.180 million EUR per year over the period 2000 to 2005. A compensation for the annual inflation was agreed in 1999. The average inflation rate in Austria during the years of 2000 to 2006 was 2.5% annually. To compensate for the inflation rate and to cope with unexpected delays and expenditures, another 0.673 million-EUR were approved in 2006 to finish the project. The project was finally terminated 10 months later than scheduled with an overdraft of actually 4.7%, see tab. 4 for more detail.

Analyzing manpower in relationship with the tasks

In tab. 5 manpower related to the tasks and the function within the project is analyzed. Summarizing the functions involved, 50% of the total manpower was directly applied to the tasks, supported by roughly 32% in characterization, safety, and health protection against 18% directed into management functions.

Analyzing manpower over the years

Table 6 analyzes manpower against the years. Following the budgetary demands and due to the dom-

Table 2. ASTRA decommissioning – tasks and materials

	ASTRA decommisioning – tasks and materials	Operating license		Decommissioning license		2000 to 2006	
		2000	2001 2002	2003 2004 2005	2006		
		Phase 0	Phase 1	Phase 2	Phase 3	[t]	[%]
Radioactive waste	High level waste – spent fuel (special treatment required)	(1)					
	Intermed. level waste – metals (shielding required, 5 mosail container)		3			3	0.1
	Low level waste – metals (no shielding required, 1 Konrad type 2 cont.)		9			9	0.4
	Low level waste – graphite (no shielding required, 1 Konrad type 2)		7			7	0.3
	Low level waste – concrete (no shielding required, 3 Konrad type 2)			25		25	1.2
	Low level waste – solid unburnable (no shielding required 200-L-drums)		34			34	1.6
	Low level waste – solid burnable (no shielding required, to incinerator)		5			5	0.2
	Total radioactive waste					83	3.8
Inactive waste	Waste (cleared for conventional disposal)		7	137		144	6.6
	Metals (cleasred for re-use through melting process)		42			42	1.9
	Materials (cleared for unrestricted re-use)		91	1430		1521	70.1
	Materials (removed from building after clearance) for re-use on site)				384	384	17.6
	Total inactive waste					2091	96.2
	TOTAL AMOUNT OF WASTE [t]	0	198	1592	384	2174	
	[%]	0	9.1	73.3	17.6		100

Table 3. ASTRA decommissioning – tasks and costs

	ASTRA decommissioning – tasks and costs	Operating license		Decommissioning license		2000 to 2006	
		2000	2001 2002	2003 2004 2005	2006		
		Phase 0	Phase 1	Phase 2	Phase 3	[million EUR]	[%]
Category	Management, engineering, administration, documentation	0.317	0.528	0.883	0.330	2.058	13.5
	Characterisation, radiation protection, safety engineer	0.747	0.820	1.446	0.381	3.394	22.3
	Personnel (project staff and contractors)	1.078	1.287	2.611	0.512	5.488	36.0
	Equipment and materials procured	0.194	0.489	0.407	0.195	1.285	8.5
	Conditioning and intermediate storage of radioactive waste	0.568	0.518	1.011	0.694	2.791	18.3
	Additional funds required for fuel disposition	0.207				0.207	1.4
	TOTAL [million EUR]	3.111	3.642	6.358	2.112	15.223	
	[%]	20.4	23.9	41.8	13.9		100

ination of the costs of manpower, it was essential to keep the staff employed on an even level. It can be observed that the average of slightly more than 11 man-years per year was only exceeded throughout the years 2004 and 2005, mainly because of employing external specialists for the diamond-wire cutting of the biological shield.

CONCLUSIONS AND LESSONS LEARNED

It is the function of the project management to plan and prepare the decommissioning tasks on the technical, administrative and legal levels properly and well in advance. Flexibility in coping with unforeseen difficulties or delays is another important obligation. Therefore all technical and administrative skills necessary to plan and execute the tasks must be represented within the project to react and cope immediately with unexpected occurrences. Regular contacts and open co-operation with regulators and authorities is an asset.

It is of utmost importance to continuously upgrade project data and carry out proper surveys before and during the work to ensure a smooth execution. Good quality of the established data is essential for quick and reliable decisions and procedures, the reduction of hazards and the minimization of waste.

Table 4. ASTRA decommissioning – budget development

	ASTRA Decommissionig – budget development		2000	2001	2002	2003	2004	2005	2006	Total
Budget	Project budget as estimated in 1999 (not validated)	[million EUR]	2180	2180	2180	2180	2180	2180		13080
	Project budget-average annual inflation-rate of 2.5% considered		2.235	2.290	2.348	2.406	2.466	2.528		14273
	Costs exceeding provisions for fuel-transfer		(due to exchange rate EUR / US$ – not calculated in 1999)							0.207
	Purchase of a whole-body monitor		(further use after decommissioning – not foreseen in 1999)							0.070
	Additional funding in 2006, necessary to finish the project		additional expenditure + 4.7%						0.673	0.673
	Actual costs of the decommissioning of the ASTRA	[million EUR]								15223

Table 5. ASTRA decommissioning – manpower and tasks

ASTRA decomissioning – manpower and tasks		Operating license: 2000, Phase 0	Operating license: 2001–2002, Phase 1	Decommissioning license: 2003–2005, Phase 2	Decommissioning license: 2006, Phase 3	2000 to 2006 [million-EUR]	2000 to 2006 [%]
Project staff	Management, engineering, administration, documentation	2.4	4.0	6.7	2.5	15.6	18
	Characterisation, radiation protection, safety engineer	3.6	4.6	8.8	2.2	19.1	22
	Decommissioning tasks and waste treatment by project staff	4.3	5.8	7.7	1.8	19.5	22
	Support by hot cell department	3.8	3.9	3.0		10.7	12
Contract	Physicists (radiation protection and reactor)	2.7	2.1	2.8	0.9	8.5	9.7
	Personnel replacing retirees			5.8	2.8	5.6	9.8
	Specialists for concrete cutting			5.8		5.8	6.6
TOTAL (27 individual persons involved)	[million EUR]	16.7	20.5	40.5	10.2	87.9	
	[%]	20.0	23.3	46.1	11.5		100

Table 6. ASTRA decommissioning – manpower and time

	ASTRA decommissioning – analysis of manpower		2000	2001	2002	2003	2004	2005	2006	2000 to 2006	
Category	Management, engineering, administration, documentation		1.6	1.9	2.0	2.6	2.6	2.1	2.8	15.6	17.7
	Physicists (radiation protection and reactor)		2.0	1.7	0.8	1.0	1.0	1.0	1.0	8.5	9.7
	Characterisation, radiation protection, safety engineer		2.6	2.3	2.3	3.0	3.3	3.3	2.4	19.1	21.7
	Workforce on the project-team		3.0	3.0	3.0	3.0	2.8	2.7	2.0	19.5	22.3
	Support by hot cell department		2.6	3.0	1.7	1.6	0.9	1.1		10.7	12.2
	Workforce leased externally						2.6	3.0	3.0	8.6	9.8
	Specialists for concrete cutting						3.3	2.6		5.8	6.6
TOTAL (27 persons involved)		[million-EUR]	11.8	11.9	9.8	11.2	16.4	15.7	11.1	87.9	
		[%]	13.4	13.5	11.1	12.7	18.8	17.9	12.6		100

Early recognition of *e. g.* the fatal influence of impeding delays and decisions to take counteractions by investing into clearance efforts resulted on the one hand in the profitable reduction of radioactive waste and on the other hand by improving the flexibility to cover part of the additional costs in manpower, allowing for uninterrupted continuation of the work with a tendency to level the projects balance.

The establishment and the proper application of suitable indicators together with the implementation of a comprehensive documentation process are reliable means to assess the projects performance, to validate the effect of measures and to communicate the status of the project equally to staff, management, and stakeholder.

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ДЕКОМИСИЈА ИСТРАЖИВАЧКОГ РЕАКТОРА АСТРА – ПЛАНИРАЊЕ, ИЗВОЂЕЊЕ И КРАТАК ПРИКАЗ ПРОЈЕКТА

Декомисија истраживачког реактора АСТРА, који се налази у аустријском истраживачком центру у Сајберсдорфу, делом је већ представљена у три рада објављена у часопису Nuclear Technology & Radiation Protection – године 2003, 2006, и 2008. Следећи препоруку Међународне агенција за атомску енергију, пројекат је спровођен и пошто су документа склопљена, пре из административних него техничких разлога, започињући са пројектним налогом, објашњењем структуре пројекта, дефинисањем кључних чинилаца и кључних показатеља извођења. Описан је систем непрекидног документовања и извештавања који је уведен да задовољи потребе за информацијама власника, управе и особља на пројекту. На крају, пројекат је укратко приказан у вези са показатељима извођења.

Кључне речи: декомисија, истраживачки реактор АСТРА, кључни чиниоци, показатељи извођења, документација