At home on the range

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Gwyn Winfield visits Porton Down's "range" to look at the work that DSTL is doing on demilitarisation

THOSE ASPIRANT scholars of British chemical warfare prowess would do well to visit "the range" at Porton Down. This area was at the cutting edge of British offensive CWA delivery during the 1950s. Shells would pour down from the Iron Age fort at Figsbury, just outside Salisbury, onto the "bowl", or some of the hard target sites around it, at Porton and scientists would examine how well the burster, or ejector, munitions worked and what the spread of agent was likely to be. It is fitting then that the range is now the home of the UK's chemical demilitarisation project. Unlike the US and Russian demil, which have far larger and more varied arsenals, the UK's is a more… parochial affair.

The UK never had the stocks of nerve agent held by the two major Cold War adversaries, and neither did they keep their conventional CWA so long. With the exception of the minute amounts allowed under the Chemicals Weapon Convention for improving NBC defence, the UK disposed of all its chemical weapons in the 1950s, which was a much less sophisticated time for such an event. Free from things like Health and Safety and EU Environmental Guidelines, the 1950s saw a jamboree of chemical weapons disposal; some went into the oceans (dilution being the solution to pollution) to be picked up by trawler nets, some went into poorly marked pits to be found when digging bunkers on golf courses, and the majority were incinerated.

The big round-up

The Chemical Weapons Convention (CWC) has no such cavalier approach to demilitarisation; each munition must be tagged, with documented proof given of its final demise. Signatory countries to the CWC have until 2007 to clear their stocks, but this has been extended – at least for the US and Russia that have immense stocks of these munitions still to be safely destroyed. The UK and Germany fit into a second tier of countries that have a historical legacy of these weapons – other countries that have a First World War legacy of these munitions, such as Belgium or France, are not covered as the Convention includes only post-1925 munitions.

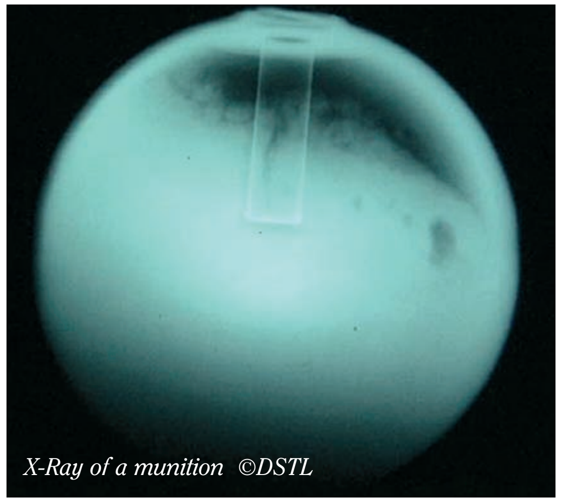
The majority of the 200-300 finds that the UK has to destroy each year comes either from the ranges where these weapons were used or developed (such as Winterbourne Gunner), or from (stretching an allusion) "orphaned sources"; meant to be destroyed but lost either in the 1950s MoD bureaucracy or misplaced in the UK. The majority are mustard, of varying quality, but occasionally phosgene and BBC (Bromo Benzyle Cyanide – a non lethal version of hydrogen cyanide) turn up as well. The UK's approach to the destruction of these agents is commensurate with the amount and virulence of the agent; the majority are incinerated at 1,000 degrees, though some are now going through a process of hydrolosis.

Richard Soilleux, Technical Leader for DSTL's demilitarisation program, described the procedure: "When we receive a munition, it has been already been examined by a military EOD team who have decided that it is explosively safe to move", he said. "Once they have done that we send our experts up to assess whether or not it is a chemical munition. It is then packed into suitable sealed containment – so that if there is an accident we know it won't be spilled all over the public highway – and it all goes in convoy. Once it arrives at Porton Down it goes into storage, is given a unique tag and is then x-rayed, which is done at a 45 degree angle so we can see the liquid – this also allows us to see the fusing mechanism and whether there has been any corrosion or decay there.

"Once we know it is chemical we take it for further examination by PINS (Portable Isotopic Neutron Spectroscopy), which uses thermalised neutrons to penetrate the munition where they react with the atomic nuclii inside the shell and give a gamma spectrum. This gamma spectrum has characteristics of the matter it reacts with, so we look for signature atoms such as chlorine or sulphur, both of which are found in mustard – the software then analyses these spectra and says we have chemical agent and it is likely to be mustard. It gives us a good indication, but it is not foolproof because you can have mixtures that can confuse it, or small munitions with small quantities of agent. It is very good for HE and white phosphorous;

those two things are rather dangerous and we wouldn't want to put them thorough our processing system – so it is good screening method to remove the hazardous items to allow us to concentrate on the chemical items."

As Dr Soilleux remarked, PINS does allow a certain amount of knowledge to be gleaned from a closed container, but it still requires skilled operators to run it. Some of the tell-tale elements that you would be looking for are also found in benign substances – such as sea water. The latter is not as esoteric a conclusion as one might think, as sea water was used in test shells because it was deemed to have the same density as mustard – allowing spread patterns to be judged with a safe liquid. At the various testing grounds where these trials took place, these test shells are not uncommon; it requires a precise understanding of the spectra to appreciate what is likely to be mustard and what is likely to be sea water.


X-Ray of a munition ©DSTL

Whatever the chemical payload, most of the shells have a small explosive device to disperse the agent over a wide area. In later devices these were small explosive rods in the centre of the munition that would split the canister in a useful manner while incinerating as small a proportion of the agent as possible – some US manufactured shells that turn up in the UK are pressurised as well (as are some UK shells that have had a secondary chemical reaction inside the shell) which poses additional problems.

"The chemical munitions usually only have relatively small explosive bursters," said Richard Soilleux, "so it is a lot safer to deal with those than conventional munitions, explosively speaking; chemically it is a different matter. If that is the case then we will drill them to take a sample and send that to a lab for definitive analysis. Once we have done that, we can decide on a disposal method. If it is phosgene we will drill it out and neutralise it; if it is mustard or BBC it goes to the incinerator, which is straightforward and gives good results. We are developing a hydrolysis method as a fallback. Having done that, we need to treat the shells before we can release them for scrap – which we do in an incinerator – we have far less environmental restrictions on that as the contamination is only residual."

The hydrolysis method is a new procedure that the range team are developing. While it has been used in the past by the US, for example, the smaller quantities in the UK make incineration an easier and more cost effective solution. "Basically, our demilitarisation method is incineration," said Dr Soilleux. "Mustard burns very well – it burns like diesel, and with our pollution abatement system we can get very good clean-up rates. We don't have any Crown immunity; we have to meet all the environmental guidelines, we are regularly inspected by the Environment Agency and we have to meet all the statutory requirements. It is a very good way of dealing with mustard; we didn't talk about phosgene, because it is a lesser problem, but when we do find it we drill the munition and pump it into sodium hydroxide at the facility and that neutralises it.

"We decided to develop hydrolysis as a second string to our bow. We had reliability problems with the incinerator – it is getting older – and we were looking for a replacement. After 2007 we are going to have to come up with another solution for these old munitions, so we are studying that now – and it may or may not involve an incinerator. Because we have these reliability problems, and because we wanted to make sure we were compliant with CWC, we came up with another method which is hot water hydrolysis. We then neutralise it with some bacteria – otherwise we'd end up with thiodiglycol, which is controlled as a schedule two compound under the CWC as it is one of the base chemicals of mustard."

Working with the natives

In an example of "nature will find a way", the bacteria that Porton Down uses to break down thiodiglycol is naturally occurring. The range is now working closely with Oxford University to come up with a natural chain reaction that will render mustard completely harmless. "We found that there were one or two sites where there were residual elements in the soil from the disposal efforts in the 1950s – which wouldn't meet modern standards but were deemed fine for the day. We revisited these sites and we, together with Oxford University, found that the normal soil bacteria had adapted and had become much more tolerant to mustard and could work in that environment much better than normal bacteria. Normal bacteria will break it down eventually, but these bacteria are just more efficient because they have decided to use the elements found in mustard. We are planning to use some of those bugs to destroy our thiodiglycol, and some of the other by-products of the hydrolysis of the mustard. All we are doing is speeding up a naturally occurring process – there is not one super bug that deals with it; it is a whole family, or consortia, of bugs. One of them will take thiodiglycol down to an acid and another will take it down to another stage, so each one makes a waste product that the next one eats. They all support themselves in other ways too, feeding nutrients into the others to take advantage of this food source and eventually they will reduce it to an innocuous sulphate."

While it may end up an innocuous sulphate, this mustard is anything but innocuous when it is brought up. While mustard degrades and can polymerise – turning into a rubber-like substance – part of the agent remains as deadly as it was when it was first created. Richard Soilleux explained, "The problem with mustard is that even though it does polymerise – which accelerates as it comes up to the surface and is likely to be something to do with the rapid change in temperature from day to night – it is variable. The ones from Woburn Golf Course, for example, were in very good condition – it also depends on how pure it was to start with – so we brought them up in absolutely beautiful condition, they were well stored and there is nothing to say that in 50 year's time they wouldn't be as lethal as they are now. It is a long term problem."

While there may be some clues from their location as to what their likely state might be – those that were fired at a target are likely, due to impact, to be in a worse state than those that were buried intact – it is often not until the team is able to extract a sample that they have a clear idea of what they are dealing with. Due to the bursters running the length of the munition, often it is not practical to saw the top off, as is done with base eject munitions, and the team have to drill the munition, either to take a sample or drain it completely. Previously they had relied on a large, static, industrial drill to do this, but now the team are using the Monica system, which allows them to take the drill to the munition – especially useful for any munitions that need to be drilled in the field.

Dr Soilleux admitted that the site is not as sophisticated as the US versions, but pointed to the fact that it is easy to maintain (all maintenance is done on site by members of the team), train people on and is, most importantly, safe. All operations are done remotely, ensuring that the operator is protected, and that by adhering to the filtered negative pressure working environment (and the stringent Environmental Agency regulations) the system is clean – the public and staff are never at risk. The site focusses strongly on history – the team need to be able to differentiate between 12 versions of a four-inch mortar shell, for example, and is soon likely to be history itself.

There is currently no provision for legacy chemical munitions after the end of the CWC in 2007 and, while this is a problem that will lessen as all the low hanging fruit (such as the 1,000 odd shells that were recovered from Winterbourne Gunner) are destroyed, it will never completely disappear, as finds will appear over time that will need to be dealt with. While the range is not prohibitively expensive to run, unlike the US and Russian systems, there is a cost attached to it in terms of training and staffing that the MoD would no doubt like to minimise. There is already a touch of nostalgia from staff, who have clear enthusiasm for this unpalatable job, over what will happen to the range post-2007 when much of the work will dry up. While the OPCW deliberates over what will be the fate of nations like the UK post-2007, the final testaments to Britain's CWA past are being fed into the incinerator and this page of warfare slowly erased.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