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# Physical Protection of Small Amounts of Nuclear Material or Contaminated Parts

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**Abstract:** In July 2001 an incident was recognized where a worker occupied with decontamination of structures in a shut down reprocessing plant for spent fuel illegally removed a small amount of radioactive material from the facility site. The investigations exhibited that he brought this material to the apartment of his partner in life and she incorporated significantly  $\alpha$ -activity in the form of plutonium. Immediately after the incident was discovered the supervisory authorities and the operating company of the facility took action to minimize the harms to third parties arising from the radioactive material released and to prevent a similar event to occur.

As the overall inventory of radioactive material in the shut down facility at the time the theft occurred was below the limit where measures of physical protection are required by the German regulatory work discussions were raised on consequences to be drawn from this incident to close this obvious gap. The German Federal Ministry for Environment, Nature Protection and Reactor Safety (BMU) as the superior competent authority therefore ordered GRS to draft a set of fundamental requirements for future rules to make a repetition of the initiating incident unlikely. Further discussions of the authorities involved on supplementary rules and guidelines aiming to better protect small amounts of radioactive material from being illegally removed out of nuclear facilities and laboratories are based on these fundamentals defined by GRS but not yet finished.

## 1. Introduction

In terms of physical protection as requested by the German Atomic Energy Act /1/ the nuclear facilities are categorized according to their capacity of nuclear material. The basis for this categorization is formed by the criteria provided by the Convention on the Physical Protection of Nuclear Material which was ratified by Germany in 1990 /2/. In addition, in Germany nuclear facilities according to the current regulations must be protected like category I facilities if it would be possible in principle to cause considerable release of radioactive material to the environment by intentional acts applying for instance explosives or combustibles. If such release is estimated not relevant and there is less nuclear material

present in the respective facility than defined for category III facilities the German regulation foresees that this facility may be operated under the conditions of careful operation. This means that the rules of radiation protection have to be regarded and the use and manipulation of the radioactive material has to be controlled and documented.

An incident at the German facility Wiederaufarbeitungsanlage Karlsruhe, WAK, in the year 2001 shocked the German public and political responsible persons when an employee of a contractor of WAK has stolen an old sample cylinder and contaminated cleaning tissues from the facility and subsequently seriously contaminated his partner in life.

In the following some discussions and considerations on possible consequences to be drawn from this incident shall be presented.

## **2. The WAK**

The „Wiederaufarbeitungsanlage Karlsruhe“ WAK was the pilot plant for the reprocessing facility for spent nuclear fuel formerly planned in Germany. In this scaled down facility the industrial processes foreseen for the original plant were established, evaluated and optimized during the operational period from 1971 to 1990. Due to the considerable content of plutonium and large amount of high active waste in the process and stored the WAK was ranked as category I facility.

When the plans for a national reprocessing facility were given up in Germany also the WAK became obsolete and it was decided to shut down and dismantle the facility. Accordingly the process line was run free of nuclear fuel and radioactive waste and decontaminated as far as possible. At the end of the final shut down and at the beginning of the dismantling of the process building of the facility this building was released from physical protection and turned over to careful operation.

The current status of the WAK is as listed below

- The process hardware has completely been removed from the process building
- There is no nuclear fuel in the process building except contamination residing on structure surfaces
- There is considerable activity remaining in the tanks of the shut down main waste storage HWL
- There are about 70 cube meters of liquid high active waste concentrate stored in the storage facility LAVA waiting for vitrification
- The vitrification facility VEK is being constructed in proximity to the storage facility LAVA

Due to the large inventory of high radioactive waste the WAK in total with regard to physical protection is treated as a category I facility.

## **3. The Incident**

For various tasks to be performed during dismantling of the facility WAK employs skilled contractors. In this particular case a small specialized company was in charge with cleaning up the surfaces of concrete structures in the core of the process building. Due to the significant contamination of this area the work had to be performed under full protection conditions.

One of the crafts, who already was employed for a longer time in the WAK and therefore was well familiar with the local situation, took the opportunity to smuggle a small probe cylinder which he found in the area he had to clean up and tissues he used to clean up structural surfaces out of the facility. Doing this he managed to bypass the monitors which everybody should pass at the passage of the controlled area boundary.

The parts the man had stolen from the WAK were contaminated primarily with plutonium and he transferred them to the apartment of his partner in life. Some time between the time of the theft and the

seizure of the material by official forces this woman incorporated a significant amount of  $\alpha$  contamination.

The case became obvious when by routinely performed health care tests of the thief unusual  $\alpha$  incorporation was detected. The subsequent investigations and actions to find and to seize the illegally removed radioactive material found extra ordinary public interest.

#### **4. Short and Medium Term Consequences**

As a first consequence of the illegal removal of the radioactive material from the WAK the work to dismantle the process building of the WAK was halted due to an order of the supervisory authority and a vulnerability study with respect to possible repetition of such an incident was performed by WAK. The results of this study were carefully discussed with the supervising authority and their consultants to define further preventive actions. Consequently the entries of the controlled areas were retrofitted so that the boundaries between different controlled areas are now completely closed and can normally just be passed by using sluices with radiation detectors installed. Only few defined small parts like eye glasses, keys, or identity cards may be carried over these borders. Leaving a higher ranked controlled area to a lower one the above small parts have to be checked for possible contamination either in a special small parts sluice or by radiation protection personnel with hand held detectors.

In addition, all doors which are only due to emergency escape or for extra ordinary use are detected for inadvertant opening and are monitored by TV cameras whose pictures show up on screens in the central control room.

Amendments to the internal regime of regulations further contribute to the consolidation and strengthening of the radioactive material management.

As the German public is very sensitive to incidents with radioactive impact to people outside nuclear installations competent committees discuss general actions to further on make similar incidents as happend at the WAK more unlikely. In a first step a variety of installations where radioactive materials are handled were reviewed with respect to possibilities to illegelly remove small fractions of the radioactive inventory. While installations of nuclear energy production and nuclear fuel cycle were found to be in general well equipped with preventive measures to detect illegal removal of nuclear or radioactive material such precaution is not necessarily in use to the same extent at laboarories or industrial and medical installations.

#### **5. General Considerations**

The regulatory bodies in Germany are now in the process to define and enforce general rules and guide lines which on the one hand can effectively prevent illicit trafiking of small amounts of radioactive material and on the other hand do not inappropriately hinder the daily work in institutions or companies handling such material in the normal course of their usual process of work.

GRS as the principal expert organization in the field of physical protection of nuclear facilities and nuclear materials in Germany was charged by the Federal Ministry of Environment, Nature Conservation and Reactor Safety (BMU) to elaborate a proposal for general principles on preventive measures against illegal use of small amounts of radioactive or nuclear materials.

Starting off from the current status of regulation where facilities with an inventory of nuclear material composed of the isotopes  $U^{233}$ ,  $U^{235}$ ,  $Pu^{239}$  and  $Pu^{241}$  less than defined in /1/ are not subject to measures of physical protection the other rules, guidelines and standards to control small amounts of radioactive material were reviewed. Such regulations, primarily the ordinance of radiation protection /3/, include

- Keeping the radioactive material under control in a locked location and controlling the respective keys
- Controlling and limiting access to locations with radioactive inventory to authorized persons
- Documentation of the inventory of radioactive material and nuclear fuel
- Inventory of radioactive materials exceeding limits defined by the ordinance of radiation protection /3/ have to be stored and handled in protected rooms or have to be stored in containers to be duly locked
- Inventory of radioactive materials exceeding the limits defined by /3/ have to be protected against unauthorized access and removal

The above measures primarily aim to the protection of staff or visitors to institutions which are handling or storing nuclear fuel or other radioactive materials. The protection measures against illegal removal is subject to defined classes of activity. Unauthorized removal of materials below these classes of activities with criminal motivation by now is not an objective of the current regulatory work in Germany. To have regard to this in future GRS developed some fundamentals to be discussed in the process of future regulation which are listed below.

### **Scope of the Protection**

Hazards to lives or health of third party persons and to goods as a consequence of illegal removal of radioactive material must be prevented.

### **Concept of Protective Measures**

The removal of radioactive material should be prevented or be discovered in due time. Discovered in due time in this context means that the radioactive material can be taken in custody again still on the site of the institution or company

The protection system should be made up of technical, structural and administrative measures which should be harmonized with the measures of radiation protection.

Protective measures to be taken should be based on safety studies.

### **Responsible Persons**

A person responsible for the development and implementation of the concept of physical protection should be appointed for each site or facility. The persons responsible for physical protection and radiation protection should work closely together.

## **Safety Studies**

For Installations where radioactive materials are handled safety studies should be performed and be presented to the competent authorities. These studies should at least address issues listed below

- Nuclidic composition and shape of the material (sealed or open) handled or stored
- Possibility to illegally remove the radioactive material
- Storage locations and accessibility of radioactive material
- Procedures of handling of the radioactive material with respect to illegal removal
- Possible paths of illegal removal of radioactive material
- Possibilities to detect illegally removed radioactive material at the entrances/exits of restricted areas or on the site of the installation

Protective measures should be based on such safety studies. The studies should be updated regularly for installations being shut down or in the process of dismantling.

## **Access Control**

The areas with restricted access should be defined and should be, if possible, identical with the controlled areas for radiation protection. At the entries authorized access should be verified and technical installations should be used to inspect exiting personnel for carried radioactive or fissile material.

Paths of personnel and material should be clearly separated to enable optimized inspection for radioactive or fissile material.

By applying physical violence it should not be possible to detour the measuring devices at the passages between the controlled/restricted areas.

## **Storage of Radioactive Material**

Shelters or containers where radioactive material is stored should at least withstand attacks applying physical violence.

Containers for radioactive material should be protected against unauthorized removal.

## **Inspection of Personnel and Material**

At the exits of the controlled/restricted areas preferably technical devices for the detection of radioactive or fissile materials should be installed. In cases where such devices seem to be inappropriate, spot-checks of exiting persons should be performed.

Delivery and return of radioactive material should carefully be documented. Analyses of returned material should be performed in due course.

## **Administrative Measures**

Administrational regulations for the physical protection of small amounts of radioactive materials should include

- Regulations for bringing in and bringing out of material

- Regulations for access to the controlled/restricted areas including special clothing
- Regulations for the delivery and administration of keys
- Education of authorized personnel with respect to physical protection issues and measures.

### **Supervision**

Measures to prevent illegal removal of radioactive material implemented in installations must be subject to supervision by competent authorities.

## **6. Conclusions**

The theft of radioactive material from the WAK and contamination of the partner of life of the thief exhibited that the unauthorized removal of small amounts of radioactive material with criminal motivation was not duly covered by the current nuclear regulatory work in Germany.

To support the discussions of advisory commissions GRS was charged by the Federal Ministry of Environment, Nature Conservation and Reactor Safety (BMU) to draft fundamentals to be regarded for the prevention of possible repetition of actions similar to that of the WAK case.

Based on the fundamentals drafted by GRS /4/ the decision making bodies on federal and state level are currently discussing to extend to the German nuclear regulatory regime to impede in future the unauthorized removal of small amounts of radioactive or fissile material with criminal motivation. In this course also the regulations for materials classified by the ordinance of radiation protection and subsequent standards may be reviewed and rediscussed.

## **7. References**

- /1/ Atomic Energy Act, Gesetz über die friedliche Verwendung der Kernenergie und den Schutz gegen ihre Gefahren in der Fassung der Bekanntmachung vom 15. Juli 1985, zuletzt geändert durch Artikel 1 des Gesetzes vom 03. Mai 2000 (BGBl I S. 2113)
- /2/ Convention on the Physical Protection of Nuclear Material, IAEA, INFCIRC/274/Rev. 1, May 1980
- /3/ Radiation Protection Ordinance, Verordnung über den Schutz vor Schäden durch ionisierende Strahlen in der Fassung der Bekanntmachung vom 26. Juli 2001 (BGBl I Nr. 38)
- /4/ L. Ackermann, A. Hagemann: Grundsätze für die Sicherung sonstiger radioaktiver Stoffe gegen Abhandenkommen, Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH/Köln, Januar 2002

## 8. Abbreviations

BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit
HWL	Haupt-Waste-Lager
IAEA	International Atomic Energy Agency
LAVA	Lager- und Verdampfungsanlage
VEK	Verglasungseinrichtung Karlsruhe
WAK	Wiederaufarbeitungsanlage Karlsruhe