Dr Nikolaus Schneider, Head of Nuclear Decontamination Section at WIS, tells Gwyn Winfield about the work that they are doing on radiological decontamination

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With the exception of the mass media and the general public, it is generally accepted that a radiological dispersal device (RDD), or "dirty bomb," is a threat to infrastructure and buildings rather than individuals. While in the immediate vicinity of the device dose rates will reach very high levels that may lead to receiving a lethal dose for people affected, , its direct lethality can't be compared to chemical or biological warfare devices. This is not to downplay it as a threat: the clean up from anthrax ran into billions of dollars, and radiological devices can be effectively spread over a far greater area than biological agents can be.

CBRN defence is always going to be a balance of counter measures – from offensive operations to destroy capability through to mitigation of the event itself – but the ubiquity of radiological sources and their ability to be explosively disseminated (in a robust way that cannot be copied for chem or bio) makes mitigation the most obvious area for research and development. If the infrastructure and immediate area can be effectively decontaminated then much of the attraction of RDDs will be lost – possibly reduced to the same level as a Hazmat spill.

Yet the challenges of radiological decontaminations cannot be underestimated. While chemical and biological, especially the latter, pose their own decon challenges, they are far beneath those of radiological. As Dr Schneider explained, "On the one hand we have nuclear fallout, the old Cold War threat, but we don't put too much effort on that anymore. We have new decontamination equipment, as Dr Grabowski talked about in the last issue (*CBRNe World* Summer 2008, p 50), and there is a nuclear part within that, but what we are mainly working on now is the radiological aspect. We have to look at this, it is hugely important. If you look at contamination and what we need to do to decontaminate, there is a huge difference between nuclear and radiological. In fallout the particle size ranged from 100-200 microns and can be easily washed off surfaces, but radiological contamination, from a dirty bomb or RDD, may be very fine particles, liquids, aerosols; moreover, it may consist of different nuclides or whatever, and these adhere to a surface and are much more difficult to decontaminate."

He continued: "Radioactive contaminations can't be destroyed, the only thing you can do for radiological decontamination is to loosen it from the contaminated surface and wash it off. We have a liquid decontaminant for radiological material that contains a surfactant to clean dirt off the top layer and a chelating agent to bind the nuclides and take the ones that are on the surface into the aqueous solution, then rinse and wash them off and finally collect the runoff. That is how we do radiological decontamination.

The success of decontamination largely depends on what surface the agent lands on. Some are quite easy to clean – painted surfaces, glass, ceramic plates etc – while others, such as bricks and mortar, are far more complicated as they can absorb the agent (if it is liquid) or it can reside in cracks deep inside the substance. Considering how much of the infrastructure is going to be made of bricks, mortar and concrete – all of which absorb or conceal agent making it hard to be washed off – the full challenge of radiological decontamination becomes clear. Dr Schneider went into some detail here: "Let's look at caesium in concrete, for example. Most of the caesium compounds are water soluble; some studies in the US have shown that, if you get it into concrete , the contamination may penetrate to a depth of up to up to 5mm! So, if you have a road or building you can go over the surface and try and shake off the first couple of millimetres mechanically to reduce activity at that depth. Applying standard military decontamination procedures, you can reduce the contamination directly on the surface but you can't decon what is going inside."

There are a wide variety of ways of stripping the top millimetres off a building – from mechanical to laser – but they all leave a scar, and on things like marble facings, such as high prestige/value targets have, this is not desirable. Certainly the work that the UK's Health Protection Agency did for Litvinenko, which involved small amounts of alpha contamination, followed this pattern, with bathrooms ripped out and all the dust and rubble carted away. Is this a useful case study for the future of radiological decontamination, or will technology consign this to ancient history?

"We did not get much information on Litvinenko," admitted Dr Schneider. "I don't know much more than has been in the media on that. Talking to someone that was involved in it they were dealing with very low amounts of radiological material, and it was hard to measure – the problem was of course that he had ingested the material which lead finally to a lethal internal dose. It is different if you have a wide area contamination and we don't feel that this is an issue for us."

In terms of chemical and biological decontamination there is an obvious threat spectrum. Those agents that survive the dissemination method, the environment and retain lethality/effect are those that are high-priority decontamination targets – thickened chemical agents, anthrax etc. How does radiological equate to this? Most of those that are attractive to terrorists have a half

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life far in advance of the military useful age of vehicles, and some of them will remain effective long after the building has crumbled into dust. How then do you assign a threat spectrum to them or do you just treat them all the same?

"There are a few nuclides likely to be used, like Caesium-137 or Strontium-90," said Dr Schneider. "Especially Strontium may be very harmful to man due to high radiotoxicity and the enrichment in the bones. –High activities, 20000-40000 Curies of strontium-90 can be found in radionuclide thermo-generators that have been in use in the former Soviet Union. There are hundreds of these all over Russia and the other successor states and for quite a few no-one knows where they have gone. Abandoned sources have been found in Georgia and Tajikistan already.

In my opinion," he continued, "something with high activities of Strontium 90 in a dirty bomb would be a really dangerous thing, more than, for example, caesium. Considering an RDD, it will not cause many direct deaths; there will be a limited, highly active area around the point of the explosion, but dose rates further out from "point zero" are not likely to be that harmful. But it's also the psychological effect that must not be underrated. Just think of Chernoybl, and the irrational public reactions, especially here in Germany. The dose rate didn't cause any harm, and were during the few weeks after the accident lower than in the late fifties at the high time of nuclear weapon testing for years, but the public consideration of potential dangers and health effects was extreme. From that point of view you better not imagine a dirty bomb exploding in a city like Berlin or Hamburg., . Potential terrorists will surely take this into consideration."

The current radiological decontaminant that WIS worked on, now marketed as Kaercher's RDS2000, is a broad agent system. It doesn't take any notice of what nuclide it is, all of them get collected and dealt with the same way. For CBW decontamination, however, thorough decontamination only becomes effective when agent-specific chemicals are used. Is it the same for radiological, that while RDS might provide a quick and effective means of "battlefield" decon, it is only when specific isotope chemicals are used that it will be really clean?

"The main point for military decontamination is to reduce surface activity and the dose rate in a rapid and easy way," stated Dr Schneider. "For this we developed RDS2000, and for thorough military decontamination this works very well. For decontamination down to civil threshold values, this might not be sufficient depending on activity and properties of the contamination and also on the nature of the contaminated item. But, as radiological contaminations are easy to measure, you can go and measure the residual activity, possibly identify which nuclides are left and if necessary do more specific decon processes. In terms of radiological agents, caesium, for example, is chemically very different to strontium, iodine or cobalt. They have a different chemistry and would need specific decontaminant to achieve the best-possible decon factors. So it was important to get something that could deal with as many of the different nuclides as possible. What we have now can be used for 70-80% of the nuclides that may be found in contamination. We can't have one that does everything but we can do one that covers as much as possible.. If we want to go further we need stronger decon processes like acids or alkalines . We have also done experiments on surface abrasive methods, tested surface treatment with lasers or dry ice that will take off the dirt and upper levels of the surface to decontaminate what remains after liquid decon."

Dr Schneider stated, that one might like to think that repeating a decon process two or more times with a decontaminant like RDS2000 could lead to complete decontamination, but - most of the contamination is removed in the first step. The first application might take 90% of the contamination off, the second application would take only a remaining 5% off, and subsequent ones would take very little off as the contamination would be fixed to the surface. This would suggest that the absorption of nuclides by building material might be a problem that will continue to occur until there is a mechanism to stop it penetrating the material in the first place. One of the options for that would be peelable coatings, that the UK's DSTL Porton Down is working on, but Dr Schneider suggested that there are other options too. "If you know that the material is going to get covered, then peelable coatings are surely a way to look at it. We have also tested what we call easy-to-clean surfaces: making them very smooth, covered with a silicon material or nanosurfaces that avoids contamination. This means it doesn't stick to it strongly and the activity of sticking to the surface is 20-50% lower than the non-treated surface and decontaminability is 3-5 times better than the non-treated material."

One of the other options that is being examined for use in other forms of contamination is nano-reactive surfaces that highlight where the contamination is, so that decontaminants can be applied in a more efficacious and time-efficient way. Dr Schneider suggested that this was less important to radiological than chem or bio as radiological material could be measured at far lower levels, and with far greater chance of success than chemical or biological agents. The next step for the WIS team is to try and look at more abrasive methods and chemicals for thorough decontamination that go beyond the capabilities of an universal decontaminant like RDS 2000. They are working closely with CEB and DRDC, in France and Canada respectively, to evaluate and develop such methods. Would it be possible that if they developed an efficient thorough decontamination we could stop talking about the CBRN threat and move to CBN? As nice an idea as it might be, Dr Schneider suggested not, "this implies an end state that is impossible to reach: especially with regard to urban materials. The aim of our work can only be to improve decontamination above the levels we have reached up to now, thus reducing the immediate risk. A complete decontamination, as far as it will be achievable at all in some way, will be expensive, time consuming and will surely not be a military task."