T3.2-P12

Enhanced Search Methods for Finding and Identifying Radioactive Material for OSI Deployment

Fraunhofer INT
Nuclear Security Policy and Detection Techniques

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Introduction

The CTBTO verification system comprises an On-Site Inspection (OSI) to verify the suspicion of a banned nuclear test. An OSI comprises different methods of verification, one of them being the radiological survey of the inspection area.

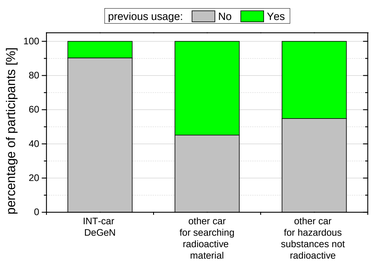
The radiological survey is done by airborne survey, carborne survey, and environmental sampling, thereby narrowing the inspected area with each step. Our institute operates a measurement car DeGeN (German acronym for Detection of Gamma and Neutrons) with highly sensitive neutron and gamma detection systems. In the present study we investigated the influence of the human factor by investigating measurement results obtained by a larger group of test persons operating our measurement car DeGeN.

Measurement outline

- Task: Localization and identification of nuclear and radioactive material with the measurement car DeGeN
- Aim: Determination of the test persons' impact on the measurement result (all teams measure in the same source situation without getting any information concerning the source positions)
- Large number of test persons necessary (sample size)
- 2 people per team (driver and co-driver/operator of the measurement system)
- Test persons with different level of experience (see below)
- 17 teams with 33 persons participating, consisting of both INT staff and other organisations

Previous experience of participants

- Previous use of measurement vehicles

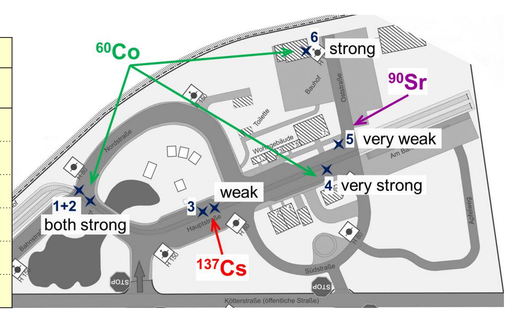


- Other areas

Test course with radioactive sources at the exercise area of the IdF

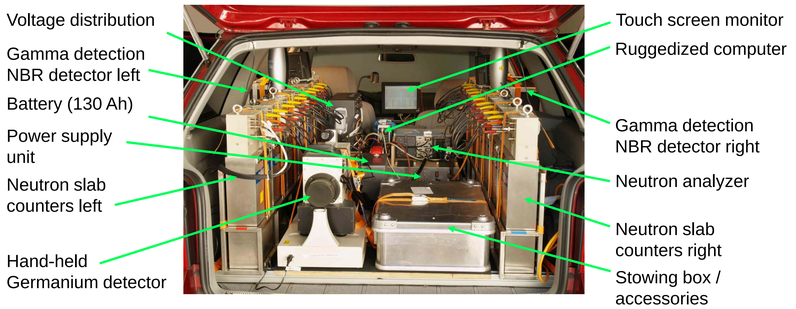
(Institute of the Fire Brigade North Rhine-Westphalia in Muenster, Germany)

Hidden Sources		
Position	**Nuclide**	**Activity [MBq]**
1	^{60}Co	100
2	^{60}Co	100
3	2 x ^{137}Cs	0.4
4	^{60}Co	2200
5	^{90}Sr	6
6	^{60}Co	90



The measurement car DeGeN

The main use of the measurement car is the search and detection of concealed nuclear material and radioactive sources from roads, pathways or other vehicle accessible areas. The measurement system in the car consists of sensitive neutron detectors and two scintillation gamma detectors. The position of the car is recorded by GPS synchronized with the measured data. The complete system is mounted in a square steel rod assembly so that it fits in all standard station wagons easily. Between the racks for the neutron detectors we have fastened a voltage converter (with back-up battery), the electronics and a electrical cooled HPGe detector. The figure shows the measurement car completely equipped. The NBR detectors are located in the black boxes in the rear windows. The small suit-case on the left side contains an additional Identifinder (HM5).



Detectors

Neutron detection

is performed by two rows of large-area neutron slab counters with ^{3}He detectors (reaction: n + ^{3}He → p + ^{3}H + 765 keV). Both sides are evaluated separately, therefore it is possible to differentiate between left and right.
The typical measurement interval for the neutron measurement is 2 s.

Type	JCC 71SS (Canberra)
Gas	^{3}He (4.2 · 10^5 Pa)
Tube diameter	2.54 cm
Tube length	33 cm
Tube number	6 tubes per counter 6 counters per side of car => in total 36 tubes / side
Moderator	Polyethylene (minimum 1.7 cm)
Efficiency	0.12 % (for a single Slab Counter with ^{252}Cf source in a distance of one meter from the detector surface).

Gamma detection

is performed by two NBR probes (Natural Background Rejection). It is determined if the radiation is natural, artificial or anormal. Anomaly is signaled if an outsized part of high energy gamma radiation, an exceptional high ^{40}K or ^{228}Th part of the ambient radiation or neutron radiation is present.

Type	FHT 672 M (Thermo)
Detector type	plastic scintillator
Volume	12 liters
Energy threshold	Approx. 100 keV
Detection limit gross counting	Approx. 1 nSv/h
Detection limit NBR	20 % artificial dose rate
Sensitivity	Typ. 50000 cps/µSvh^{-1}
Dimensions	118.5 x 33.5 x 9 cm^3
Total weight	24 kg

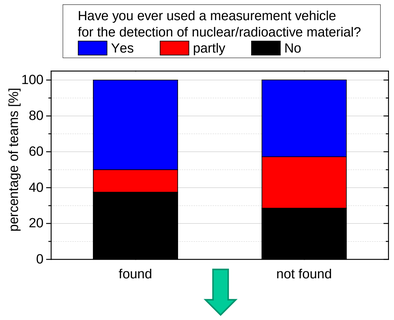
Measurement procedure

- Briefing: the teams are introduced in the use of the measurement vehicle and the task
- Task: localize and identify unknown number of radioactive sources using the measurement car
- Time: 20 min in the course, discussion and documentation afterwards possible
- Strategy for searching: not specified, can be chosen by the team
- Documentation: by specific result sheet

Measurement results

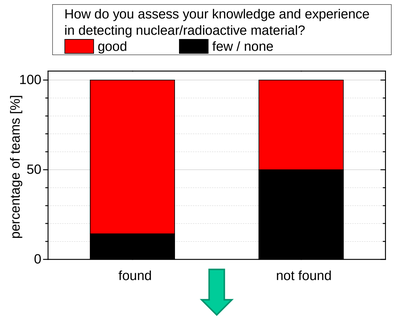
Color-coded track of the total dose rate as yielded by the gamma detector on the left side of the car:

Correlation regarding former use of measurement vehicles:



No correlation between measurement result and former use (Same result for nearly all areas)

Correlation regarding the level of experience:



Correlation between measurement result and level of experience: advantage due to good experience

Conclusions

- INT measurement vehicle DeGeN was successfully used by all participants after an appropriate briefing
- All kind of users were able to search and find notable radioactive sources
- Correlation between the search results and the previous experiences of the participants
- In the case of weaker sources experienced users have advantages
- Training with real radioactive material is mandatory to gain experience