International Conference
Nuclear Energy for New Europe 2006
Portorož, Slovenia, September 18-21, 2006
http://www.djs.si/port2006

Termination of Past Nuclear Activities at the Nuclear Research Institute

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ABSTRACT

Many countries, particularly in Europe, started with nuclear programs in the fifties of the last century. As a consequence nuclear research institutes were established, among them also the Institute Jožef Stefan (IJS) in Slovenia. The nuclear activities at the IJS were related to the development of uranium ore processing technology and technologies comprising uranium oxide and hexafluoride. After very intensive period of nuclear activities the decline began step by step due to different reasons. Various approaches of the termination and decommissioning of facilities were used.

The inspectors of the Slovenian Nuclear Safety Administration (SNSA), the responsible authority, started intensive activities at the IJS at the end of 2004. All together 22 research laboratories or research units were included in the inspection program and around 50 researchers of the IJS were involved into the inspection procedures. The inspection was very intensive in the laboratories and storages where past nuclear activities took place and were later on abandoned. As a result several contaminated equipments and sites in addition to around 200 unregistered sources were found. The majority of these sources is related to past nuclear activities. The inspection program related to the terminated research activities is still in progress.

The IJS immediately started with the remediation activities including the development of methodology related to decontamination of radioactive liquids. The decontamination of two nuclear laboratories and three different storages of radioactive waste at its sites is in progress. Sixty of the above mentioned sources have been already stored in the Central Interim Storage for Radioactive Waste.

1 INTRODUCTION

After the Second World War many countries particularly in Europe started with nuclear programs establishing nuclear research institutes. The nuclear programs or part of them were usually suppressed afters several decades. Six main reasons for the termination of activities could be identified, namely:

- The complexity of fundamental research in nuclear physics required establishing large national or international centres as for example CERN, European Organization for Nuclear Research.
- In addition, the bloom of commercial use of radioisotopes and apparatus producing ionizing radiation in industry and medicine moved to industry sector.
- The accidents in nuclear power plants, especially the Chernobyl accident in 1986 prevented the lively development of nuclear science.

- The vivid evolution of radiation protection safety standards in addition lead to cautiousness in developing the nuclear programs.
- The other area of research become more and more important shrinking the financial resources for nuclear programs.
- Finally the political changes and implementation of international conventions related to nuclear safety and security lead to suppression of military programs.

Due to all these facts which did not occur simultaneously the termination of nuclear activities at laboratories performing research nuclear activities occurred sporadic. Different methodology and radiation protection standards were used in the termination procedures.

In Slovenia the only one nuclear research institute was established in 1949, namely Institute Jožef Stefan (IJS) [1]. It was involved in numerous research and development activities in the nuclear field which comprised uranium ore processing technology and technologies related to uranium oxide and hexafluoride. The IJS was also involved in the basic research on nuclear techniques and research with the use of the experimental reactor TRIGA Mark II and accelerators. Such activities were especially intensive in the seventies and eighties of the last century. The decline began step by step and different approaches were applied for the termination of nuclear activities and decommissioning of facilities.

The IJS facilities are located at several locations. The headquarters and a part of nuclear laboratories are located in Ljubljana, while another part of laboratories related to past nuclear facilities is placed in a vicinity of Ljubljana, namely Brinje.

2 INSPECTIONS AT THE IJS

The Slovenian Nuclear Safety Administration (SNSA) is responsible regulatory authority for nuclear safety in Slovenia. After adoption of updated legislation in 2002 it stated with an intensive inspection program in order to prevent unauthorised exposure of people due to improperly handled sources of ionising radiation or radioactive waste [2]. The SNSA started with the inspection activities at the IJS at the end of 2004.

The details of an inspection methodology used and developed by the inspectors of the SNSA which was also used for inspection of the IJS is described elsewhere [3]. It included very extensive preparation for on – site inspections including the study of the past records available to the regulatory authority related to nuclear and radiation safety, interviews of past and present workers of the institute as well as a study of research publications of the collaborators of the institute.

On the on – site inspection as a rule an inspector was accompanied by the expert of the SNSA. The essential part of the on – site inspections was a use of the measurement equipment in order to find the contaminated areas or sources of ionising radiation. The instrument *FieldSpec* [4] for measurement of gamma dose rate and identification of radionuclides emitting gamma with ^{3}He counter for a detection of neutrons was used. In addition a contamination monitor was used when necessary. Also a personal electronic pager for a fast detection of the gamma radiation was used. The contamination areas were scanned by a Berthold *Contamination Monitor LB 122*. Figure 1 shows the expert from the SNSA on the on site – inspection at the IJS measuring the contamination of the floor of an abandoned storage.

In addition, for personal dosimetry the team of the SNSA used the personal thermoluminiscent dosimeters as well as other personal protective equipments.

Figure 1: Measurement of the floor contamination on the on site inspection of the SNSA at the IJS.

The final part of the inspection included a comprehensive assessment of the risk associated with contamination or source, optimisation of recovery process, enforcement of legislation and a post-analysis of recovery control over a specific source or decontamination.

At the IJS all together 22 research laboratories or research units were included in the inspection program in the period 2004 – 2005. Around 50 researchers of the IJS were involved into the inspection procedures. The set of laboratories inspected comprises chemical, physical and biological laboratories as well as laboratories related to ceramics. The inspection was very intensive in the laboratories and storages where past nuclear research activities related to parts of nuclear fuel cycle took place. Special attention was given to abandoned sites where unsealed radioactive material was used.

The inspections findings as well as the documentation available at the IJS and related to past nuclear activities of the institute were recorded. In addition, an extensive photo documentation was prepared.

3 RESULTS AND REMEDIATION ACTIVITIES

The inspections resulted in an overall assessment of the lifecycles of radioactive sources at the IJS which were either produced at the IJS, imported or acquired from other institutions in the state in the past. It was found out that in the past no centralised recoding system of acquiring or producing sources was present at the IJS. As a result it was not possible later on in the lifecycle of a source to consistently implement additional radiation protection measures including protection of workers and visitors of the IJS. Consequently many sources were used or stored without proper protective measures, moreover the contaminated equipment, areas and radioactive waste were not always identified and handled properly. The surveillance of sources was very scarce or ineffective.

Three main areas of inspection control were identified namely contamination of areas and equipment as well as sources out of a proper control. Each area requires specific remediation programme.

- The contamination of several laboratories and adjacent areas in use was identified as well as the contamination of several storages of old research equipments or materials which were not supposed to be used in future. The contaminations were found at two different locations of the IJS, namely at the headquarter locations as well as at the location in Brinje. In some cases contamination of laboratories and adjacent areas included also the contamination of pipes, ventilation and liquid discharge systems. The leakage of radioactive liquids was found.
- At the inspection equipments as for example fume hood or glass installations in chemical laboratories contaminated with radionuclides were found.

- In addition during the inspections of SNSA around 200 unregistered sources or out of a proper control were found at the IJS. During handling of some sources only part of protective measures was in place. Furthermore, some sources were not treated as radioactive material at all either during their storage or during their everyday use. Some sources were liquids which required pre-treatment before their storage in the Central Interim Storage for Radioactive Waste. Figure 2 shows abandoned storages of the liquid radioactive waste with uranium compound as well with yellow cake at the IJS.

Figure 2: Abandoned storages of the liquid radioactive waste with uranium compound as well with yellow cake at the IJS.

The majority of sources as well as all contaminations of areas and equipment found were related to past nuclear activities at the IJS. Those activities comprised uranium ore processing technology and technologies related to uranium oxide and hexafluoride. Such activities were especially intensive in the seventies and eighties of the last century.

After the on – site inspections the identification of radioactive sources was based on the exemption levels given in [5] which are for example for uranium U-238+ 10 kBq/kg and U-238sec 1 kBq/kg as defined in [5]. The identification of contamination was based on the contamination levels defined in the legislation which is valid either for occupational areas or areas with unconditional use as appropriate.

The IJS immediately started with the remediation activities including the decontamination of two nuclear laboratories and three different storages of radioactive waste at its sites. Meanwhile 60 above mentioned sources have been already stored in the Central Interim Storage for Radioactive Waste. The IJS staff started with decontamination procedures at some areas and the pre-treatment of radioactive liquids. The decontamination procedures are still in progress. Figure 3 shows the decontamination of contaminated oven which was used in the past in the research of uranium compound at the IJS.

It was found out that majority of areas could be decontaminated and all radioactive waste stored in the mentioned storage. Sources could be either used or stored in the Central Interim Storage for Radioactive Waste. The remaining problems which could not be solved in a near future are contaminated objects which are inside the walls or have a difficult access. The decontamination would be possible only after the extensive remediation of the buildings. The inspection of the SNSA required that such buildings should be identified and all intervention on such a building could be done under the supervision of a qualified expert.

Figure 3: Decontamination of contaminated oven which was used in the past in the research of uranium compound at the IJS. The picture was provided by the IJS.

The laboratories at the IJS are also involved in numerous on going nuclear research projects. As a result the inspections of the SNSA did not focus only on the proper termination of the past activities but also on the establishing the safety procedures at the institute which would enable the researches to follow the updated safety standards in their everyday work.

4 CONCLUSIONS

The inspection related to termination of nuclear activities which took place after the Second World War was a challenging issue even in a country with a small nuclear programme. The contaminated laboratories, storages and other sites, contaminated equipments and in addition around 200 sources mainly related to past nuclear activities were found by the SNSA inspection in the years 2004-2005 at the IJS. It has to be pointed out that this inspection program was the first comprehensive inspection program related to a full scope of nuclear activities at the institute. It has to be also mentioned that the program included inspections of the past activities which were under restricted access and related to classified documents and work.

The SNSA program and followed up remediation prevented the possible existence of orphan sources or materials outside the sites of the IJS. In addition, the further unjustified exposure of workers and general public at the IJS sites was prevented. The building up the system of control over sources from cradle to grave started.

The SNSA inspection program showed that the research institutes with past nuclear activities could have a predisposition not to follow the development of safety standards. It has to be also pointed out that in many cases safety culture of researchers in the past was different from today's standards which require a very strong commitment to the safety of all involved in the nuclear activities, including researchers.

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