

Radiation Protection Experience with Alpha Nuclides

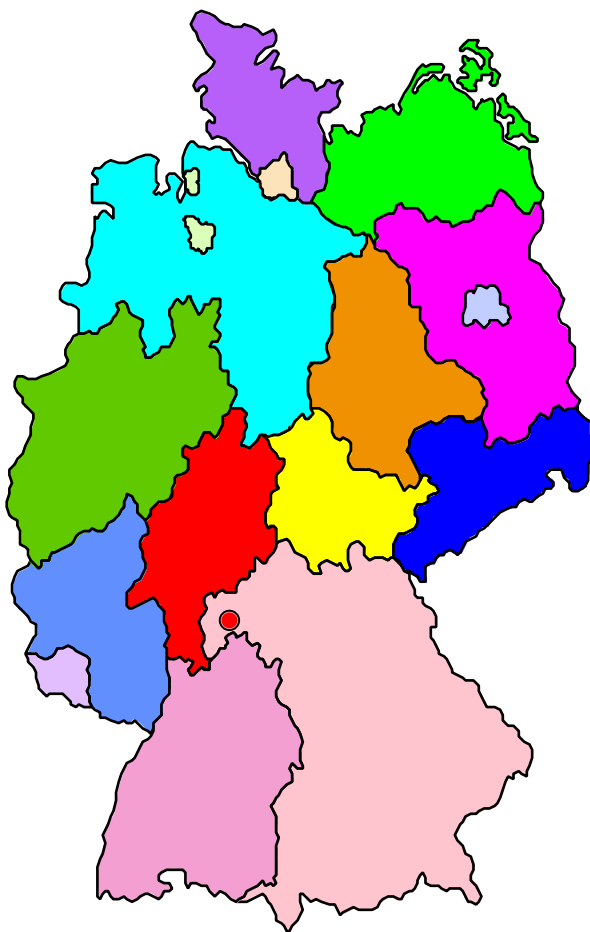
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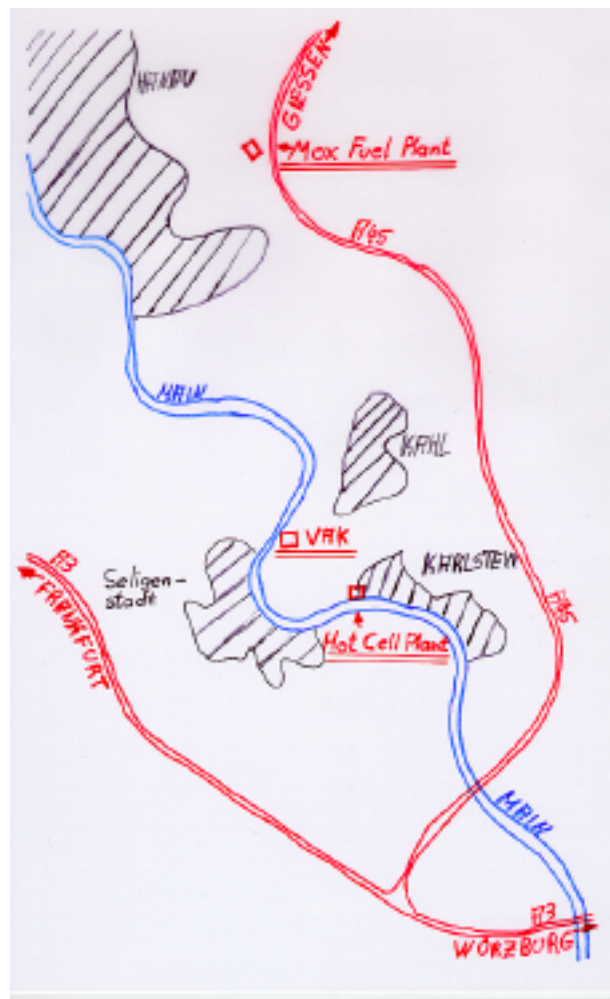
Radiation Protection Experiences with Alpha Nuclides

This presentation is based on the experiences gathered in three plants of the German nuclear fuel cycle. These are the manufacturing of Mixed Oxide Fuel Assemblies of the company Siemens KWU in Hanau, the Hot Cell Plant of the company Siemens KWU in Karlstein and the Experimental Nuclear Power Plant Kahl GmbH in Kahl. All the three plants are in the stage of dismantling.

All the three plants are located in the same region alongside the motorway A45 in the Rhein-Main area.



Picture 1 Map of Germany



Picture 2 Map of area

What may be the problem of Alpha Nuclides from the point of view of radiation protection?

1. Outside the body alpha emitters are of little radiative load while inside the body they provoke a very high dose rate.
2. In case of incorporation in the human body it is rather difficult to determine the resulting dose rate because the quantity of the applied activity and the incorporation time are usually not known.
3. Outer radiation exposure enables to move away from the radiation source. In case of incorporation, however, the activity is carried in the body itself which may lead to a high psychical stress.
4. An exact determination of the applied activity and an exact determination of the dose rate can only be achieved by means of excretive analysis mainly through analysis of excrements. This is unpleasant for the person under consideration and it is for the plant administration expensive and time consuming as well.
5. Alpha emitters are not as easy measurable as the usual beta-gamma emitters.

These facts - especially items 2, 3 and 4 - result in the conclusion that both, the plant administration and the responsible regulators try to avoid the radiation load by incorporation of alpha emitters completely.

The difference of radiation exposure by alpha emitters and beta-gamma emitters is clearly shown by comparison of the Co-60 and Am-241 values represented in the Radiation Protection Directive.

Comparison of Co-60 and Am-241	
Encl. VI, part 3, New Radiation Protection Directive According to Council Directive 96/29, Euratom	
Radiation Quality factor	
Co-60 =	1
Am-241=	20
Maximum allowable activity concentration in the exhaust air	
Co-60 =	1 Bq/m ³
Am-241=	0,0004 Bq/m ³

Picture 3 Comparison Co-60 and Am-241

By means of a further example we would like to point out what the problems are with Alpha Nuclides also as far as their measurement is concerned.

**Contamination control levels for
alpha nuclides**

Encl. III, Table 1, New Radiation Protection Directive
according to Council Directive 96/29, Euratom

Am-241 or Pu-230 0,1 Bq/cm₂ = 100 mBq/cm₂

Practicability level by measurement

25 – 30 mBq/cm₂

Example: palm (9 x 17 cm) x 20 mBq/cm₂

ca. 3000 mBq 10 % apple, cigarette 300 mBq

300 mBq 10 % incorporated 30 mBq

30 mBq 10 % excrement analysis 3 mBq

3 mBq

Doserate from 3 mBq supplied by 2 intakes

3 mBq incorporation 1 week ago: 0,08 mS

3 mBq incorporation 1 month ago: 0,36 mS

No discussion about intake times!!

Picture 4 Limits of Contamination for Alpha Emitters

This diagram leads into a very important requirement: There must be no discussion about the time of activity intakes. This means, if a single person or a group is incorporation controlled by means of excrement analysis this has to be done regularly and in short time intervals.

ALPHA INKORPORATIONSÜBERWACHUNG VAK (Verdachtspersonen VAK)

JAHR 1997

NAME	Nuklide	KW17 mBq abs.	KW18 mBq abs.	KW19 mBq abs.	KW20 mBq abs.	KW21 mBq abs.	KW22 mBq abs.	KW23 mBq abs.	KW 4 mBq abs.	KW25 mBq abs.	KW26 mBq abs.	KW27 mBq abs.	KW28 mBq abs.	KW29 mBq abs.	KW30 mBq abs.	KW31 mBq abs.	KW32 mBq abs.	KW33 mBq abs.	KW34 mBq abs.
Monteur	Am-241		<NWG			<NWG			<NWG			2,0		2,7	8,4	4,7	6,2		
	Pu-238		<NWG			<NWG			<NWG			<NWG		<NWG	3,6	<NWG	1,6		
	Pu-239/240		<NWG			<NWG			<NWG			<NWG		<NWG	2,0	<NWG	1,7		
Monteur	Am-241		<NWG			<NWG			1,7			<NWG			4,9			8,9	11,2
	Pu-238		<NWG			<NWG			<NWG			<NWG			<NWG			3,5	1,7
	Pu-239/240		<NWG			<NWG			<NWG			<NWG			<NWG			1,2	2,3
Dekont	Am-241	<NWG			<NWG			<NWG			26,0			<NWG	1,5		2,7	1,6	1,0
	Pu-238	<NWG			<NWG			<NWG			8,0			<NWG	<NWG		<NWG	<NWG	<NWG
	Pu-239/240	<NWG			<NWG			<NWG			6,7			<NWG	<NWG		<NWG	<NWG	<NWG
Strahlen- schutz	Am-241		<NWG			<NWG			1,7			15,0		4,8		8,0	2,2	1,9	2,4
	Pu-238		<NWG			<NWG			<NWG			6,4		2,1		2,2	<NWG	<NWG	<NWG
	Pu-239/240		<NWG			<NWG			<NWG			4,7		1,4		1,6	<NWG	<NWG	<NWG

NWG = Detection limit

Picture 5 Alpha Incorporation Control at VAK

With these samples the problems in connection with the incorporation of Alpha Nuclides can be reduced, however, is not given a solution.

If alpha contaminations appear in a plant possibly leading to incorporations three things have to be respected strictly.

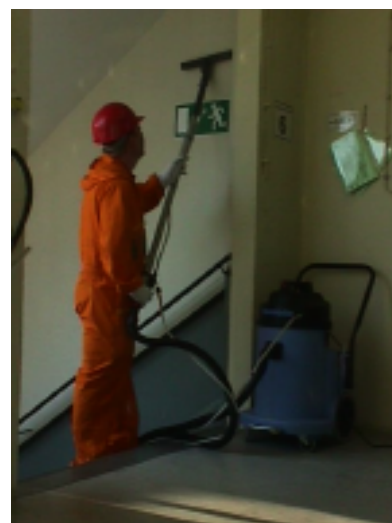
1. A thorough and intensive cleaning of common ways of circulation.
2. The search for and the localization of the alpha sources.
3. A highly disciplined use and handling of protective clothing in the field of alpha contamination especially when undressing and during the subsequent handling of protective clothing.

These three items we would like to illustrate by some transparencies.

The cleaning or rather the decontamination is carried out —wherever possible— by means of cleaning machinery. This machinery disposes of the advantage that fresh cleaning water and detergents have to be used regularly.



Picture 6 Floor Decontamination by Machinery



Picture 7 Wall Decontamination by Machinery

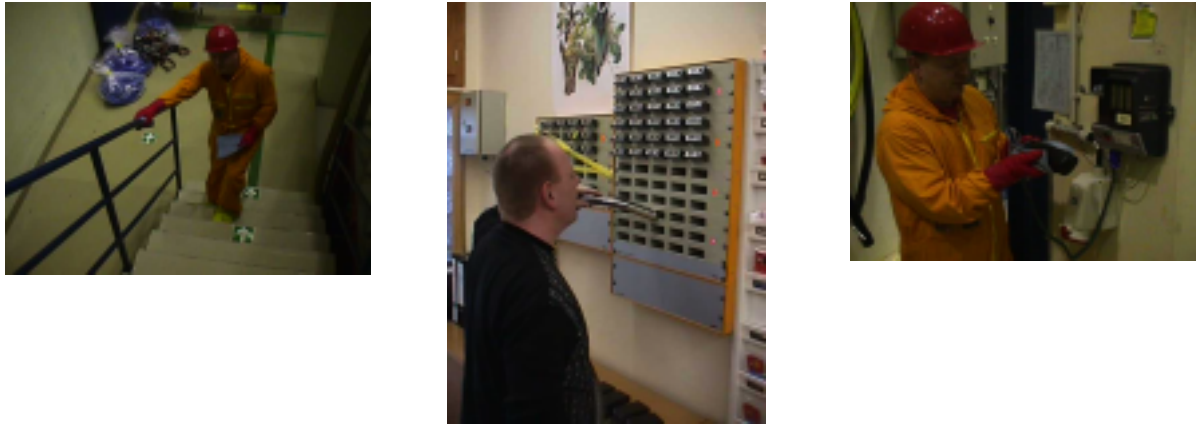
It is proven practice for the personnel for decontamination to use a check list prescribing the different steps to be taken and to concentrate on and the systematic methods of application.

Monday	01.09.	08.09.	15.09.						
main area, 3 times a day									
decontamination of telefon app.									
MZH downstairs, once a day,									
decontamination of floor									
MZH decontamination of material lock									
Tuesday	02.09.	09.09.	16.09.						
main area, 3 times a day									
decontamination of banister									
decontamination of stair case									
(reprocessing building)									
MZH downstairs, once a day,									
decontamination of floor									
Wednesday	03.09.	10.09.	17.09.						
main area, 3 times a day									
decontamination of telefon app.									
MZH downstairs, once a day,									
decontamination of floor									
MZH decontamination of material lock									
Thursday	04.09.	11.09.	18.09.						
main area, 3 times a day									
decontamination of banister									
decontamination of stair case									
(reprocessing building)									
MZH downstairs, once a day,									
decontamination of floor									
Friday	05.09.	12.09.	19.09.						
main area, 2 times a day									
decontamination of telefon app.									
MZH downstairs, once a day,									
decontamination of floor									

Remarks.....

Picture 8 Check List for Cleaning — Control Area

What has strictly to be taken into account with the regular decontamination are the manifold possibilities of transferring contamination to the hands.



Picture 9 Examples of the Routine Decontamination

In case alpha incorporations should cause an alpha contamination in a plant, the search for the sources is an important aspect besides the thorough and methodical cleaning. In this connection it is certainly helpful and necessary to make use of all the usual radiation protection measurements such as testing the values of air activity, of contamination in a direct way or by wiping test and the evaluation of test pieces.

It will, however, happen from time to time that a person produces a positive value in the analysis of excrements which cannot be explained. Considering the time axis — the results of the analysis of excrements bases on a test piece taken two weeks before while the corresponding contamination dates back 2–5 weeks.

If you want to be successful in the search for the reasons and sources you will need an open and trustful co-operation with the personnel in the plants. The personnel must not be afraid to report about irregularities and laxities. Any alteration of a planned procedure, any distinctiveness should be reported. It proved to be helpful if the persons who work in a plant write kind of a diary about their activities in their working place. There is nobody to know better about the strong and the weak points of the plant than your personnel in the site. Every hint and every proposal for improvement, any impulse from this group of persons is worth thoroughly controlled and verified.

The third item, the use of protective clothing is the most important one. Experience proves that most of incorporations happen when taking off the used protective clothing and during the subsequent handling of it. If protective clothing and filter masks are put on according to the rules, an incorporation is excluded. The decisive question is how to get people out of their contaminated protective equipment

avoiding the incorporation by themselves or by third parties same as avoiding the spread of the contamination.

The two following pictures show some important instructions when taking off the equipment.



Picture 10 Fixation of Contamination Clothing



Picture 11 Taking off the Protective Clothing

It is important that people don't take off their clothing by themselves but that a second person gives help. The contamination has to be fixed before undressing which has to be done in a waste bag in order to minimize the handling of contaminated protective clothing.



Picture 12 Wrong Handling of the Waste Bag



Picture 13 Right Handling of the Waste Bag



Picture 14 Evacuation of the Waste Bag



Picture 15 Evacuated Waste Bag

The right handling of the contaminated protective clothing is as important as the right undressing:

Two persons are better than just one — no air has to be pressed out of the waste bag — full value filtermasks and protective clothing. These are the main topics .

Contaminated protective clothing should never be cleaned but disposed immediately as shown in pictures 12–15. For the filtermask this is not possible due to costs involved. This is why special care has to be taken to avoid any risk of contamination for the personnel that is busy with the cleaning and the maintenance of the filter masks.



Picture 16 Cleaning of Masks

These examples show that the most important things to be respected in radiation protection when handling Alpha Nuclides can be described by the following topics.

- to plan sequences of operation precisely and down to the last point.
- not to carry out works by single persons. Use trained teams instead
- thorough and disciplined work
- the classical principles of radiation protection have to be respected which is of special importance for avoiding the spread of contamination.

Coming to the end of our presentation we would like to highlight three simple possibilities for the unambiguous detection of alpha contamination



Picture 17 Deposit of Dust at the Exhaustion of Ventilation Installations.



Picture 18 Adhesive Mat in front of the Exit Monitor



Picture 19 Working Overall Cut in Pieces

By analyzing these three test pieces same as the excrements you will get a quick and unambiguous statement about the existence of Alpha Nuclides. When also determining the Co-60 and Cs-137 portion you will get an information about the quantity of Am-241 in relation to the Co-60 value in the plant. This method provides you an indirect means to determine the portion of alpha contamination in your plant with all measurements.