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RADIOACTIVE WASTES IN A CONVENTIONAL MILITARY ENVIRONMENT

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Although other types of radioactive waste exist, it is intended to concentrate on wastes originating from the process of luminising military equipment as this constitutes the bulk of the waste. The talk outlines the way radioactive materials have been used for the purpose of luminising United Kingdom military equipment, from its first use during the First World War, through its expansion of use in the Second World War to the current situation. The way in which the radioactive materials have been used, and the type of radioactive material used, is explored as are the consequences of the luminising of military equipment.

It is appropriate to consider at this time why military equipment has been luminised. Primarily, it is to provide a PERMANENT light source in all field conditions. Additionally, the weight carried by any individual Serviceman can be reduced, as no batteries are required. With the development of better power cells, the weight considerations have diminished since the last World War, but it is nevertheless true that every little weight reduction is a gain. Finally, the light level from luminised equipment is low; sufficient to enable the equipment to be used, but not so bright that night sight is destroyed.

When luminising first began, the radioactive material used to provide the energy for the light source was radium, commonly referred to as radium-226. Some radiations from radium are highly penetrating. The radium itself has a long half-life and takes a long time to be cleared from the body if it has been taken in. It also gives off radon, a radioactive gas which readily diffuses and consequently can spread radioactive contamination. More positively, items luminised with radium did not need to be re-luminised frequently due to the very long half-life (define half-life if thought necessary) of the radioactive material, and the radium itself was very environmentally stable.

Recognising the contamination problems from radium, and its environmental toxicity and persistence, the UK MOD substituted a less radioactive material for luminising compounds in the late 1960s. This was a radioactive metal, promethium-147. The use of promethium proved unsatisfactory as the radiation energy from it was much reduced, leading to lower light intensities, and the half-life was very short. Both of these properties, while satisfactory from an environmental point of view, lead to increased maintenance and reduced operational effectiveness.

The radioactive material of choice for luminising is tritium, the radioactive form of hydrogen. It has a sufficiently long half-life so that re-luminising is not often required and is not particularly toxic. Initially used as a paint, which was found to flake off and cause contamination in the luminised equipment, the commonest method is the use of Gaseous Tritium Light Sources. These have tritium contained in glass envelopes which are internally coated with the luminising compound, which allows easy replacement of these light sources while reducing the risk of spreading radioactive material to the environment.

They proved to be a considerable improvement over the use of paint, but are quite fragile and require protection within the equipment. Should the glass envelope be broken, the tritium itself is environmentally mobile and rapidly diffuses to the extent it can be no longer found. However, tritium contaminated fragments of glass will remain and require proper disposal.

From this data, it can be seen that toxic materials can be replaced by less environmentally harmful alternatives and that the radiation industry and UK MOD have been carrying out this strategy for many years. However, there remains the legacy of toxic materials used in the past. Primarily, this

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legacy consists of sites contaminated with radium, as the promethium has all decayed to levels which are no longer detectable, and any tritium released is rapidly dispersed in the environment.

Sites become contaminated with radium due to the way it was used in the past and the way earlier site remediation was carried out. Radium does not constitute the only contaminant, and frequently heavy metals, ash and asbestos are also found. Indeed, a recent decontamination was undertaken on a site which had been used for the disposal of "mustard gas" test kits dating from the Second World War.

In the past, radium was, for financial reasons, a tightly controlled substance. Its full toxicity was not recognised at that time. Consequently, radium paint was stored in secure conditions but any waste from the luminising process was dealt with as if it were non-toxic material. This normally resulted in the waste being burned on the site in uncontrolled conditions and the ashes and debris resulting from this disposed of in the site dump. This dump was often a small landfill pit, and was also used for the dumping of many other materials, including batteries.

Contamination of the site also arose from the normal luminising work carried out. Because radium was not considered toxic, control of the workplace was poor. Consequently, radium escaped from the luminising buildings into the ground outside. This was often as a result of leaving material on windowsills or failing to wash properly before leaving the building.

Finally, when luminising work ceased, there was a requirement to put many of the buildings to alternative uses. Some remediation of the buildings was therefore required. This was done on the basis that it must be sufficient to allow the re-use of the building; it was not necessary to totally remove all the radium. This was in keeping with the accepted national standards and practices of the time, but did not lead to a full remediation. Again, the waste produced from this form of decontamination was burnt and buried on the site. Indeed, one person involved with this work had a habit of burying the radium contaminated ashes in the flowerbeds associated with the Officers Mess!

Problems associated with the decontamination and remediation of sites contaminated in this way are best considered from a practical example. The project chosen for this is the decontamination of a site in London.

A brief history of the site is that a building on the site was used for the radium luminising of military equipment. Once luminising ceased on the site in the 1970s, the building was partially decontaminated but was not required for operational reasons and was therefore only used for storage. Radium remained in the fabric of the building.

During the late 1980s, it was decided to bring the building back into operational use and a project to decontaminate and refurbish the building and its immediate environs was initiated. The Works Phase was carried out in 1989/90.

An extended survey of the site carried out following the building refurbishment identified that additional contamination was located in a landfill area and in the "dell stream and ponds". Contamination left in place as the usage of these areas was as fitness training for soldiers, which involved no disturbance of the ground. However, new use for the site was proposed in 1994 and this led to a requirement to decontaminate the landfill and dell areas.

This project was completed in 1996 and only this last phase is considered further.

Landfill site is a rectangle bordered on its long sides by a Cemetery and the operational side. The former Gatehouse and the dell stream and ponds border the narrow sides. The site was narrow but several hundred metres long and was extensively contaminated. Although contaminated, the contamination was not present at levels which constituted a hazard to personnel working on the surface. Only if the ground were disturbed would a hazard arise.

Note the works in progress; eventually, contamination was found in the landfill to a depth of 5m. Main works access was along the border between the remediation site and the Gatehouse. Some screening for noise/nuisance was required. Photograph is from early in the project as decontamination began at the end where photo taken from and worked back towards the Gatehouse.

Screening between contaminated area and the Gatehouse. Note the narrowness of access. Also note that his back door was less than 3 metres from the screen.

Turning to the dell, this begins at the edge of the landfill site and continues northwards toward the Thames getting wider all the time. It is heavily wooded and was used for the training of soldiers.

A stream emerges from the landfill area and flows down the dell to join with a stream emerging from the local housing estate. The joint flow then forms a series of interconnected ponds of various sizes. Pond 4 is the largest and furthest down the dell and was extensively fished. Ponds 1 & 2 were found to contain contaminated silt. The series of ponds had acted as settling tanks which prevented the contamination from reaching pond 4. This meant that fishing was only required to be banned for the period surrounding the actual remediation works. This was considered necessary even though steps had been taken to prevent any contamination reaching the lower ponds. Note that, as mentioned before, the radium was in an insoluble form (as demonstrated by laboratory tests) and was not environmentally very mobile; its spread to the dell is a consequence of "wash out" from the landfill area.

Decontamination of pond 2 required the draining of the pond and removal of the silt. Here the pond is shown as part drained. Silt was very soft and all had to be removed eventually. This proved to be a layer 1.5 m deep and the refilled pond was left in a much improved state.

Considering the complexity of the site, how was a successful remediation achieved? The internal procedures are not detailed, but the key areas identified.

Contract must: Define End Point
Define Site
Define Responsibilities and Lines of Communication

Regulators have to be involved at an early stage. It is impractical to attempt a decontamination without an appropriate Authorization from the Regulator and without having identified a safe, legal disposal route for the waste. A policy of openness with the Regulator is used.

The Regulator must: Agree End Point *(legally, this is partly defined in the Regulations but the Regulator should confirm the interpretation in order to avoid any later disputes).*

Confirm that job is necessary (Justification is required under EU Directives, to be strengthened in UK Legislation later this year).

Publicity must be expected. It is better to Inform the Media that a job is to take place. If any adverse publicity results, it should occur at the planning stage and not when the works are taking place. If Regulators have been consulted and kept fully informed, they will give the same answers as you. The locally elected authorities should also be involved as they have a considerable role in acting as an interface to the public. However, in the UK, such bodies only have a minor role in relation to radioactive materials.

Contractors need to be aware that their work is subject to scrutiny. Such scrutiny has to be technically competent due to the specialist nature of the works.

MOD will not pay for work which is not of sufficient quality. Greater care is taken with the work and greater openness by the works contractor results. All safety and disposal records should be examined on a regular basis.

DERA/DRPS role in this is as the RPA (a legally required post) and technical adviser to the UK MOD for the Project. It is noted that although MOD use commercial firms to carry out the work, MOD is nevertheless responsible for ensuring that this is carried out in a safe and professional manner. Furthermore, MOD continues to own the waste until its authorised disposal. DRPS advise the Project Sponsor on the technical areas relating to this.

This frequently involves DRPS being given an oversight role in the contract regarding the carrying out of the work and the confirmation of the contractor's clearance certificate. As MOD retain overall responsibility, they have the right to halt the job at any time if any safety questions arise. Step in and dispute resolution rights are also retained by MOD.

Addressing these areas early in the project leads to the formation of a motivated team who are aware of their roles and responsibilities. The creation of such a team reduces the chances of poor information flow and poor performance, which therefore increases the probability of successfully dealing with the legacy of past practices.

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By

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Why Luminise

Advantages of Radioactive Luminising

- Permanent
- Low Weight
- Low light intensity

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Luminising Materials and their Properties

Luminising Materials

	Half Life	Toxicity	"Environmental Persistence"
Radium-226	1600 yrs	High	High
Promethium-147	2.6 yrs	Medium	Low
Tritium (Hydrogen-3)	12.26 yrs	Low	Low

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Site Contamination Mechanisms

- Waste Disposal
- Poor control
- Past remediation

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Key Areas

- Contract
- Regulators
- Media/Publicity
- Audit/Checking

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