
Comparison of decommissioning options for the example of 2 research reactors of type TRIGA

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Abstract:

For decommissioning of nuclear facilities usually the two decommissioning strategies “immediate dismantling” or “deferred dismantling (safe enclosure)” are applied. In general, immediate dismantling is regarded as the more advantageous and more preferable option. Accordingly, immediate dismantling is the mostly selected option. Nevertheless, only in a case by case analysis it can be shown, which decommissioning option is the better one e. g. with respect to technical aspects or to a use of the facility / remaining facility. For two real decommissioning projects of two similar research reactors of TRIGA type GRS with support of the operator, German Cancer Research Center Heidelberg, performed a study on possible advantages of the two different strategies selected. While the first research reactor, TRIGA HD I, was dismantled immediately, the second research reactor, TRIGA HD II, was dismantled after a 20 years period of safe enclosure. As a result, it could be shown, that the selected different decommissioning strategies reflected the special conditions of each both research reactor in best way, so that a clear preference for one of the two decommissioning strategies can not be deduced.

1 INTRODUCTION AND BACKGROUND

German and international practice show, that at the end of their intended life time nuclear facilities are finally shut down and are dismantled either immediately after shut down (so called *immediate dismantling*) or after a period of safe enclosure (so called *deferred dismantling*).

Since several decades the advantages and disadvantages of both decommissioning options (immediate dismantling, deferred dismantling) have been discussed repeatedly on a national and international level to conclude on recommendations how to derive the optimized decommissioning option for an individual nuclear facility. These discussions showed and still show, that at least due to the complexity of the individual nuclear facility and due to the still evolving experiences on the conduct of decommissioning from a variety of projects such recommendations will be re-assessed repeatedly. As an example in the past the decay of Co-60 was regarded as the most important advantage of the deferred dismantling. Today it is expected, that in case of nuclide vectors composed of Co-60 and alpha emitting radionuclides the loss of Co-60 contamination will be one of the major disadvantages: as far as the Co-60 fraction is high with respect to the fraction of the alpha emitting radionuclides the Co-60 can be used as an appropriate and easy to detect representative whose activity is a scale for the activity of the alpha emitting nuclides. If the fraction of Co-60 is small, than any uncertainty in the detection of its activity will result in a high uncertainty of the alpha emitting nuclides. Thus for that later case, measures on radiation protection or on clearance become

¹ Retired

more complex to ensure conservatism. Summarizing, the selection of an optimized decommissioning option continues to be a difficult process.

Nevertheless, within the last decade immediate dismantling, especially in case of nuclear power plants, on the international level became the preferable and meanwhile recommended dismantling option ([1], [2]). Also in Germany in past and recent decommissioning projects immediate dismantling has been implemented (e.g. decommissioning of Stade Nuclear Power Plant or Obrigheim Nuclear Power Plant).

But still today there are new decommissioning projects (e.g. Doodeward Nuclear Power Plant) for which deferred dismantling has been selected. In addition, according to international opinion there may be reasons for the individual case to prefer and justify deferred dismantling (see e. g. [3], [4]). Thus, immediate dismantling is not always the preferred option to decommission nuclear facilities.

As a contribution to the discussion sketched above a study of the decommissioning projects of two similar nuclear facilities may give some additional insights into the selection of decommissioning options. The challenge of such a study is to identify two nuclear facilities in deferred dismantling and under immediate dismantling, which are comparable with respect to their design and to the technical and regulatory framework relevant during decommissioning. In addition, all relevant information from the period of preparation of the safe enclosure to the end of the safe enclosure needs to be available also.

Such a study was performed from 2005 to 2007 for the two research reactors of type TRIGA MARK I (Training, Research and Isotope Production Facility of General Atomic [5]) of the public owned German Cancer Research Centre at Heidelberg. The study and its results are subject to this report.

The research reactors TRIGA HD I and TRIGA HD II were operated in sequence from 1966 to 1977 and from 1978 to 1999. After final shut down of TRIGA HD I, in 1980 the research reactor was brought into the safe enclosure. In 2006 the safe enclosure was terminated and the remaining few systems and installations were dismantled; the reactor building was released from regulatory control for demolition. In contrast to the deferred dismantling of the TRIGA HD I the research reactor TRIGA HD II was immediately dismantled from autumn 2004 to autumn 2005. The reactor building was unrestrictedly released from regulatory control in 2006 for a later use of the building by the German Cancer Research Centre.

2 OVERVIEW ON THE TWO RESEARCH REACTORS AND THEIR DECOMMISSIONING

In the following two subsections the two research reactors and their decommissioning will be briefly described. The descriptions are intended to support the understanding of the study on the two projects and on the comparison of the two decommissioning options. The comparison of these options is subject to section 3.

2.1 TRIGA HD I and its Decommissioning

2.1.1 Overview on TRIGA HD I

The research reactor TRIGA HD I was a tank reactor of TRIGA type with a thermal power of 250 kW(th). The reactor was built for production of short lived radionuclides for medical

treatment and investigations and for neutron activation analysis in the context of cancer research.

The reactor was located in a dedicated building comprising of the reactor hall, radionuclide laboratories, machinery room with components of the primary and secondary circuits, storage rooms for radionuclides and for radioactive waste and a set of measuring rooms. In addition several offices were located in the building.

The reactor comprises of an aluminum tank which was nested in a biological shield made of concrete. In the tank a combined core grid with graphite reflector was located (see also section 2.2.1). The biological shield was completely nested in the foundation of the building. All components to operate and control the reactor were inserted into the reactor from the reactor top. The material samples to be irradiated were inserted also from the reactor top (see also section 2.2.2).

The research reactor which had been commenced in August 1966 was finally shut down in August 1977. A brief chronology of the research reactor is presented in Figure 1.

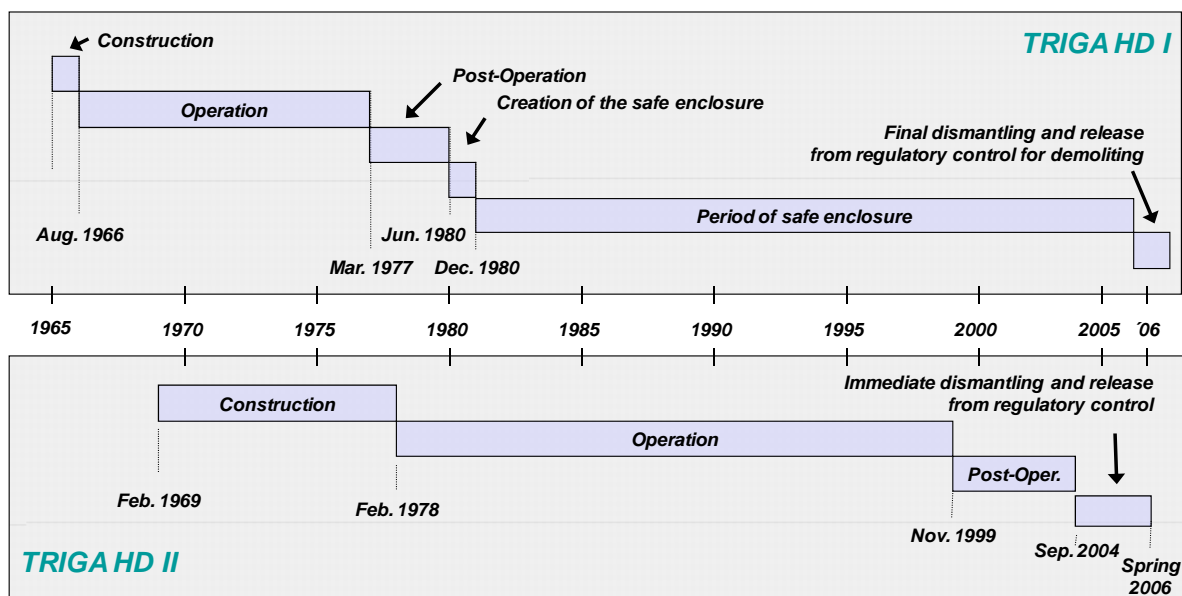


Figure 1 Brief chronology of TRIGA HD I and TRIGA HD II.

2.1.2 Overview on the decommissioning of TRIGA HD I

After final shut down in 1978 the research reactor TRIGA HD I was prepared for safe enclosure in 1980 and kept in safe enclosure until 2006. In 2006 the remaining systems and components of the reactor were dismantled and the remaining structures were released from regulatory control with the condition of demolishing of the reactor building.

After final shut down the spent fuel was removed and transported to TRIGA HD II. During preparation for safe enclosure among others the reactor internals (e.g. core grid with graphite reflector, irradiation rotary system) were dismantled and partially disposed of. As far as possible, the water in the reactor tank was used for shielding purpose during dismantling, and later released from regulatory control after purification. In addition, the components of the primary circuit and the components in the machinery room (e.g. pumps of the primary or secondary circuit) were dismantled and disposed of. All infrastructure as ventilation systems, radioactive waste storage area, decay tanks for radioactive liquids and the radionuclide

laboratories remained in the reactor building for further radioactive use by third party users during the period of safe enclosure.

After removal of the reactor water from the tank the tank was decontaminated and the reactor top was closed off by a sealing of a quadratic concrete plate with a manhole which allowed inspection of the reactor tank during the period of safe enclosure (see Figure 2).



Figure 2 View into the reactor hall of the TRIGA HD I after realization of the safe enclosure by sealing the reactor top (square with a manhole for inspection reasons).

The period of safe enclosure lasted from 1980 to 2006. During that time the reactor building and the remaining infrastructure were used by a university institute, among others to handle radioactive material under a license according to the German Radiation Protection Ordinance. As the reactor tank was sealed and fully contained in the foundation of the reactor building no restriction on the use of the building existed. The integrity of the safe enclosure had to be inspected annually and the tank every 10 years.

Based on first preparatory work (e.g. inspection of the infrastructure) starting in 2003 the dismantling of the remaining parts of the research reactor was performed in 2006. A radiological characterization was performed, identifying some radioactive contaminations in decay tanks belonging to the sewerage system of the reactor and in a venting channel and in some activation of the concrete of the biological shield close to the former zone of the reactor core and at the bottom of the biological shield. As far as possible the contamination was removed before dismantling of the tanks and of the channel. If contamination could not be removed the affected material was cut and disposed of as radioactive material, if the clearance levels could not be met. Concerning the activation of the biological shield the inner activated layer of the biological shield in the zone of the reactor core was peeled off and disposed off as radioactive waste after the aluminum tank had been cut and removed. The remaining biological shield was cleared using the clearance levels for demolition of a building as laid down in the German Radiation Protection Ordinance. After completion of clearance measurements in the reactor building the reactor and the reactor building were released from regulatory control with the condition that the building had to be demolished.

During preparation of the safe enclosure the collective effective dose of the workers amounted to 5.6 Pers.mSv. During the period of safe enclosure no dose uptake was determined as the ambient dose rate at the sealed reactor top was in the order of the background ambient dose rate. For the dismantling activities after the period of safe enclosure a conservative estimate of the collective effective dose of the workers was 1 Pers.mSv but the real collective effective dose of the workers was determined to be equal to 0 Pers.mSv.

2.2 TRIGA HD II and its Decommissioning

2.2.1 Overview on the TRIGA HD II

The research reactor TRIGA HD II was as its predecessor TRIGA HD I a tank reactor. The research reactor was designed for a thermal power of 1,000 kW(th) but was operated only at a thermal power of 250 kW(th). It was mainly used for research in the area of oncology, the production of radionuclides for the cancer therapy, calibration of PET scanners and for neutron activation analysis.

The research reactor was located in a reactor building which was built to house the TRIGA HD II and a cyclotron. The structures of the TRIGA HD II consisted among others of the reactor hall, in which the reactor was located, a radionuclide laboratory for loading and handling of the irradiated samples, a hot workshop, and a machinery room containing the primary and secondary circuit components and components of the water purification system. The biological shield of the reactor was half embedded in the foundation of the reactor hall and half in the reactor hall itself. Figure 3 provides a view onto the biological shield in the reactor hall (left picture) and into the reactor tank. Specific to the TRIGA HD II was a fast sample transport system (rabbit system) to load and unload the samples to be irradiated into the irradiation rotary system at the reactor core. This fast rabbit system was operated with tank water and connected the reactor and the radionuclide laboratory.

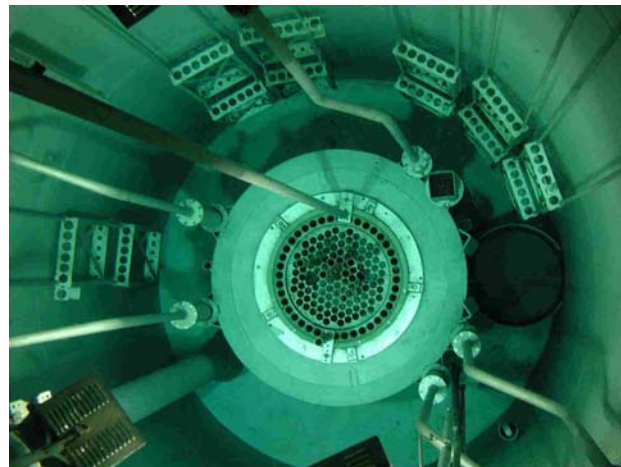
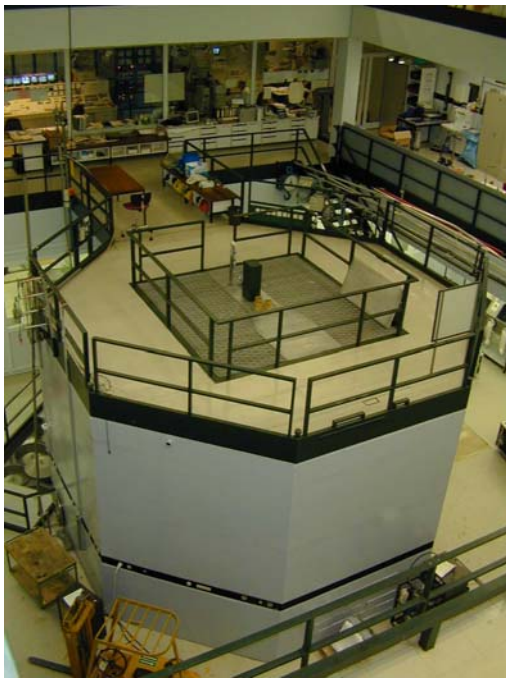


Figure 3 Left: view of the TRIGA HD II from the upper gallery of the reactor hall.
Right: view into the reactor tank and onto the reactor core with graphite reflector without fuel elements.

The research reactor was commenced in February 1977 and was finally shut down in November 1999. A brief chronology of the reactor is presented in previous Figure 1 (see section 2.1.1).

2.2.2 Overview on the decommissioning of TRIGA HD II

After final shut down of the TRIGA HD II in November 1999 measures were conducted as part of the post operational period until September 2004 to prepare the immediate dismantling which was performed from September 2004 to September 2005. After completion of the clearance measurements in April 2006 the reactor hall was released from regulatory control.

During the post operational period the spent fuel elements and control rods of the TRIGA HD II, which included also the re-used spent fuel elements of the TRIGA HD I, were transferred to the USA as the state of origin. Also, the radiological characterization was conducted which was used as a fundamental input to the decommissioning planning. Based on this planning but still covered by the operating license some measures were performed to support an immediate start of the dismantling activities as soon as the license for decommissioning was granted. These measures included the separation of the research reactor area from that of the cyclotron, modification of the venting system, installation of a new access point for the reactor area, the installation of clearance measuring equipment and the logistics for the conventional and radioactive waste.

After granting the license for decommissioning in September 2004 decommissioning of the TRIGA HD II started. The measures included the dismantling of the primary and secondary loops and the water purification system, of all components located in the machinery room, of the core internals, of the aluminum tank of the reactor, the upper part of the biological shield and of the radionuclide laboratory. For the lower part of the biological shield, which was nested in the foundation of the reactor hall, the activated zones close to the reactor core and at the bottom of the biological shield were peeled off to meet the relevant clearance levels of the German Radiation Protection Ordinance for the remaining structure. The measures performed included also clearance measurements for material and structures, including the lower part of the peeled off biological shield.

For the decommissioning of the TRIGA HD II a conservative estimate of the collective effective dose of the workers resulted in 20 Pers.mSv. After completion of the decommissioning and dismantling the real collective effective dose of the workers was 1.8 Pers.mSv.

3 COMPARISON OF IMMEDIATE DISMANTLING AND DEFERRED DISMANTLING

Within this section the basic concept of the study is described and the results of the analysis of the two decommissioning projects of TRIGA HD I and TRIGA HD II with regard to the selected decommissioning option are presented.

3.1 Concept of the study

The study was performed as an iterative process, with the following elements:

- Determination of a set of evaluation aspects, on which the analysis and the comparison should be based and which helped to structure the available information;
- Collection of available information on the decommissioning projects and processing of that information to support an understanding of the decommissioning of each research reactor and of the influencing parameters and
- Evaluation of the information and deduction of results for the intended comparison.

During the conduct of the study, adjustments of the analysis criteria and of the structure to collect the information became necessary to ensure that the evaluation aspects and the information collected fitted together and allowed an appropriate comparison.

The set of criteria was based on national and international documents on the decommissioning of nuclear facilities and contained mainly recommendations and best practices from decommissioning projects. Up to now, only few documents address details on how to derive an optimized – if any – decommissioning option.

As a result of the analysis of documents and after iterations the following evaluation aspects were considered in the comparison:

- Use of the site / building after completion of decommissioning and during the period of safe enclosure;
- Collective effective dose of the workers;
- Identification and management of radioactive material;
- Amount of radioactive waste (for the study limited to concrete);
- Availability of the operator's know-how on the research reactor, availability of qualified personnel;
- Complexity of the dismantling measures and dismantling techniques to be used;
- Availability of appropriate dismantling techniques, taking into account ALARA as far as appropriate;
- Availability of options to dispose of conventional and radioactive waste and
- Availability of the necessary infrastructure.

Originally, also the costs should have been analyzed. During information collection it turned out, that for the preparation of the safe enclosure of the TRIGA HD I not all relevant information was recorded in a way allowing a clear comparison of both decommissioning projects with respect to the costs. Accordingly, costs were deleted from the set of evaluation aspects.

As planned the available information on both decommissioning projects was collected, processed and documented in a synoptic form. The information was structured as follows:

- Information on the general situation after final shut down / before start of the decommissioning;
- Information on the post operational period of the research reactor (covered by the operating license) and
- Information on planning and conduct of the decommissioning of the research reactor (covered by the decommissioning license or a specific regulatory permit).

For each of the sub-bullets definitions were developed to ensure a clear allocation of the available information to the relevant structure.

As last element of the iterative process for each criterion the information was evaluated with respect to the question, whether for the individual decommissioning project the selected decommissioning option resulted in an advantage or disadvantage or was just neutral from that point of view.

3.2 Results from the evaluation

The results of the evaluation of both decommissioning options “deferred dismantling” (TRIGA HD I) and “immediate dismantling” (TRIGA HD II) are presented in Figure 5.

| Evaluation Issues | Immediate Dismantling | Deferred Dismantling |
|---|-----------------------|----------------------|
| Use of the building / site | ☺ | ☺ |
| Collective effective dose | ☺ | ☹ |
| Identification & management of radioactive material | ☺ | ☺ |
| Amount of radioactive waste (concrete only) | ☹ | ☺ |
| Operator's availability on know-how on the facility / availability of qualified personnel | ☺ | ☺) |
| Complexity of the dismantling activities and of dismantling techniques | ☺ | ☺ |
| Availability of necessary dismantling techniques | ☺ | ☺ |
| Availability of a disposal route | ☹ | ☺ |
| Availability of the necessary infrastructure | ☺ | ☹ |

Figure 4 Results of the evaluation of the immediate dismantling and the deferred dismantling for the two decommissioning projects TRIGA HD I and TRIGA HD II (☺: regarded to be of advantage; ☹: regarded to be a disadvantage; ☹: regarded to be neither an advantage nor and disadvantage).

Brief discussion of the results:

- Usually it is assumed that a period of safe enclosure imposes restrictions on the use of the structures, systems and of the site of nuclear facility during that period. In case of TRIGA HD I there were no restrictions on the use of the reactor building as the relevant biological shield was fully nested in the foundation. Moreover, as the university institute was interested in using the infrastructure of TRIGA HD I for handling of radioactive material, the option of safe enclosure allowed an early use of that infrastructure.
- For the collective effective dose it is usually assumed that the collective effective dose for the immediate dismantling is higher than for the deferred dismantling. In case of the dismantling of TRIGA HD I and TRIGA HD II the situation is opposite. Going into detail it turns out that the collective effective dose for TRIGA HD I mainly resulted from the preparation of the safe enclosure, while the contribution from the dismantling of the remaining systems and components after the period of safe enclosure is negligible which is in agreement with the usual assumption.
- For none of the two decommissioning projects the identification of radioactive material and its management was a challenge. This is mainly due to the very low contamination, if any, and the absence of alpha contaminations as fuel element failures had not occurred.
- Concerning the amount of radioactive waste generated the study could only consider the amount of radioactive concrete as only for radioactive concrete a full set of data was available for TRIGA HD I (for the components dismantled in 1980 not all information was available).

The data for concrete show that the amount in terms of mass of radioactive waste generated during the dismantling of TRIGA HD I was about 1/3 of the amount generated at TRIGA HD II. On a first view this is consistent with the generic assumption, that due to long decay a higher fraction of material can be cleared. Nevertheless, a detailed analysis showed that the density of the concrete of

TRIGA HD II was higher than that of TRIGA HD I and that the neutron flux integrated over the operational life time of TRIGA HD II was about 3 times higher than for TRIGA HD I. Thus, the original activation of the concrete of the biological shield of both reactors was not the same and cannot be used as an argument for the advantage of the deferred dismantling. But taking the decay of the radioactive inventory of the biological shield of TRIGA HD I from 1.1 GBq in 1979 to 35 MBq. in 2004 as a criterion the advantage of the deferred dismantling becomes obvious; it should be noted, that this decay is not automatically a direct measure for a decrease in radiation exposure.

- Concerning the availability of know-how on the research reactor and the availability of qualified personnel usually it is assumed that for the deferred dismantling the situation is much worse compared to that of the immediate dismantling. This situation in general was true for TRIGA HD I, but a former staff expert could be involved in the clarification of any open issues on that research reactor and in addition one staff member at TRIGA HD II was working at TRIGA HD I in its last years of operation. Thus the availability of know-how on TRIGA HD I was a real challenge, but could be solved under special conditions.
- Although different in some technical details (e.g. fast rabbit system and redundant components of the primary circuit of TRIGA HD II) the complexity of the radiological relevant decommissioning activities for both research reactors was comparable and not providing technical challenges or requiring further research or development activities.
- At the time of final shut down of TRIGA HD I no appropriate techniques were available to cut the aluminum tank. Dismantling in 1980 would have required a more complex process than was used in 2006. For decommissioning of TRIGA HD II all necessary dismantling techniques were available and proven fit for purpose.
- For both decommissioning projects at each phase of the project disposal options were available and the radioactive waste could be delivered to a service provider and related interim storages. In case of TRIGA HD II a condition for delivering the radioactive waste to the service provider / the interim storage was the agreement to take over future costs if the radioactive waste might require a re-conditioning due to changed conditions of a final disposal site. As for that reason some financial resources needed to be foreseen the evaluation result is regarded to be neutral.
- While the infrastructure of TRIGA HD II was in good condition due to the operation of the reactor and the use of the building for operation of a cyclotron the infrastructure of TRIGA HD I had to be refurbished to meet the conditions of the dismantling.

4 CONCLUSION

While TRIGA HD I was partially dismantled, brought to safe enclosure and finally dismantled after about 20 years of safe enclosure, TRIGA HD II was immediately dismantled. Thus, at the German Cancer Research Centre at Heidelberg two research reactors were dismantled following nationally and internationally practiced decommissioning options. It has to be mentioned, that the option for TRIGA HD I due to the work necessary to prepare the safe enclosure in fact was a mixture of the immediate dismantling of some systems and components and a safe enclosure of the reactor tank and the biological shield.

Based on the results of the evaluation of both projects as explained in section 3 the following conclusions can be drawn for both projects:

- Both decommissioning projects could be conducted successfully without any safety relevant deficiencies. Existing problems on the documentation of TRIGA HD I could be solved taking benefit from the knowledge of a former staff expert.
- For each decommissioning project the selected decommissioning option allowed the intended use of the former reactor building in an optimized way. While for TRIGA HD I an immediate use of the reactor's infrastructure was of high interest, for TRIGA HD II the unrestricted release of the reactor was of prime interest. Accordingly, no option resulted in relevant disadvantages.
- The collective effective doses for both decommissioning projects were of the same order of magnitude. Nevertheless, the progress in the optimization of procedures and techniques with respect to radiation protection could be recognized in the lower collective effective dose for TRIGA HD II although for this research reactor immediate dismantling was selected.
- In case of the deferred dismantling of TRIGA HD I missing documentation on the research reactor turned out to be of highest risk for an efficient dismantling of the biological shield and of the remaining systems after the period of safe enclosure. This risk did not become effective as a former staff expert was still available to compensate for the lack of information.
In the case, that the missing information would not have been available any more, the conduct of the work would have had become more complex as uncertainties would have been covered appropriately. But due to the small size and low complexity of TRIGA HD I no additional safety related risk would have been resulted from such a lack of information.
- In case of the deferred dismantling of TRIGA HD I only a small amount of radioactive concrete had to be disposed off as radioactive waste. It is worth to mention, that as a result of a study in 1979 no radioactive concrete to be disposed off was predicted. The difference resulted not only from uncertainties concerning the degree of activation of the concrete at the time of the study, but even more from the development of procedures and clearance levels in the regulatory system within the last 20 years and which could not be expected in 1979. Thus as a conclusion it is confirmed that mid or long term prognoses may become subject to regulatory uncertainties.
- The existence of the safely enclosed biological shield and reactor tank of TRIGA HD I did not influence the use of the reactor building during the period of safe enclosure. But during the final dismantling it turned out that there was a lack of information on the use of the remaining systems and of the reactor building itself during the period of safe enclosure. In addition, it became obvious that – as a matter of former times – in the license on the safe enclosure the rooms subject to the later final dismantling and clearance were not precisely mentioned. As a consequence all rooms of the whole reactor building became subject to dedicated clearance procedures, even if they were not used for handling of radioactive material during the operation of the research reactor, to ensure, that no activation or contamination above the German clearance levels did exist. Thus, insufficient knowledge on the use of the reactor building during the period of safe enclosure resulted in some disadvantages for the deferred dismantling option.

The conclusions mentioned above are specific for the two decommissioning projects discussed. Although for TRIGA HD I some challenges occurred due to the expanded clearance process and due to some back fitting activities, no safety related deficiencies could be found for any of the two projects and decommissioning options .

From a general perspective it can be concluded at least for the deferred dismantling that

- an early start of a decommissioning oriented documentation of the nuclear facility (including design and construction documentations) and of the documentation of the operational history (involving the staff) and
- a precise description of rooms, structures and boundaries of the controlled area still belonging to the nuclear facility in safe enclosure and thus being subject to a later final disposal in the license for safe enclosure

represent important contributions for an effective and optimized final dismantling and release from regulatory control.

5 SUMMARY

This contribution to the EUROSAFE 2008 conference provided an overview on a study on the decommissioning of two research reactors of TRIGA design at the German Cancer Research Centre at Heidelberg evaluation the decommissioning options selected. Objectives of the study were a comparison of the two decommissioning options and the deduction of conclusions as contribution to the still ongoing discussion on how to derive the optimized decommissioning option.

TRIGA HD I was partially dismantled after final shut down in 1977 and brought in safe enclosure in 1980. The final dismantling of the remaining systems and components was successfully performed in 2006 resulting in a radiological restricted release of the reactor building from regulatory control for conventional demolishing. TRIGA HD II was finally shut down in 1999, successfully dismantled in 2004 / 2005 and release from regulatory control without any restrictions in 2006.

The evaluation of the two decommissioning options shows that for both projects no severe disadvantages, especially no safety related disadvantages occurred. In fact both decommissioning options ensured an early use of the reactor buildings thus providing high benefit for the users. Both research reactors could be dismantled reliably and without any events, so that from this point of view these projects do not provide general indication to strongly prefer one decommissioning option.

Detailed analysis of the decommissioning projects shows among others some lack of information on the facility description for TRIGA HD I (deferred dismantling), which could be compensated with help of a former staff expert. It shows also, that the description within the license for the safe enclosure on the rooms still belonging to the formal controlled area of TRIGA HD I was not sufficiently precise; this inaccuracy resulted in an increased scope and effort for the clearance measurements. It is worth to mention, that neither the original lack of information nor the increased scope and effort for the clearance measurements did result in any safety related deficiencies during the final dismantling. Nevertheless, as "lessons learned" it is recommended especially in case of the deferred dismantling to pay due consideration on a complete description of the facility and on a sufficient precise description within the license for the scope of the safe enclosure regarding structures, systems and components to be addressed in the final dismantling.

Independently from the aspects analyzed within the study and the conclusions drawn for the two research reactors it can be regarded that the decommissioning option of the immediate dismantling will support an earlier release of a former nuclear facility from regulatory control than the decommissioning option of the deferred dismantling. Accordingly, the immediate dismantling will be more in compliance with the principle, that burdens should not be postponed to future generations.

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