

Measurements by Test Persons

Operating the INT Measurement Car DeGeN

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Introduction

A lot of detection systems for measurements of nuclear radiation are developed. Very often the manufacturers propose that the devices could be used without problems by non-expert users. The Fraunhofer INT has long lasting experience in evaluating measuring results of different detection systems especially in the area of nuclear material. Automated analysis routines partly lead to results which are not correct and could be recognized as such directly by experts but would be taken as correct by non-experts. Measurements with hand-held devices operated by different persons have shown the influence of the human factor. In general studies on that topic are rare. Therefore 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 (German acronym for Detection of Gamma and Neutrons).

Series of Measurements with Test Persons using the INT - DeGeN

- Aim: investigation of the influence of the human factor
Impact of the test person on the measurement result?
More important than the effect of the detector?
- Several radioactive sources are placed in the test area
- Two persons form a measurement team
- Each team searches by using the DeGeN measurement car:
localization and identification of nuclear and radioactive material
- All teams measure in the same source situation without getting any information from the other teams
- No competition between the teams!



INT Measurement Vehicle DeGeN

- The Fraunhofer-INT has designed a measurement car equipped with highly efficient gamma and neutron detection systems to track down and analyze nuclear or radioactive material. The car was developed for search tasks, e.g. the searching of a defined area or the tracking of suspicious vehicles.
- Detectors:
 - 5 l plastic scintillator detector with natural background rejection (NBR) functionality on each side for **gamma detection** (now: 12 l).
Measured detection capability:
Unshielded source of 50 MBq ^{60}Co at 60 km/h in at least 10 m.
 - 6 slab counters for **neutron measurements** on each side (72 ^3He -Tubes with PE-moderator)
Determined detection capability:
About 3.5 kg weapon grade plutonium at 40 km/h in at least 10 m behind a 20 cm concrete wall.

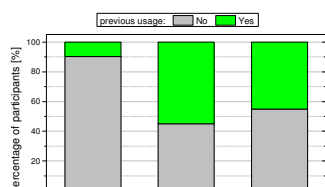


Measurements

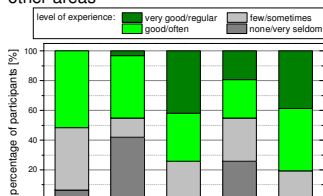
- large number of test persons necessary (sample size)
- 2 people per team (driver and co-driver)
- test persons with different level of experience, evaluated by questionnaire "Participant"
- 17 teams with 33 persons participating:
 - INT staff
 - other organisations:
 - Kerntechnischer Hilfsdienst GmbH (KHG)
 - German Federal Office for Radiation Protection (BfS)
 - Federal Office of Civil Protection and Disaster Assistance (BBK)
 - Bundeswehr Research Institute for Protective Technologies and NBC Protection (WIS)
 - Members of fire brigade: FW Münster, FFW Duelsen/Coesfeld (Germany)

Previous experience of participants

- previous use of measurement vehicles

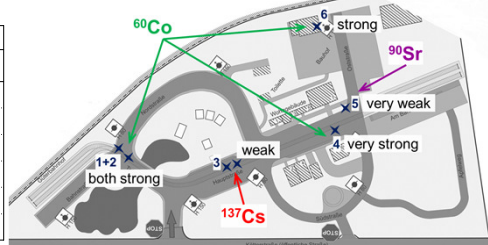


- other areas



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

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



Test procedure

- Briefing: the teams are introduced in the use of the measurement vehicle and the task ("clipboard")
- 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: result sheet "Ergebnisblatt"



Results

Colour coded track of a measurement

Depicted is the outcome of the gamma detector of the left side of the car



Overview of the general result of all measurement runs – 17 Teams

source position	source found; number of teams	correct identification; number of teams
strong and very strong sources	1+2: 17	15
	4: 17	11
	6: 17	17
weak and very weak sources	3: 8	5
	5: 1	0

localization possible independent on the experience of the user

below detection limit

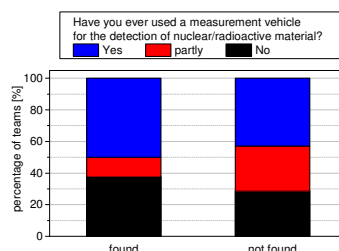
correlation with level of experience?

Evaluation of results at source position 3

Position 3:
two weak ^{137}Cs sources at a tram

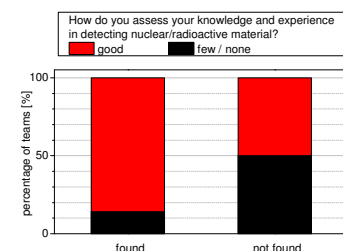


Correlation regarding former use of measurement vehicles



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

Conclusion

- INT measurement vehicle DeGeN
 - powerful tool
 - successfully used by all participants after an appropriate briefing
- All kind of users were able to search and find notable radioactive sources
- It is not easy to correlate the search result with the previous experiences of the participants. The strategy for searching should be given:
 - drive without stopping, direct record of result
 - detailed secondary inspection at interesting positions, record of final result
- In the case of weaker sources experienced users have advantages
- Training with real radioactive material is mandatory to gain experience

Acknowledgement

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