CHEMICAL AND BIOLOGICAL WEAPONS

POST note 111 February 1998

With the current concern over remaining chemical and biological weapons (CBW) capability in Iraq, parliamentary interest has been high.

This note looks at some of the CBW agents of concern and related aspects.

BACKGROUND

Following the end of the Gulf War in 1991, the United Nations Security Council passed Resolution (SCR) 687, of 3 April 1991, which obliges Iraq to accept the destruction, removal, or rendering harmless of:

- all its nuclear, chemical, and biological weapons,
- all ballistic missiles with a range over 150 km;
- all research, development, and manufacturing facilities associated with the above.

SCR 687 is legally binding on member States and it requires Iraq to accept unconditionally the destruction, removal or rendering harmless of the specified weapons and missiles; to submit full details of locations, amounts and types of her weapons of mass destruction (WMD) and undertake not to use, develop, construct or acquire WMD in the future; and to submit to immediate on-site inspections of weapon-making facilities.

To implement the resolution, the Secretary-General was instructed to establish a UN Special Commission (UNSCOM) to oversee these processes in conjunction with the International Atomic Energy Agency (IAEA). In the years since the resolution was passed, both UNSCOM and IAEA teams have worked to locate and then destroy WMD. UNSCOM has also set up an 'on-site monitoring and verification' (OMV) system which includes cameras at 'dual-use' facilities capable of being diverted to CBW purposes (e.g. sites with fermenters); it also controls the import of sensitive materials.

Many thousands of personnel from over 40 countries have been involved and so far, UNSCOM has uncovered and eliminated (*inter alia*) the following:

- 48 operational Scud missiles and components.
- 6 missile launchers.
- 38,000 chemical weapon munitions.
- 30 special missile warheads for CBW.
- 690 tonnes of chemical warfare agents and 3000 tonnes of CW precursors.
- A large BW agent manufacturing plant dedicated to the production of anthrax and botulinum toxin.

UNSCOM also found that, despite Iraqi claims that a project to produce VX nerve agent was a failure, it had the capability to produce VX on a substantial scale, and had produced at least four tonnes. Iraq also disclosed to UNSCOM its production of 19,000 litres of botulinum toxin solution, 8,400 litres of anthrax culture, and 2,000 litres of aflatoxin. Iraq has admitted filling ballistic missile warheads and bombs with these agents, but claims that they were subsequently destroyed. Most recently, the Defence Secretary referred to intelligence that at the time of the Gulf war, Iraq may have possessed large quantities of a chemical warfare mental incapacitant agent known as 'Agent 15'[1]. This was in addition to the large-scale production of numerous chemical agents such as sarin, tabun and mustard gas, which had all been deployed ready for use.

BOX 1 CBW COMPONENTS 'UNACCOUNTED FOR'

The FCO cite UNSCOM as concerned that:

- Iraq may still have operational SCUD-type missiles with chemical and biological warheads. Critical missile components, warheads, and propellant are not accounted for.
- 17 tonnes of growth media for BW agents
- Key items of CW production equipment
- UNSCOM strongly suspects that admitted Iraqi figures for production of BW agent are still too low
- 4,000 tonnes of CW precursors
- Over 31,000 CW munitions
- Over 600 tonnes of VX precursors

In 1997, UNSCOM reported to the Security Council that it was now satisfied that Iraq's nuclear weapons capacity had been removed. With CBW agents, however UNSCOM had evidence that agents, their precursors and essential support materials for their manufacture were still unaccounted for (see **Box 1**). Iraq's refusal to allow access to a range of sites targeted by UNSCOM has led to the current crisis.

THE IRAQI BW PROGRAMME

Iraq's decision to acquire biological weapons was taken in 1975, but apparently made little progress until 1985 when a staff of 10 was established at Muthanna. Anthrax and *Clostridium botulinum* strains were imported and, after initial work, a full-scale programme was launched at Al Salman. There, animal tests and field trials were conducted on lethality and production designs developed. During 1988 and 1989, 1500 litre fermenters were in place producing material, trials of weapons with these agents were underway, and aflatoxin had also been produced.

1. This is believed to be related to the earlier glycolate agent BZ which causes overheating, hallucinations and coma.

Iraq clearly approached its search for WMD in a very comprehensive way. Data on many CBW agents, their toxicological properties, safety and handling measures, and methods of preparation are quite widely known and published, so there is no great challenge in obtaining the formulae and recipes. Great advances in the whole field of microbiology and aerobiology also meant that much of the specialised equipment (e.g. reliable fermenters) were available 'off-the shelf' - indeed, Iraq diverted to military use equipment already installed at facilities involved in veterinary research, animal feed production etc. The main challenges for BW were maintaining the agent's potency through weapon storage, delivery and dispersion - requiring considerable research in the laboratory and field trials. The latter had involved bombs, spray planes and rockets and, despite initial failures, were deemed a 'success' by 1990.

By the Gulf War, Iraq had deployed (in addition to its many chemical weapons) BW munitions at four or more locations as follows:

Agent	in R400 Bombs	in Al-Hussein warheads
Botulinum toxin	**100**	**13**
Anthrax	**50**	**10**
Aflatoxin	**16**	**3**

Launch authority had been delegated to local commanders. In addition to these, Iraq has admitted producing other BW agents as shown in **Table 1**. Iraq is also believed to have been working on the plague bacterium *Yersinia pestis*, but has not admitted this.

It has become apparent from UNSCOM enquiries that Iraq had conducted trials of several delivery systems and that these would have been effective (particularly against unprotected civilian populations), even if they had not yet made the delivery as efficient as possible. Moreover, the intellectual knowledge gained up to that point remains, and experts have pointed out that stores of freeze-dried organisms could be easy to keep and hide, allowing a BW programme to be swiftly re-instated. Since much of the equipment required remains because it also has legitimate (e.g. pharmaceutical) uses, the concerns are that production of militarily significant quantities could resume in as little as 6 months.

INTERNATIONAL CBW TREATIES

The dangers of CBW have been a source of international concern since chemical weapons were used in WWI, and are now covered by international agreements (**Box 2**). The 1993 **Chemical Weapons Convention (CWC)** has been signed by 168 States, and ratified by 107, and is now in force. UK enabling legislation passed Parliament in 1996 in the form of the Chemical Weapons Act. One requirement of the Act was for the DTI to submit an annual report to Parliament, and the latest has just been lodged. The **Biological Weapons Convention (BWC)** was agreed in 1975, and has been signed by 159 nations and ratified by 141, but is relatively weak because of its lack of verification provisions. Negotiations to update and strengthen the Treaty have been underway since 1995, and good progress has been made towards a binding verification protocol (Box 2).

TABLE 1 MAIN BW AGENTS INVESTIGATED BY IRAQ

Bacteria:	**Anthrax, Clostridium perfringens,**
Viruses:	**Haemorrhagic conjunctivitis virus; rotavirus; Camel pox virus**
Toxins:	**Botulinum, aflatoxin and other mycotoxins, ricin**
Fungus:	**Wheat coversmut**

BOX 2 INTERNATIONAL CBW CONTROLS

Both chemical and biological weapons are classified as **weapons of mass destruction** and covered by the 1925 Geneva Protocol, which prohibits their use. More recently, the modern **Chemical Weapons Convention (CWC)** entered into force in 1997.

Article VI of the CWC, together with a Verification Annex, sets up a comprehensive system of monitoring through declarations and on-site inspections, particularly of the chemical industry. The type of inspections relate to the Schedules of Chemicals, which list categories of chemicals according to the risks they pose. The CWC embraces all toxic chemicals and their precursors but, for routine inspection, 14 families and 29 chemicals are listed. Those in Schedule 1 are effectively removed from commercial use. Chemicals in Schedule 2 must be reported when a certain level of production is reached, and production facilities are then subject to inspection. Schedule 3 contains chemicals which are in large-scale use and these must be reported when a higher threshold is reached.

The **Biological Weapons Convention (BWC)** entered into force in 1975. Unlike the CWC, the BWC has no effective verification provisions. Efforts have been made at the BWC's five-yearly Review Conferences to find means of increasing confidence of compliance. A set of Confidence Building Measures (annual data exchanges) were agreed in 1986, and extended in 1991, but the responses to this (non-legally) binding mechanism were disappointing. The scientific and technical aspects of verification have, however, been evaluated, and this has led since 1995 to a series of Ad Hoc Group meetings to develop a **legally-binding Verification Protocol**. Given sufficient political support, these negotiations could be concluded this year, and a new protocol submitted to a Special Conference for approval in 1999.

Central to both Conventions is the principle that many types of substances and equipment must be monitored and their export controlled or banned. Since many have legitimate uses (e.g. as agricultural or industrial / pharmaceutical reagents), national controls have to be supplemented by a strict verification regime. For CW, this is the responsibility of an international body set up to implement the CWC called the Organisation for the Prohibition of Chemical Weapons; this has the responsibility for evaluating national declarations and carrying out on-site inspections in each country.

Although Iraq was required to ratify the BWC as one of the Cease-fire conditions, it is not a signatory to the CWC. The only international **inspection** regime which applies at present is thus that of UNSCOM.

KEY CBW AGENTS INVOLVED

The main agents involved in current concerns have a very wide range of effects on people:

- **Nerve Agents** are highly potent chemical weapons, and work by inactivating cholinesterase (involved in the transmission of nerve impulses between adjacent cells), thus blocking normal nerve function. In general, these agents are most dangerous when inhaled as a vapour, and high doses kill rapidly through paralysis of the respiratory muscles (often complicated by other symptoms arising from their affects on the cardiac, nervous and gastrointestinal systems). Examples of nerve agents include Tabun, Sarin, Soman and VX.
- **Blister Agents** include the oily liquids mustard gas and lewisite, and cause blisters that then burst, often become infected and may take weeks to heal. These also cause chronic respiratory complaints and are established mutagens, increasing risks of cancer, possibly also causing reproductive dysfunction.
- **Blood Agents** such as cyanide are easy to make and block the uptake of oxygen from the blood. Symptoms thus consist mainly of breathing difficulties, convulsions, etc. and death is due to respiratory arrest.

The above chemical weapons have been used by Iraq against Iraqi Kurds or in the Iran-Iraq War.

The **biological weapons** researched in quantity were:

- **Anthrax** - an infectious bacterial disease of cattle that can also be transmitted to man. The bacterial toxin leads to a severe pneumonia-like illness, with death in 1-5 days through poisoning of organs and blood stream.
- **Botulinum toxin** (from the bacterium *Clostridium botulinum).* Symptoms include dry mouth, visual difficulty, difficulty in speech and swallowing, nausea, vomiting, dizziness. Death occurs in hours from progressive muscular paralysis and respiratory failure.
- **Aflatoxin**- a fungal toxin which attacks the immune system and is carcinogenic.
- **Clostridium perfringens** is a bacterium which can cause gas gangrene in battlefield wounds.
- **Ricin** (from Castor Bean plants) causes a severe diffuse breakdown of lung tissue resulting in haemorrhagic pneumonia and death.

Iraq's choice of weapons has been seen as indicating a range of targets beyond specific military applications. Some agents (e.g the nerve agents) have been used militarily (both internally and against Iran), and attempts to adapt these and anthrax/Bt toxin to missile delivery systems clearly had similar objectives (even if also capable of attacking civil populations). However, aflatoxin's effects are not immediate, suggesting that it would have been more likely to be designed for civilian targets. Similarly, work on plant (e.g. wheat) diseases implies interest in an economic weapon.

DOSE AND DELIVERY

The doses required to inflict death or injury are all small, and much has been made in the press that "*one teaspoon of sarin has the toxicity to kill 10,000 people*" or "*one teaspoon of anthrax has the toxicity to kill 100,000,000 people*". Such figures assume a 100% efficient delivery system - i.e. one that delivers exactly the minimum dose necessary to each person in the most 'efficient' manner. Relative toxicities are thus only part of the picture, and the method of dispersal is critical to how effective the weapon is[2]. Iraq was able to deliver CW agents by mortar, tube artillery, air-to-surface rockets and aerial bombs, but for BW and missile use, 'weaponisation' poses greater challenges, since the agent must survive the missile launch and journey and then the explosive dispersal on target.

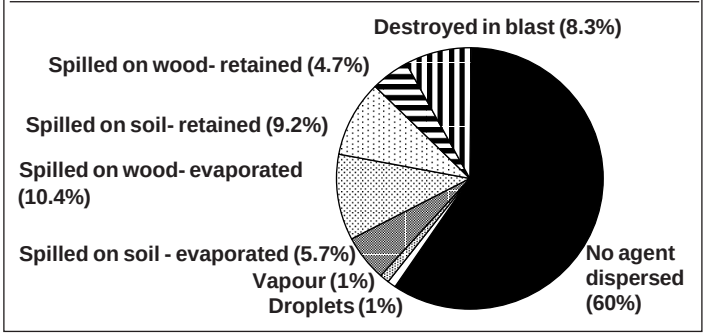
There is much variation in the persistence of CBW agents and the ability to clean-up spills. The nerve agents are oily liquids and some (e.g. sarin) will evaporate quite quickly; others (e.g. VX) are less volatile and would remain in the soil, degrading over time. Soil clean-up would involve washing with a caustic solution. Some CBW however, are very long-lived; mustard gas remains for extended periods, and anthrax spores survived on some of the former test island of Gruinard for 40 years, before being successfully deactivated by treating the relevant 10 acres with 5% formaldehyde solution in sea water.

At present, it is not known whether intelligence sources have located stocks of complete CBW agents; it has also been suggested that if such exist, they would not be directly targeted in any military action. Nevertheless, **there is interest in how any such stocks might respond to bombing**. CW and toxin agents are basically organic chemicals which will burn or decompose if heated; live biological agents can be killed by moderate temperatures (as in sterilising with boiling water). All agents are thus sensitive to the extreme heat of an explosion and there may be types of munitions which can prolong the heat pulse to maximise destruction of CBW agents. Whether toxicologically significant quantities of agent would remain after a hit would thus be questionable, but would clearly depend on a number of factors - the quantity and the agent involved, the type of munition, the location of the strike etc. Military research has looked at such questions, but much information is not in the public domain. That some releases may occur can however be illustrated by experience of the destruction of sarin at Khamisiyah by US troops after the Gulf War. Here, at least 8.5 tonnes of sarin (and the closely related cyclosarin) nerve agents were blown up (it was not realised that the bunker contained chemical warheads).

Subsequent investigations have been the most detailed to date into nerve agent behaviour on demolition (in the

2. CBW can be susceptible to weather and their effect is not predictable; typical miltary payloads are more likely to be in tonnes than grammes.

Figure 1 FATE OF SARIN AT KHAMISIYAH



public domain). US investigators built on data available from tests in the 1960s of how CW agents react when bombed or detonated, and built mock-ups which were then blown up and the fate of a simulant agent measured, and its subsequent dispersion modelled[3]. The report reaches the following conclusions:

- the original demolition used inadequate explosives and destroyed less than half of the 1200-1400 rockets present. Remnants were subsequently bulldozed and buried by Iraqi forces.
- The only warheads which burst and volatilised were those with a charge just below the nose. Adjacent warheads leaked agent into the soil or wooden crates; some then evaporated, some degraded (the simulated agent's fate is summarised in **Figure 1**). Many rockets remained intact and spilt no agent.
- When combined with atmospheric dispersion models, predictions are that levels of sarin could have been high enough to incapacitate unprotected people close (up to 1.5km) to the dump, and some 'first noticeable effects' (e.g. runny nose) might also have been encountered at points up to 20km from the demolition for 2-3 days - mainly due to releases from evaporation.

The only other recent example of release concerns the outbreak of anthrax in 1979 in Sverdlovsk, when some 68 people died. This is now accepted to have been caused by an airborne release from a military biological facility. The quantity involved is believed to have been very small; yet people and animals were killed up to 50km down-wind of the release.

Using this limited experience to assess possible consequences of bombing current day installations is fraught with difficulty, but some points are worth considering.

- Firstly, Khamisiyah possessed large quantities of active agent. Many of the current 'unaccounted-for' substances are precursors without the toxicity of the final CBW agent (or in the case of the missing bacterial growth medium, harmless).
- Demolition at Khamisiyah was very inefficient, using limited explosives. Aerial bombardment could deliver much greater amounts of explosive. In a 'direct hit' scenario (e.g. on a stockpile of CW warheads if such exist), destruction of the agent could be high, and dispersal (and thus dilution) of any active agent swifter and upward.
- The Russian experience reminds however, of the very small amounts of anthrax which, if effectively dispersed, can kill.

Table 2 BIOLOGICAL AGENTS IN US ARMY DEFENCE MANUAL

Anthrax	Botulinum Toxins	Brucellosis
Cholera	Clostridium Perfringens Toxins	Ricin
Plague	Crimean-Congo Hemorrhagic Fever	Saxitoxin
Q Fever	Trichothecene Mycotoxins	Rift Valley Fever
Smallpox	Staphylococcal Enterotoxin B	Melioidosis
Tularemia	Venezuelan Equine Encephalitis	

THE FUTURE

The BW developed by Iraq included only some of the many diseases and toxins which have been seen as possible BW agents - for example, the US Army biological defence manual cites 17 such agents (**Table 2**). But since then, the advances in microbiology which made it easier for Iraq to develop BW agents in the 1980s than the 1970s have continued apace, and there now exist a whole range of tools which can be used to adjust the genetic makeup of microorganisms. Equally, understanding of the nature of viral and bacterial toxins has grown. This research has been for peaceful, biomedical purposes and underlies many important advances in modern medical treatment. But equally, some see such techniques opening up new possibilities in BW.

Some assessments are now that whole new threats are at least theoretically possible. Existing agents' effectiveness could be increased (e.g. by including antibiotic resistance or genes to improve survivability after release); toxin genes could be inserted into common non-harmful bacteria which are used to living in a human host. This would not only make it easier for them to spread, but also make them difficult to detect. Such possibilities underline **the importance of negotiating and extending to BW the type of verification regime** now applied via the CWC.

Parliamentary debate shows widespread agreement on the importance of preventing Iraq from continuing or resuming its programmes of CBW. The problem with much CBW work is that it is small-scale and easy to disguise and hide. UNSCOM's persistence in pursuing its mission through painstaking investigation is thus, in many views, the most effective means of discovering remaining elements of the Iraqi CBW programme, while the ease of resumption means that UNSCOM needs to continue to monitor for Iraqi WMD facilities and activities, via current OMV sites and any further ones established as a result of future inspections.

3. This was to establish whether troops could have been exposed to CW as part of investigations into possible causes of Gulf War Illness - see POST report "Gulf War Illnesses - Dealing with the Uncertainties".