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UNMOVIC
UNITED NATIONS MONITORING, VERIFICATION AND INSPECTION COMMISSION

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DRAFT WORK PROGRAMME

1. This document is being presented pursuant to operative paragraph 7 of Security Council resolution 1284 (1999), which requires the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC) to submit, for approval by the Security Council, a Work Programme for the discharge of its mandate.

THE RESOLUTIONS GOVERNING THE WORK OF UNMOVIC

2. Resolution 1284 (1999), which established UNMOVIC, was followed by, but not replaced by, resolution 1441 (2002). Several other resolutions also contribute to the mandate of UNMOVIC, notably, 687 (1991), 707 (1991) and 715 (1991). While the export/import mechanism is also highly relevant for the work of UNMOVIC, it is not addressed in this paper, which focuses on work in the field of disarmament and ongoing monitoring and verification.

3. In drawing up its work programme, UNMOVIC must take into account the demands placed upon it under all the relevant resolutions. Although they differ in focus and emphasis, there are no inconsistencies between them, whether in relation to tasks, powers or work methods.

4. With respect to powers, there has been over the years an aggregation of rights, most recently and most significantly through resolution 1441 (2002), which considerably strengthened the authority of the inspectors.

5. With regard to working methods, resolution 687 (1991) distinguished between inspection and ongoing monitoring and verification. The latter working method was described in the plan (S/2287/Rev.1 and S/1995/208) submitted by the United Nations Special Commission (UNSCOM) and approved by resolution 715 (1991). However, over time the two methods were applied side by side and resolution 1284 (1999) expressly endorsed the merger as the "reinforced system of ongoing monitoring and verification" (R-OMV). Resolution 1441 (2002) has made no change in this regard.

6. Under all the resolutions, the general task laid upon the inspecting organizations is to achieve through inspection and verification a high degree of assurance that Iraq has been freed from, and remains free of, weapons of mass destruction. Resolutions 687 (1991) and 1441 (2002) relate to Iraq's comprehensive disarmament as they are described in the former resolution. While resolution 1284 (1999) requests UNMOVIC to identify "key remaining disarmament tasks", at the same time, it also directs UNMOVIC to "address unresolved disarmament issues". Hence, the scope of the issues to be dealt with by UNMOVIC did not change under that resolution. The required identification of "key remaining disarmament tasks" does suggest a prioritization. However, this is not new, as UNSCOM had also worked with what it called "priority tasks". Under resolution 1441 (2002), UNMOVIC may continue to prioritize some disarmament issues as "key remaining disarmament tasks" and this is done in the present work programme.

7. None of the resolutions that govern the work of UNMOVIC lays down a date for the completion of the work. Resolution 687 (1991) did assume that the disarmament phase would be short, that economic restrictions would be lifted thereafter and that the disarmament phase would be followed by monitoring and verification until the Security Council decided otherwise. Resolution 1284 (1999) enables the Council to suspend economic restrictions after a finding that Iraq has cooperated in all respects for 120 days and made progress on the resolution of key disarmament issues. The resolution, however, does not establish any date for the completion of the work. Resolution 1441 (2002) conveys a sense of urgency by presenting a "final opportunity" for Iraq to comply with its disarmament obligations. At the same time, it does not indicate how long the window of opportunity is

to be open. It only stipulates that the Council shall be "updated" 60 days after the resumption of inspections, which turned out to be 27 January 2003.

8. The Work Programme presented in this paper includes the implementation of a reinforced system of ongoing monitoring and verification (R-OMV) as required by operative paragraph 7 of resolution 1284 (1999). The system incorporates the new powers conferred upon UNMOVIC by resolution 1441 (2002). It covers both "unresolved disarmament issues" and "key remaining disarmament tasks", which are to be completed by Iraq. It seeks clearly to define what Iraq is required to do for the implementation of each of the key remaining disarmament tasks. Like the resolutions governing the work of UNMOVIC, the work programme is predicated on the assumption that Iraq will provide immediate, unconditional and active cooperation.

UNRESOLVED DISARMAMENT ISSUES

9. The unresolved disarmament issues have recently been listed in the form of clusters and been described in the working document of 6 March 2003, which was presented informally to the Security Council. In the identification of these issues, a number of sources, such as the UNSCOM (S/1999/94) and Amorim reports (S/1999/356), UNSCOM inspection reports for the period from the end of 1998, and various declarations and documents of Iraq, including those from the Haidar Farm, were consulted. For the period from the establishment of UNMOVIC until the resumption of inspections in November 2002, reliance had to be placed on sources such as overhead imagery, published material, suppliers and intelligence. Account was taken of the information supplied by Iraq in its "Currently Accurate, Full and Complete Declaration" (CAFCD) of 7 December 2002 and other documents it has provided prior to, and since the resumption of inspections. The results of those inspections and UNMOVIC's rebaselining activities constituted another important source of information. The working document of 6 March is an evolving one, and will be adjusted in the light of any new developments and the results of inspections and new information supplied from the Iraqi side. There has also been a good deal of destruction of missiles and missile related equipment, which will be taken into account.

10. In its CAFCD of 7 December 2002, Iraq stated that it had not pursued any proscribed activities in the period 1998 to the present day. However, this statement has been contradicted by reports from a variety of sources,

and some further disarmament issues have now been identified as being unresolved for the period after 1998. Particular attention has been drawn to the possible existence of mobile CW and BW agent production facilities, of underground facilities involved with research and indigenous production of CW and BW agents, the movement of proscribed materials around Iraq to avoid detection and to a surge of activity in the missile technology field.

11. It should also be noted that disarmament issues could exist, which neither the inspecting organizations nor any other authority outside Iraq is aware of. If and when such issues are identified as a result of inspections or intelligence information, they will be addressed, and it cannot be excluded that some such issues will be deemed to be of high priority. In such an event, additions to the list of key remaining disarmament tasks would, as appropriate, be made with the approval of the Security Council.

KEY REMAINING DISARMAMENT TASKS

12. UNMOVIC has had extensive discussions in the past with the College of Commissioners on the question of criteria for the selection of key disarmament tasks. In selecting the key remaining disarmament tasks, primary importance has been given to the level of danger or threat, the respective weapon or other item would pose, should it exist. In determining the level of danger of the different items, aspects such as shelf life and viability, readiness for deployment or use, lethality, quantities, indigenous capabilities have been taken into account. The distinction between disarmament issues requiring resolution and outstanding questions that may be dealt with through a reinforced system of monitoring and verification is not always easy to make.

13. The selection of key tasks is inevitably a matter of judgment. For this reason, it was particularly important that the initial selection made by UNMOVIC was submitted to the members of the College of Commissioners. Their advice has been taken into account in the selection made in this document. While the advice given by individual members naturally varied, the selection now advanced by UNMOVIC has substantial support. The three months of inspections and rebaselining have been of great value to give UNMOVIC a better sense of which issues it should pursue with priority.

14. The disarmament tasks identified as key have been selected from the cluster of issues presented in the document of 6 March and, for convenience, the texts from that document concerning each key issue are appended to the present paper (Annex 2). For each key issue, a statement of actions that Iraq can take to resolve the issue is indicated in as clear terms as possible. While the descriptions of these actions build on the actions described in the document of 6 March, they have been further examined with a view to making them more precise. It should be noted that the suggested actions are sometimes alternative and may not be exhaustive. Other possible actions that could solve the issues are not excluded. The actions are not listed in any other order of priority than that the first solution, if at all applicable, is the presentation of any remaining proscribed item. While it is generally possible to define a disarmament issue that is to be resolved, a comprehensive definition of the ways in which this could be achieved is often difficult.

15. Following is a list of the issues which UNMOVIC has identified as key disarmament tasks to be completed by Iraq. They are set out in detail in Annex 1. Annex 2 contains the background information relating to each task identified, under a heading relating to that task.

- Scud missiles and associated biological and chemical warheads;
- SA-2 missile technology;
- Research and development on missiles capable of proscribed ranges;
- Munitions for Chemical and Biological agent fill (CBW);
- Spray devices and remotely piloted vehicles/unmanned aerial vehicles (RPVs/UAVs);
- VX and its precursors;
- Mustard gas and its precursors;
- Sarin, Cyclosarin and their precursors;
- Anthrax and its drying;
- Botulinum toxin;
- Undeclared agents, including smallpox; and
- Any proscribed activities post 1998

16. Iraq has the primary duty to help resolve the key remaining disarmament tasks: to present proscribed items, to provide documents and other evidence, to present witnesses for interviews, etc. At the same time, UNMOVIC will use all its resources to verify Iraq's declarations and the evidence presented. It will thus contribute actively to the resolution of

unresolved disarmament issues as well as the key remaining disarmament tasks of Iraq.

METHOD OF WORK: THE REINFORCED SYSTEM OF ONGOING MONITORING AND VERIFICATION (R-OMV)

17. As noted above, the various resolutions applicable to disarmament in Iraq, beginning with resolution 687 (1991), give relevant guidance on methods of work. In resolution 715 (1991), an ongoing monitoring and verification plan was approved. This monitoring and verification system, as conceived and implemented by UNSCOM, was not to search for proscribed weapons and materials. Rather, this task was to be carried out separately, through disarmament activities and investigations.

18. The concept developed in the Amorim Report, and subsequently endorsed in resolution 1284 (1999), was that the disarmament objectives (the identification, verification and disposal of any of Iraq's proscribed weapons, materials and programmes) and its monitoring objectives (determining that proscribed activities are no longer being carried out by Iraq) could be achieved in an integrated fashion. This could be done through the use of on-site inspections, with full and immediate access, including no-notice inspections of civilian and military facilities, sample analysis, overhead surveillance, evaluation of documentation, interviews, installed monitoring equipment or, most effectively, a combination of them.

19. The retention of the right to investigate any aspect of proscribed weapons is a fundamental element of the integrated system. One benefit of the integrated approach is that all information gathered from the disarmament/OMV activities is analysed systematically, considered against other data and examined in a multidisciplinary context. The export/import mechanism is a critical component of the R-OMV to identify both imported dual-use items, which will have to be monitored in Iraq and, possibly, new locations where dual-use items are installed, which will also have to be subject to monitoring. In addition, the receipt of more intelligence that can be acted upon would enhance the discharge of UNMOVIC's mandate. Finally, Iraq's full cooperation is vital for the realization of the objectives of the R-OMV.

20. The implementation of the R-OMV is not limited to dealing with the key remaining disarmament tasks, but must also address all unresolved

disarmament issues. Any planning of inspections must therefore take both into account.

21. The main activities through which UNMOVIC will implement the R-OMV system and discharge its mandate are set out below in this paragraph. The activities in the spheres of disarmament and monitoring will overlap. Most of the activities detailed below are already being undertaken by UNMOVIC.

A. Inspections and Monitoring

(i) Identification and designation of new sites;

(ii) On-site inspections for the purpose of verification and investigation;

(iii) Enhancement of mobility/access through the use of regional offices in Mosul and Basrah;

(iv) Credible interviews on site, and separately, in Iraq and abroad, with individuals identified by UNMOVIC as being relevant to the resolution of disarmament issues in Iraq;

(v) Discussions with Iraq relating to data provided by Iraq in its declarations and other documents;

(vi) Systematic sampling and analysis. Procedures for sampling and analysis have been developed by UNMOVIC both for use on site at the Baghdad Ongoing, Monitoring, Verification and Inspection Centre (BOMVIC) and by the network of international laboratories;

(vii) Systematic inspections of underground facilities, including the use of ground penetrating radar and other tools;

(viii) Establishment and implementation of a ground transportation monitoring system to detect movement of

proscribed material, including mobile BW and CW production units;

(ix) Use of aerial platforms such as fixed-wing aircraft, helicopters and drones to support verification/inspections by collecting photographic, video, infrared and radar data;

(x) Supervision of the destruction, removal or rendering harmless of proscribed items by Iraq, including weapons, subsystems, components and software records;

(xi) Establishment of exclusion zones for the purpose of freezing a site to be inspected, including the surrounding areas;

(xii) Application of seals and tags to identify, restrict access to and use of, relevant materials or items selected by inspectors;

(xiii) Installation and operation of surveillance cameras and sensors and containment devices, and other relevant technology;

(xiv) Examination of records, budgets, reports, customs data and other relevant Iraqi documents and;

(xv) Monitoring of the import and end use of dual-use items by Iraq;

B. Analysis and assessment of Information from the following sources:

(i) Inspection reports, documents, semi-annual declarations by Iraq;

(ii) Overhead imagery: Commercial and government satellite imagery, aerial surveillance (U-2, Mirage, Antonov-30B, drones);

(iii) Suppliers;

(iv) Intelligence;

(v) Published material; and

(vi) Interviews.

22. Additional human resources would be required for some activities, such as monitoring ground transportation and the systematic inspection of underground facilities. UNMOVIC is able to draw on its roster of inspectors to augment its inspection staff as required. In addition, consideration will be given to having persons with expertise in budgetary and other financial matters join the roster of inspectors.

TIMELINES

23. The Security Council resolutions provide only limited guidance on timelines, and no timelines or phases have been included in this Work Programme for the completion of individual tasks. Clearly, Iraq's cooperation is decisive for the early resolution of issues. In resolution 1284 (1999), the Security Council has set a period of 120 days after UNMOVIC has become fully operational to measure the extent of Iraq's cooperation and progress achieved in the completion of key disarmament tasks, with a view to suspending economic restrictions. The most recent resolution, 1441 (2002), injects a greater sense of urgency and has provided Iraq with a final opportunity to comply with its disarmament obligations under the relevant Security Council resolutions.

24. Even with a proactive Iraqi attitude, it will take some time to verify the disarmament of Iraq's weapons of mass destruction. The same is true for the resolution of key disarmament tasks. UNMOVIC will pursue all key issues in the work programme simultaneously and with the same priority. Apart from the extent of Iraqi cooperation, the time needed will also depend on the nature of the verification required to resolve the respective issue. It is evident that the presentation and destruction of proscribed missiles can be done and verified in a very short time – even days or weeks. The same could be true of CBW agents if they exist and are presented. The resolution may be more difficult and time consuming in cases where verification relates

to the absence of an item which may require the submission of documents, sample analyses or conducting interviews, etc. In both cases it is estimated – still assuming a proactive Iraqi cooperation – that the time necessary to complete the work programme is months rather than weeks or years. Verified disarmament, once achieved, would still need to be followed by a long-term inspection and monitoring effort that would give confidence and strike an alarm if signs were seen of a revival by Iraq of any proscribed weapons programme.

25. The Work Programme will become effective immediately upon its approval by the Security Council.

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Annex 1

Key Remaining Disarmament Tasks
Actions that Iraq can take to resolve the issues identified below

NOTE: For background information, see the corresponding headings in Annex 2

I. Scud missiles and associated biological and chemical warheads

- Present any retained proscribed missiles and associated equipment, including propellants and the 50-tonne trailer declared to have been stolen, or the results of the investigation into the theft.

- Present any remaining Scud-type special (CBW) warheads.

- Present the remnants or the melted ingots of the seven engines, which Iraq declares were indigenously produced and used for "training" purposes.

- Present the melted remnants of other unilaterally destroyed key engine components, including the turbo-pumps.

- Provide missile related documentation and material, including the two reports written by the missile force commander on 30 January 1991 and in May 1991; videotapes and tracking data concerning the interception missile project; the two diaries that relate to the unilateral destruction of the proscribed missile propellants; and any remaining Scud-B guidance and control drawings, documentation and hardware.

- Provide information on any proscribed missile activities conducted after the adoption and acceptance by Iraq of resolutions 687 (1991) and 715 (1991), including Scud-B guidance and control systems and attempts to procure missile launchers.

- Provide documentation or other evidence to support the information Iraq had submitted during the Technical Evaluation Meeting (TEM) in 1998 on the number of indigenously produced Scud-type warheads, such as a complete production-planning chart and supporting documents.

- Explain why no Scud-type biological warheads were found until after Iraq's disclosure in 1995 of an offensive BW programme and provide documentary evidence in support.

II. SA-2 Missile technology

- Present any remaining Fahad missiles.

- Explain how the parts dismantled from SA-2 missiles were used in its Al Samoud 2 programme.

- Provide additional detailed descriptions, with credible evidence, of the various SA-2 related projects, including their organizational structures.

- Provide additional detailed descriptions, with credible evidence, of the work carried out at Al Sadiq in the period 1991–1993, including production, documentation and quality assurance records.

- Provide verifiable information on the inventory and consumption of SA-2 missiles, including imported missiles, missiles fired and those that have been dismantled.

III. Research and development (R&D) on missiles capable of proscribed ranges

- Present all materials related to its work on SA-2 based Space Launch Vehicles (SLVs).

- Provide all of the input/output data generated during computer simulations of Scud-based SLVs.

- Explain, with credible evidence, the precise nature of its missile activities concerning clustering, staging and separation mechanisms, particularly after the adoption of resolution 687 (1991).

- Provide documents or other evidence substantiating the declared destruction of the imported Unsymmetrical Dimethyl Hydrazine fuel (UDMH).

- Iraq has declared it is conducting research and development on UDMH fuel. Explain, with credible evidence, the purpose for which Iraq planned to use this fuel.

- Provide all drawings of the 7-tonne thrust engine and the turbo-pump developed to simultaneously feed four clustered SA-2 engines.

- Provide verifiable evidence that it abandoned research and development on the 7-tonne thrust engine and on the turbo-pump developed to simultaneously feed four clustered SA-2 engines.

- Explain with credible evidence which missile systems, and their specifications, it intended to be tested at the large test stand developed at the Al Rafah site.

- Provide the drawings and any components that were acquired or produced for the development of large liquid propellant engines, and long-range cruise missiles.

- Declare all the sources for its import of equipment, raw materials and technology that were acquired for its missile programmes since 1998.

- Provide the delivery schedule that was attached to a contract signed in 1987 concerning the Badr 2000 missile system, and declare all the equipment, material and technology it had acquired for the missile.

IV. Munitions for Chemical and Biological Agent Fill (CBW)

- Present any remaining chemical and/or biological munitions, including aerial bombs, rockets or missile warheads, artillery shells, cluster munitions and fragmentation rounds and the relevant moulds, and related production equipment.

- Explain the concept of use for each type of chemical and/or biological munition.

- Explain the full extent of, and provide credible evidence for, the programme for CBW related cluster bombs and cluster warheads for rockets (including the FROG) and missiles, including all research and development and testing.

- Provide credible evidence, documentary or other, concerning import, production and consumption of munitions, intended for, or filled with, CW or BW agent.

    - Present complete documentation from all military organizations detailing their consumption of special munitions.
    - Present all documents identified by the Commission of Inquiry established by Iraq in 2003.

- Provide a detailed explanation, with supporting documentation, concerning the coding system used with the R-400 type bombs, including the coding assigned to specific CBW agents.

- Provide credible evidence that the R-400 bomb production line stopped after September 1990.

- Provide a detailed explanation, with supporting credible evidence, for the major decisions, rationale and outcome regarding the testing of all CBW munitions.

- Provide additional detailed information and supporting documentation on the various special warheads, projectile and canister field-tests, including tests relating to the development of binary systems.

- Identify all facilities, in addition to the Muthanna State Establishment (MSE) and the Technical Research Centre (TRC), involved in the production or modification of munitions (artillery shells, rockets, etc.) relating to true binary agent weapons.

- Explain, with credible evidence, all details regarding the design for binary weapons munitions.

- Explain “project 101”. Explain, with credible evidence, the project’s relationship with the Al Noaman cluster bomb factory and Iraq’s CBW programme.

V. Spray Devices and Remote Piloted Vehicles (RPVs)/Unmanned Aerial Vehicles (UAVs)

- Present any spray (drop) tanks or other spray devices created or modified for CBW purposes.

- Present information with credible supporting evidence on all work conducted on spray (drop) tanks for CBW purposes.

    - Explain the contradiction between Iraq's declaration that it had not produced a CW spray device and the letter of 10 December 1990, from the Director General of the Muthanna State Establishment (MSE) to the Deputy Director of Military Industrialization Corporation (MIC), which indicates that, by December 1990, Iraq had successfully developed a CW spray-tank.

- Explain the contradiction between Iraq's statement to UNSCOM that, due to a shortage of valves, it could not produce more spray tanks and an internal Iraqi document dated 25 August 1991, which indicates that spare valves were available.

- Provide documents or other evidence that explain what types of spray-devices it may have acquired, had developed or had planned to develop, and for which agents, for the MiG-21 RPV and any other aircraft including any smaller RPV/UAV.

- Explain, with credible evidence, the technical characteristics of, and purposes for the various RPV/UAV platforms that were created and provide the full list of names, Iraqi and foreign, of all organizations, institutions etc., and the persons involved.

- Provide details on imports for the RPV/UAV programme, such as the supply of engines, GPS guidance systems, airframes, etc. and include the full name and address of the foreign suppliers and all intermediary persons, banks, companies, government institutions, etc., both Iraqi and foreign, involved.

- Provide details, with supporting documentation, of the spray device that was developed in parallel to the so-called "Zubaidy device".

- Account for all RPV/UAV aircraft produced or modified from existing aircraft, provide design documentation and all flight records up to the present, including the L-29 aircraft and provide all records of unmanned flight tests.

- Provide details on the control mechanisms for the RPVs/UAVs, the location and function of ground control stations, location of the transmitters and the frequencies used.

VI. VX and its precursors

- Present any remaining bulk VX or VX filled in munitions. Provide credible evidence to support any quantities of VX declared produced, consumed, destroyed or spoiled.

- Provide credible evidence on the quantities of phosphorous trichloride and phosphorous pentasulphide consumed, destroyed or spoiled. Present any remaining quantities of these precursors.

- Provide credible evidence on the quantities of “Iraqi choline” and its immediate precursor diisopropylamine (DIPA) imported, produced, consumed, destroyed or spoiled. Present any remaining quantities of these precursors.

- Provide all documents and other evidence relating to work on VX development, including concepts of use, production records, R&D, scaling up, stabilization, destruction orders and decision to abandon the VX programme.

- Provide credible evidence to support the declared quantities of thionylchloride imported, produced and destroyed.

- Provide documentation or other credible evidence on work to produce indigenous VX precursors.

- Provide credible evidence, such as production logs, to support Iraq’s declaration that there were no more than 2 batches of VX produced from the second half of 1988 up to the beginning of the Gulf War.

- Explain the finding of a VX stabilizer spread over a large area and depth indicative of quantities far in excess of the few grammes of VX stabilizer Iraq declared it had used.

- Explain with supporting credible evidence all research, procurement, use and disposal of VX stabilizers.

- Provide documentary information on all munitions intended to be filled with VX.

- Provide details on the development programme for binary munitions and spray tanks intended for VX.

- Explain, with credible evidence, why the VX it declared produced in 1990 and unilaterally destroyed in 1991, was not recorded in the 1990 MSE storage inventory.

- Explain, with credible evidence, why degradation products of a nerve agent and decontaminant were found on fragments of CBW missile warheads.

VII. Mustard and its precursors

- Present any remaining quantities of Mustard, in bulk or weaponised. Provide credible evidence to support any quantities of Mustard declared produced, consumed, destroyed or spoiled.

- Provide credible evidence of the quantities of phosphorous trichloride, thiodiglycol and chloroethanol consumed, destroyed or spoiled. Present any remaining quantities of these chemicals.

- Provide credible evidence to support the declared quantities of thinoylchloride imported, produced, consumed and destroyed.

- Provide documentation or other credible evidence on research and development and production of Mustard from locally available material.

VIII. Sarin, Cyclosarin and their precursors

- Present any remaining Sarin or Cyclosarin, including unitary and binary filled munitions. Provide credible evidence to support any quantities of Sarin or Cyclosarin declared produced, consumed, destroyed or spoiled.

- Provide credible evidence on the quantities of phosphorous trichloride consumed, destroyed or spoiled. Provide any remaining quantities of the precursor.

- Identify all facilities, in addition to the Muthana State Establishment and Technical Research Centre, involved in production/modification of munitions (artillery shells, rockets, etc.) into true binary weapons.

- Provide a detailed explanation, with credible supporting evidence, of its binary weapons munitions, including design drawings intended for Sarin and Cyclosarin.

- Provide credible evidence to support the declared quantities of thionylchloride imported, produced and destroyed.

IX. Anthrax and its drying

- Present any remaining stocks of anthrax or provide evidence for its destruction.

- Explain, with credible supporting evidence:

    - the finding of anthrax in the equipment at FMDV (Daura),
    - Iraq's declaration that anthrax had not been produced in 1991,
    - the unaccounted for bacterial growth media,
    - Iraq's declaration that bulk agent had never been deployed.

- Provide information with supporting documents – production records – for the quantities of anthrax it produced, in particular, for the years 1989 and 1991.

- Provide documentation or other evidence to support its account of unilateral destruction of Anthrax.

- Provide information on any work to dry anthrax or simulant.

- Provide additional information and supporting documentation on Iraq's efforts to acquire specialized dryers from abroad and indigenous modification and production of dryers.

- Provide the location in Iraq of all spray dryers capable of drying bacteria, including the location of two dryers identical to the one that had been used for drying bacterial insecticide at Al Hakam from 1992 to 1995 .

- Provide additional information and supporting documentation on the drying of bacterial insecticide at Al Hakam from 1992 to 1995.

X. Botulinum toxin

- Present any remaining stocks of botulinum toxin.

- Provide complete records of the entire production of botulinum toxin, in particular, for the period since 1989.

- Provide a detailed declaration, supported by credible evidence, of the types and total numbers of weapons filled with botulinum toxin.

XI. Undeclared Agents, including Smallpox

- Present any stocks of undeclared agents produced, and documentation on the details of such production, including production, location and type and quantity of agents, their testing and disposition.

- Provide a comprehensive account, with credible supporting documentation, of the peptone and tryptone soya broth (TSB) it had declared imported including the purpose for which this media was to be used for.

- Provide, in addition to the 1990 Annual Report supplied to UNSCOM, all other Annual Reports relating to its BW activities.

- Provide a detailed description of any research or production of smallpox after 1972. Also provide a detailed description of vaccinations of civilians and military personnel after 1972.

- Explain, with credible supporting evidence, the fate of the smallpox isolates obtained in 1972.

- Provide documentation, such as logbooks, laboratory notes, etc. relating to the research on camelpox including any work done with recombinant camelpox as well as documents from other levels of the management hierarchy concerning virus research in connection with the BW programme.

XII. Any proscribed activities post 1998

- Present any proscribed chemical or biological agents, precursors or other material acquired or developed since 1998 and not covered under any other task.

- Declare any proscribed or reportable chemical, biological or missile related facilities, equipment, programmes etc. acquired or developed since 1998 and not covered under any other task.

- Present any mobile CBW units and their support facilities.

- Declare any underground facilities with design features suitable to support CBW activities.

- Provide complete supplier information for items Iraq has declared purchased from the "local market". Most of these items have been clearly identified through inspections as foreign made and not processed through the UN export/import mechanism. The information to be provided should include the full names and addresses of the foreign suppliers and all intermediary persons, banks, companies, government institutions, etc., both Iraqi and foreign, involved.

- Provide the employment records, from 1998 to present, of individuals identified by Iraq or UNMOVIC as having been associated with Iraq's proscribed programmes.

Annex 2

Background Documentation to the Key Remaining Disarmament Tasks

(Note: This information has been taken from the UNMOVIC Working Document of 6 March 2003, titled Unresolved Disarmament Issues: Iraq's Proscribed Weapons Programmes")

I. Scud-type missiles and Associated Biological and Chemical Warheads

i) Scud-type missiles

Introduction

In 1974, Iraq started taking delivery of the foreign made Scud-B, a surface-to-surface combat missile with a range up to 300 kilometres, and associated equipment (launchers, ground support equipment). At the beginning of 1987, Iraq started modifying Scud-B missiles to extend their range. After several tests, on 3 August 1987, a test missile achieved a range of approximately 615 kilometres. This modified missile was subsequently designated as Al Hussein. After this success, Iraq decided to reverse-engineer the Scud-B missile. At the beginning of 1988, the director of the Military Industrialization Commission (MIC) tasked a facility designated as Project 1728 to indigenously develop and produce Scud-type engines.

Background

In August 1991, Iraq declared the import of a total of 819 Scud-B combat missiles with a matching number of conventional warheads. It also declared matching quantities for the import of main fuel (818 tonnes) and oxidizer (2895 tonnes) for those missiles. Iraq further declared that it had imported 11 Scud-B missile transporter-erector-launchers (TEL), and had declared the indigenous production of four additional launchers (known as Al Nida) from imported trucks and 50-tonne trailers. These missiles, launchers and propellants constituted the core elements of Iraq's missile force before the Gulf War. UNSCOM was satisfied that 817 out of 819 imported Scud-B missiles had been accounted for. This finding was endorsed by UNSCOM Commissioners in November 1997. However, UNSCOM could not account for approximately 25 imported warheads.

Iraq had declared the unilateral destruction of significant quantities of Scud-B propellants. However, this was not supported by documentation. Iraq did not provide two inventory diaries, known to UNSCOM and requested by it, that had covered the time of the destruction of the proscribed missile propellants. Iraq has maintained its position that it did not have these diaries when UNMOVIC repeated the request in January 2003. In

June 1998, Iraq indicated that, due to the stated limited storage lifetime of the main fuel (7 years) and of the oxidizer (10 years), they would no longer have been usable.

UNSCOM could not confirm the existence of other suppliers of Scud-B combat missiles to Iraq.

Prior to the Gulf war (1988-1990), Iraq had also made extensive efforts to develop its capability to indigenously produce Scud-type missiles. In this respect, Iraq declared that it had been able to indigenously produce a total of 80 combustion chamber/nozzle assemblies, of which 54 to 57 had been rejected due to poor production quality. Iraq had declared the unilateral destruction of the combustion chamber/nozzle assemblies. However, the methods used for this destruction prevented UNSCOM from achieving a full accounting of the 80 assemblies.

Iraq also stated in 1997 that, in April 1990, it had indigenously produced seven “training” engines, which had been delivered to an operational missile unit for training purposes. Iraq stated that these engines had been unilaterally destroyed, along with the imported missiles in July 1991. UNSCOM did not find any remnants of such engines and, therefore, could not verify this declaration. These assertions were repeated in a document provided to UNMOVIC on 8 February 2003.

In February 1998, Iraq declared that, prior to the Gulf war, it had indigenously produced 121 Scud-type warheads. This was discussed during a Technical Evaluation Meeting in 1998 and, although Iraq orally provided information concerning the production of these warheads, it did not support the information with any documentation. UNSCOM could not find remnants for approximately 25 of the declared indigenously produced warheads. UNSCOM was not able to obtain a full picture of Iraq’s warhead production.

In February 1996, Iraq admitted that, before the Gulf War, it had started to construct facilities to produce Scud-B propellants and that construction had continued after the adoption of resolution 687 (1991). However, Iraq stated that the facilities never became operational and were eventually converted to civilian use and submitted for monitoring by UNSCOM until December 1998.

Iraq imported key engine components that it could not indigenously produce. For example, Iraq declared that, between mid-1989 and mid-1990, it had received from a foreign supplier 35 turbo-pumps out of an initial order of 305. According to Iraq, a total of 14 turbo-pumps had been used in testing activities and the remainder had been unilaterally destroyed in July 1991. The extensive methods used for the unilateral destruction prevented UNSCOM from making a full accounting for the declared turbo-pumps. UNSCOM also obtained documentary proof that two turbo-pumps did not arrive in Iraq until six months after the date Iraq declared it had used them in static tests.

Iraq stated that, due to the lack of certain equipment, components and know-how, Project 1728 had not been able to produce a complete engine. However, in 1998, UNSCOM concluded that, by late 1990, Iraq had had the capability to indigenously manufacture,

from indigenously produced and foreign parts, a limited number of Scud-type engines and missiles. It should nevertheless be noted that, in 1998, Iraq was experiencing some difficulties in indigenously producing/assembling an Al Samoud engine, a smaller liquid propulsion engine based on the same technology as that of the Scud-B.

Before the Gulf War, Iraq had the capability to indigenously manufacture warheads, airframes, and certain engine components but had to rely on imports for some key engine components as well as guidance and control (G&C) components. Iraq had attempted to indigenously produce Scud-B type propellants and was able to assemble an indigenous launcher.

UNSCOM found that Iraq had continued to engage in activities after they had become proscribed by the adoption of resolution 687 (1991). For example, Iraq had established working groups as late as November 1993 to work on Scud-B guidance and control systems. Iraq stated that the working groups were able to produce only preliminary production drawings and that they had been disbanded two weeks after having started work.

Following Lieutenant-General Hussein Kamal's defection, the Iraqi authorities handed over to UNSCOM a small number of Scud-B guidance and control equipment and various other parts that had been imported for its pre-Gulf War missile activities.

Iraq stated in early 1996 that, in 1995, a foreign middleman had offered Iraq five disassembled second-hand TELs of a size much larger than the Scud-B TELs. According to Iraq, since it had had no interest in the offer, the proposal had been rejected and the parts had never been delivered.

In 1995, Iraq declared that it had not informed UNSCOM of the work it had carried out at the Al Sadiq factory in 1992/1993 for some 18 months as the work had only been related to non-proscribed missile production. UNSCOM questioned this rationale given that Iraq had declared similar work at another facility.

On 3 March 2003, Iraq provided two documents concerning the material balance for combat warheads and the local production of liquid fuel engines. Earlier, on 25 February 2003, Iraq also offered to provide UNMOVIC with metal fragments, which it had informed UNSCOM were from indigenously produced engines. At that time, it had refused to provide the items to UNSCOM as it had objected to UNSCOM seeking an analysis of the items at laboratories outside of Iraq.

In the material balance for combat warheads document, Iraq indicated its readiness to discuss the details of the unilateral destruction of the warheads in 1991, and offered to conduct a recount. It also suggested that joint excavations be conducted at the unilateral destruction site and at the site where destruction had been carried out under UNSCOM supervision. Iraq also provided the names of eight persons who it states had carried out the transport and destruction of warheads in 1991. The information and other details

provided in the document is reviewed by UNMOVIC. It is not clear whether the activities suggested could help resolve any part of the outstanding issues in this area.

As for the document on local production of liquid fuel engines, it states *inter alia* that Iraq did not reach the stage of producing a combat-level engine until 17 January 1991. The document also provides a list of 46 persons, in addition to the five senior staff that had been named in its 1996 FFCD, who it states were the main scientific and engineering staff in Project 1728.

Assessment

Although UNSCOM reported that all but two of the 819 declared imported Scud-B combat missiles had been "effectively" accounted for, the stated consumption of some missiles could not be independently verified. This was the case for 14 Scud-B missiles as targets in a missile interception project. While such use is supported by some documentation contained in the so-called Scud files, it is questionable whether Iraq would have really used, what were at that time, valuable operational assets in the pursuit of such a project. Furthermore, available data could only corroborate a very small number of declared missile launches at that time. It cannot be excluded that Iraq retained a certain numbers of the missiles. The additional information Iraq provided on 8 February 2003 on the missile interception project does not resolve the outstanding questions.

Iraq's thorough methods of unilateral destruction prevented an assessment of its achievements in the indigenous production of Scud-B engines. Furthermore, the methods used prevented a clear accounting of the "training" engines and some specific key components of the indigenously produced liquid propellant engine. The lack of evidence to support Iraq's declarations on its destruction of these indigenously produced "training" engines, as well as on the key engine components, such as turbo-pumps, raises the question whether they were all destroyed as declared. Iraq could, in fact, have produced a small number of Scud-type liquid propellant engines from both imported turbo-pumps and locally produced engine components.

Moreover, the lack of documentation to support the destruction of a significant amount of Scud-B liquid propellant, and the fact that approximately 50 warheads were not accounted for among the remnants of unilateral destruction, suggest that these items may have been retained for a proscribed missile force. After investigating Iraq's statement that, due to the limited storage lifetime, the propellants would now be useless, UNMOVIC has assessed that the propellants would in fact still be usable and would therefore need to be verified as destroyed.

Questions also arise with respect to activities related to proscribed guidance and control systems that Iraq had conducted from 1992 to 1995. It is difficult to accept Iraq's statement that they were for non-proscribed missiles. Of particular concern are the guidance and control working groups that Iraq says had been established for a very short period of time in November 1993. The concern is that Iraq may have been conducting reverse engineering of proscribed guidance and control systems as part of its missile

activities even after the adoption of resolutions 687 (1991) and 715 (1991). Furthermore, it cannot be excluded that Iraq has retained such guidance and control equipment.

Another indication of possible proscribed activity is the offer that Iraq said it received from a middleman for five disassembled TELs. Some parts were already shipped to an adjacent country. Although Iraq said that it had rejected the offer, no evidence has been provided in support. These parts might have allowed the assembly of one or two TELs, which would have been another piece for a reconstituted Scud-type missile force. In this connection, Iraq has, so far, been unable to locate a 50-tonne trailer that it declared it had imported for the indigenous production of the Al Nida mobile launcher and which it claims had been stolen. Iraq also did not provide UNSCOM with the parts of an imported Scud TEL, which it states it had disassembled.

The 2002 CAFCD and its supporting documents, semi annual declarations, and the material submitted to UNMOVIC on 8 February 2003 provide no significant new information relevant to the aforementioned issues.

ii). Scud-type Biological and Chemical Warheads

Introduction
Iraq produced warheads for Scud-type missiles. These warheads were designed for the delivery of chemical and biological agents, and are referred to throughout this paper as "special warhead."

The special warhead was designed to accommodate a canister made of either aluminum or stainless steel and capable of holding approximately 150 litres of agent. UNSCOM found in almost all cases that Iraq's biological warheads had stainless steel canisters and chemical warheads had aluminum canisters. The payload of the special warhead was less than that of the original high explosive warhead. To compensate for the lesser weight and consequent change in the centre of gravity of the missile, lead ballast was added to the nose cone of the special warhead.

To produce these special warheads, Iraq both modified original Scud warheads and indigenously manufactured warheads using some imported components, for example structural rings, which it purchased from a foreign supplier.

Background
In 1991, Iraq declared that it had possessed 30 Scud-type chemical warheads. UNSCOM confirmed that these warheads had been used for chemical agent. Iraq destroyed 29 of these warheads under UNSCOM supervision. One warhead was removed from Iraq by UNSCOM for analysis.

In 1992, Iraq declared an additional 45 Scud-type chemical warheads, which it stated had been unilaterally destroyed in the summer of 1991. Later, Iraq declared that some of these had actually been biological warheads. By 1998, UNSCOM managed to verify the

destruction of 43 to 45 of these warheads from remnants, but not before Iraq's declarations had changed many times. In addition, Iraq admitted to UNSCOM that it had added warhead nose cones to a declared warhead destruction site inspected by UNSCOM in an attempt to convince UNSCOM that all declared warheads could be accounted for. Some aspects of the filling and destruction processes remained unverified.

Immediately after the defection in August 1995 of Lieutenant-General Hussein Kamal, Director of the Military Industrialization Corporation (MIC), General Ra'ad, Director General of Project 144 (Iraq's former prime missile facility), stated "*initially there was an order for 75 containers, later another 25 were ordered. The order was fulfilled and sent to Al-Muthanna"*. [Muthanna was only filling special warheads with agents and later in the same statement Ra'ad describes how the warheads were filled at Al Muthanna]. However, on 29 and 30 September 1995, Lieutenant-General Amer Al Sa'adi, then Acting Director of MIC, stated that the total number of special warheads was 75 (25 biological and 50 chemical). Later, during a high level meeting in April 1997, Lieutenant-General Amer Al Sa'adi stated that it had been wrongly reported to UNSCOM that there had been 75 chemical plus 25 biological warheads produced.

The numbers resulting from Iraq's latest statements on the subject were 50 chemical warheads and 25 biological warheads.

Iraq purchased Scud missiles with conventional (high explosive) warheads. Iraq used several missiles in testing that did not require the use of a warhead. UNSCOM did not find any indigenously produced warheads that had been filled with high explosive, but did find some that had been filled with agent. The foregoing suggests that all of Iraq's indigenously produced warheads had been intended for special purposes.

In 2003, Iraq declared that it was able to produce Scud-type warheads, including the U-ring from raw material. However, because the material specification of the raw material was not appropriate and because it took a long time to manufacture, Iraq stated that it chose to import the U-rings, which it did in 2 groups. One group of U-rings was ready-to-use and one group required final machining. Iraq also declared that the structural rings for the Scud airframe were imported in the same 2 groups and that the group requiring final machining was interchangeable between the airframe and the warhead. Hence, for UNMOVIC to thoroughly account for warhead U-rings that were imported in the condition requiring final machining, an accounting would have to be made of all such airframe and warhead rings. During recent inspections it was noted that several thousand of these rings were in Iraq's possession in 1998 and that approximately half were used in the Al Samoud 2 programme during the absence of inspections. Therefore, an accurate and verifiable accounting of the rings imported in the condition requiring final machining is no longer possible.

After convening a Technical Evaluation Meeting, UNSCOM assessed that Iraq's declaration that 15 biological warheads had been destroyed simultaneously at a location in Nibai known as P3 conflicted with physical evidence collected at the site. This finding indicated that not all these warheads had been destroyed at the same time as declared by

Iraq. This suggests that some special warheads were retained for a period and, if so, it would be logical to assume that some missiles and associated propellant might also have been retained.

UNSCOM's investigations showed that Iraq had not provided the true locations where, prior to the declared unilateral destruction, the above-mentioned 15 biological warheads had been hidden. In December 1998, Iraq pointed to new locations where it stated the special warheads had been hidden before being moved to the site where they were unilaterally destroyed. UNSCOM inspected these new locations but did not have time to complete the discussions with Iraq on this matter. The location of the warheads prior to destruction is significant since the time of their departure from the hide site should agree with the time of their arrival at the destruction site. Previous declarations of this kind have been verified or refuted using high-altitude imagery.

It was observed by UNSCOM that only chemical warheads were found during the period before Iraq's admission in 1995 that it had had an offensive biological weapons programme. This may suggest that Iraq destroyed the biological warheads only after it had declared the weaponization of biological agents, which would raise concerns over the possible retention of missiles as well during that period. In July 1998, Minister Amer Rashid promised UNSCOM that he would investigate how this could have occurred but failed to produce any findings before UNSCOM's departure in December 1998.

In April 1998, UNSCOM took samples from the excavated remnants of the special warheads. Chemical analysis revealed traces of degradation products related to nerve agents. Of the warheads sampled, Iraq had consistently maintained that those were filled with alcohol. (This is further discussed in the VX cluster).

Assessment

Although UNSCOM verified the destruction of 73 to 75 of the 75 special warheads that Iraq declared, a number of discrepancies and questions remain, which raise doubts about the accounting of the special warheads, including the total number produced: statements by some senior Iraqi officials that Iraq had possessed 75 chemical and 25 biological Scud-type warheads; the finding that, at a minimum, 16 to 30 structural rings remain unaccounted for; Iraq's numerous changes to its declarations on these matters; Iraq's admitted action taken to mislead UNSCOM on the location and number of special warheads; the physical evidence which conflicts with Iraq's account of its destruction of biological warheads; and the fact that no remnants of biological warheads were found by UNSCOM until after Iraq's admission in 1995 that it had had an offensive biological weapons programme.

As a consequence of the accounting questions above, uncertainty remains concerning the types and numbers of chemical and biological agents it filled into the special warheads. The finding of degradation products related to nerve agents, on some warhead remnants suggests that its declaration may not be complete.

Iraq has declared that it only ever produced warheads using rings that were imported in the read-to-use condition and so suggests this as the means of accounting. If the original production records of the indigenously produced warheads were provided to UNMOVIC and were found to support this declaration, such an accounting method could be acceptable.

Some doubts exist regarding Iraq's assertion that it could not do the final machining required for the semi-finished structural rings. This has been reinforced by General Sa'adi's statement, in July 2002 to UNMOVIC, that the manufacture of such rings was easy. In 2003, Iraq explained that prototype warheads rings had been indigenously produced prior to the Gulf War. Although they were produced from the incorrect grade of material, they were found acceptable. However, Iraq did not pursue production due to the lack of appropriate material and the fact that it was a time consuming process.

II. SA-2 Missile Technology

Introduction

The SA-2 (also known as Volga) is a medium range two-stage surface-to-air missile with a solid propellant booster and a liquid propellant engine for the upper stage. Iraq first acquired SA-2 missile systems from a foreign supplier in the early 1970s. The SA-2 was designed to intercept aircraft, cruise missiles and other aerial targets at medium altitudes. Iraq's military industry carried out several projects that involved the modification or reverse engineering of SA-2 missiles to achieve longer ranges - up to or beyond 150 kilometres - in a surface-to-surface mode.

Background

In July 1991, Iraq declared that, from June 1988 to July 1989, two missile projects, Fahad 300 and Fahad 500, had been working on the modification of the SA-2 missiles into surface-to-surface missiles with ranges of 300 and 500 kilometres respectively. Iraq stated that the Fahad 300 was tested but the project was abandoned due to the missile's lack of accuracy. Work did not proceed with the Fahad 500 project. UNSCOM supervised the destruction of nine Fahad 300 missiles in 1991. UNSCOM could neither verify Iraq's declarations regarding missiles consumed in testing, nor the number of SA-2 missiles modified. It is therefore not possible to exclude that some of these converted missiles may still remain in Iraq.

Between 1991 and 1993, Iraq also worked on a project to develop a surface-to-surface missile originally called "G-1" and concealed this activity from UNSCOM until after the defection of Lieutenant-General Hussein Kamal in 1995. Subsequently, in its 1996 FFCD, Iraq described a previously undeclared project within a wider missile programme. Experiments were conducted using certain major parts from the SA-2 missile. Iraq declared that the missile was not intended to reach proscribed ranges and that it did not exceed such ranges when fitted with a 450 kg warhead and a reduced fuel load. UNSCOM was unable to verify the declared range achieved by this missile. However, it assessed that the system was inherently capable of reaching proscribed ranges.

The "G-1" project was also linked with the so-called "Al Rafidain" project, which sought to reverse engineer and indigenously produce an SA-2 missile. In addition to the different role of the missiles, Iraq declared that they differed in the volume and number of fuel tanks. After the "G-1" project was said to have been cancelled in 1993, work continued within the Ababil programme to produce another design for a ground-to-ground missile based on SA-2 technology, which later was renamed as Al Samoud.

According to Iraq, from the beginning of 1992 until October 1993, the team of engineers that had worked previously on the reverse engineering of the "Scud" missile was tasked to work at Al Sadiq engineering facility on the indigenous manufacture of liquid propellant engines based on the SA-2 design. In January 1994, Al Sadiq facility merged with Al-Karama Establishment. The production of various parts was distributed among several establishments of the Military Industrialization Commission (MIC). With a view to producing five engines, several components were manufactured. However, Iraq

declared, no complete engines were produced. In order to conceal this activity from UNSCOM, drawing designator numbers were changed to refer to helicopter parts. Iraq later declared, in its 1996 FFCD, that Al Sadiq was charged with the production of liquid propellant engines for the "Ababil 100" project.

In the context of its nuclear inspections, an IAEA inspection team was taken to Al Sadiq by Iraq in November 1993. All the equipment remaining there at that time was recorded. On the IAEA's recommendation, UNSCOM subsequently inspected the facility and found no evidence of any production having occurred at the facility after November 1993. Dual-use equipment from Al Sadiq facility was gradually transferred to declared sites. However, the work that had been undertaken at Al Sadiq prior to the IAEA inspection was not declared to UNSCOM until 1995. Some of the components produced were declared to have been destroyed unilaterally. Little documentary evidence exists to support Iraq's declarations regarding the nature of missile engine production activities at this facility.

After discovery of Iraq's efforts to develop ballistic missile systems based on the modification of the SA-2, UNSCOM became concerned about the potential use of the technology incorporated in this system and decided to include the SA-2 in its monitoring activities in 1996.

After resumption of the inspection regime based on resolution 1441 (2002), Iraq declared that the design configuration for the Al Samoud was modified to increase the diameter of the airframe from 500 millimetres to 760 millimetres. The modified missile was referred to as Al Samoud 2. Iraq conducted 23 flight tests of the Al Samoud 2, 13 of which reached ranges greater than 150 kilometres, the maximum being 183 kilometres. Iraq declared the production of 76 Al Samoud 2 missiles, 118 warheads and 9 Al Samoud launchers. During an inspection, an Iraqi engineer stated that the 500 millimetres configuration was no longer being produced and explained that the larger missile provided a better length/diameter ratio, which increased the stability of the missile.

During the period 2000-2002, nine static tests were carried out using another fuel, AZ-11, that contained up to 11% of Unsymmetrical Dimethyl Hydrazine (UDMH), in an effort to achieve increased performance. Iraq stated that these tests had failed and the project cancelled.

An Iraqi engineer stated that Iraq was now indigenously producing the Volga engine turbopump starter, the oxidizer and fuel shut-off valves, the oxidizer and fuel start valves and the regulator valve (partially).

Also related to the Al Samoud question is a number of Volga engines imported outside of the export/import mechanism and in contravention of paragraph 24 of resolution 687 (1991) over the past few years. In its 2002 CAFCD, Iraq has declared that it had imported 131 Volga engines; however, during an inspection, UNMOVIC found 231 Volga engines that were stored at a missile facility responsible for the production of the Al Samoud/Al Samoud 2. Iraq provided copies of the contracts, which accounted for 234 engines, and

which clearly show that the equipment was smuggled into Iraq, via a neighboring country. Iraq further informed an inspection team of the arrival of 149 Volga engines at Al Samoud Factory, which would raise the total imported engines to about 380.

At the same time, Iraq declared that it had dismantled a certain number of Volga missiles, some of which were used in the production of the Al Samoud/Al Samoud 2.

During an inspection, an Iraqi engineer stated that a total of 567 Volga engines were obtained both from an outside source and through the scavenging of Volga missile sustainer engines for conversion into engines for the Al Samoud/Al Samoud 2.

Iraq has also declared the development of a telemetry station for the Al Samoud 2, which, as of February 2003, has not been verified by UNMOVIC.

Assessment

Iraq has not declared any existing liquid propellant ballistic missile development except for the Al Samoud 2, nor has it declared any new information about "G-1", Fahad 300/500, "Rafidain" project and the work at Al Sadiq engineering facility. It is therefore not possible for UNMOVIC to fully understand and to verify Iraq's declarations on its earlier missile development projects based on the SA-2 missile. Of particular concern is the limited amount of documentary evidence concerning the activities at Al Sadiq. Questions arise as to why this work was not declared to UNSCOM, like similar work on missile development conducted at other facilities. It is also not possible to fully understand the relationships between the different SA-2 based projects. However, based on the knowledge UNMOVIC presently has on these projects, they can be considered as initial steps towards the development of an indigenous liquid propellant engine capability.

Iraq's statement that it abandoned the Fahad 300/500 projects appears to be credible, first, because of the missile's lack of accuracy and thus low value as a military weapon and, second, because of the apparently successful development of the later Al Samoud missile. However, little documentary evidence has been presented to confirm the claimed destruction of all remaining Fahad missiles. Accordingly, it cannot be excluded that some Fahad 300 missiles still remain in Iraq. Moreover, Iraq would have had little difficulty in converting additional SA-2 missiles into Fahad 300s if it so desired.

As to the "G-1" Project, it is not possible to verify Iraq's declarations on the work it conducted under the project. As assessed by UNSCOM, the missile, in the configuration declared by Iraq, was capable of reaching a proscribed range. By Iraq's own admission, the smaller indigenously produced fuel tanks, which were intended to limit the range, were never installed in the missile. If the smaller tanks had been used, a reduction in the mass of the warhead would still have enabled the missile to reach a proscribed range.

Among the projects relevant to SA-2 missile technology mentioned above, the most significant missile development appears to be the Al Samoud 2. The modification on the missile, which was declared to have started in June 2001, was made despite a 1994 letter

from the Executive Chairman of UNSCOM directing Iraq to limit the diameter of the liquid propulsion missile to less than 600 millimetres. Furthermore, a November 1997 letter from the Executive Chairman of UNSCOM to Iraq prohibited the use of engines from Volga/SA-2 surface-to-air missiles for the use in ballistic missiles.

Amongst recent developments is the Al Samoud 2 (liquid propellant) missile system. It has been tested to a range of greater than that permitted under resolution 687 (1991) with the Al Samoud 2 tested to a maximum range of 183 kilometres. UNMOVIC convened a panel of international missile experts in February 2003, to consider this missile system. The experts concluded that the Al Samoud 2, as deployed, is capable of a range greater than 150 kilometres and UNMOVIC has therefore informed Iraq that the missile is proscribed and must be destroyed. Iraq started the destruction of these missiles on 1 March 2003 and is likely to finish by the end of the month.

Although these missile systems have been indigenously developed, they rely heavily on imported technology. The Al Samoud 2, for example, uses engines from an anti-aircraft missile. Iraq has declared that approximately 380 such engines have been imported for this purpose. Engines from cannibalized anti-aircraft missiles already in-country have also been used. All such engines found to be associated with the Al Samoud 2 programme will be destroyed under UNMOVIC supervision.

Iraq further declared the development of a liquid propulsion engine, the Kandoosh, using a combination of liquid oxygen/ethanol. Other new projects include a spin motor for the Al Fatah (previously known as the Ababil 100, solid propellant), GPS guided HY-2 and AM 39 Exocet missiles and replacement of the guidance section for several surface-to-air missiles. Iraq also declared two new remote piloted vehicle (RPV) known as Musaryara 20 and 30 with a declared range of 100 kilometres. Iraq stated, in its December 2002 declaration, that the activities related to the development of the L-29 jet training RPV (the Al Baia'a) were discontinued due to lack of imported equipment. These declarations need to be verified.

Other missile systems with ranges in excess of 150 kilometres may possibly be under development or planned. Indications of this come from solid propellant casting chambers Iraq has acquired through indigenous production or from the repair of old chambers. The size of these chambers would enable the manufacture of a missile system with a range much greater than 150 kilometres. In February 2003, after advice from the panel of experts previously mentioned, UNMOVIC determined that these chambers were proscribed. It supervised the destruction of the chambers in March 2003. As a result, Iraq's capability to produce large solid fuel rocket motors has been diminished.

Iraq has also upgraded its solid propellant test stand at Al Mutasim, enabling it to test higher thrust missiles. At Al Rafah, a liquid propellant missile test stand is under construction, which has been assessed to be capable of testing liquid propellant engines with thrusts greater than that of the SA-2 engine. Furthermore, Iraq has declared that it has resumed research on UDMH, a highly energetic fuel that could be used for proscribed or non-proscribed missile systems.

III. Research and development (R&D) on missiles capable of proscribed ranges

Introduction

Before the Gulf War, Iraq was engaged in developing a medium-range ballistic missile (MRBM) with a range of between 1,000 to 3,000 kilometres, as well as what it referred to as a "Space Launch Vehicle" (SLV). This work included flight simulation analyses, the development of concepts and related technologies for missile staging, separation and clustering mechanisms for missiles and a missile engine that used Unsymmetrical Dimethyl Hydrazine (UDMH) fuel, which is more powerful than that used in the Scud-B missile. Iraq had also acquired foreign technical support in developing MRBMs and SLVs.

After the Gulf War, by Iraq's own admission and from information obtained by UNSCOM, Iraq had conducted proscribed R&D after 1991 on clustering missile engines and on multistage missiles, some of which were based on work that had been conducted before the Gulf War.

Background

Iraq was engaged in various ballistic missile programmes from the mid-1980's onwards.

One programme was the Scud-based three-stage missile referred to by Iraq as "Al Abid SLV." The first test launch of Al Abid SLV, which used five Scud engines strapped together as the first stage, was conducted on 5 December 1989. In seeking to further develop Al Abid, Iraq stated in January 1997 that it had sought assistance from a foreign expert in designing a turbo-pump capable of simultaneously feeding four clustered Scud-type engines for the first stage of the SLV and that the expert had completed 85 percent of the turbo-pump design during June and July 1990. At the same time, Iraq declared that Project 1728, which was involved with the manufacture of Scud-type liquid propellant engines, had been instructed to design, or acquire the design, for a new 30-tonne thrust liquid propellant engine using UDMH as fuel. The same foreign expert who designed the turbo-pump was engaged for this purpose during the period May to July 1990. He completed 95 percent of the preliminary design of the engine. UNSCOM's analysis of the known design characteristics confirmed that the engine was designed for the second stage of Al Abid SLV.

With respect to UDMH fuel, Iraq declared in its 1996 missile FFCD and repeated in the 2002 CAFCD that, in 1989, it had signed a contract for the import of 10 tonnes of this fuel for use in ballistic missiles that it might develop. In January 1990, Iraq conducted a static test of a Scud engine using the imported UDMH fuel. According to Iraq, the test was unsuccessful and the remaining UDMH fuel was kept in storage. The UDMH fuel was stated by Iraq to have been unilaterally destroyed by explosion in 1992 as no real use for it could be found in the civilian sector.

While UNSCOM had independently acquired knowledge and information about Iraq's activities concerning the turbo-pump, the 30-tonne thrust engine and the static test of a

Scud engine using UDMH fuel, Iraq's acknowledgement of these activities took place only in September 1995, i.e. after the defection of Lieutenant-General Hussein Kamal.

In 1994, UNSCOM found evidence suggesting that Iraq had also been developing and testing warhead separation mechanisms for the Scud-based Al Hussein/Al Abbas missiles in 1989/1990. After the defection of Lieutenant-General Hussein Kamal, Iraq acknowledged that at the same time it had conducted these tests, it had also contacted a number of foreign companies for the supply of approximately 100 sets of a supersonic parachute system that could be used to reduce the speed of a separated warhead. Iraq provided more than one explanation for the purpose of the parachute system, e.g. that it was needed to help solve missile instability problems and that it was intended to be part of a system for taking pictures of outer space. According to Iraq, it received only one parachute system, which was delivered in October 1989. Iraq further stated that the parachute system had not been used and had been kept in storage until late 1995, when it was given to UNSCOM. UNSCOM could not verify whether only one parachute system had been delivered to Iraq.

In December 1995, Iraqi engineers informed UNSCOM that, in 1993, Lieutenant-General Hussein Kamal had also ordered them to design a turbo-pump capable of simultaneously feeding four clustered Al Samoud engines. They stated that the objective was to provide a set of drawings so as to enable the production of the turbo-pump when required. They further stated that, in 1993, Lieutenant-General Hussein Kamal had also ordered the design of a 7-tonne liquid propellant engine, but that no calculations or designs had been made and that the project had never been seriously pursued.

In January 1997, UNSCOM discovered computer diskettes containing computer files with a missile flight simulation programme. The files contained evidence that, in July 1992, a flight simulation of a three-stage missile based on Scud-type missiles had been carried out. The simulated missile was of a different configuration than that of Al Abid SLV. UNSCOM concluded that the diskettes had been part of a larger collection of computer diskettes the existence of which had not been disclosed by Iraq. UNSCOM also discovered that, from the end of 1994 to February 1995, Iraq had calculated the trajectories for six different scenarios of multistage SLVs using SA-2 engine parameters. The calculations showed that the ranges of the simulated SLVs could have been much greater than 150 kilometres.

After resumption of the inspection regime based on resolution 1441 (2002), UNMOVIC inspected a new larger liquid propellant test stand being constructed in Al Rafah. Iraq has explained that this new test stand was for both horizontal and vertical testing of the Al Samoud engine.

In its January 2003 semi-annual declaration, Iraq stated that it had resumed R&D on the preparation of UDMH at the Ibn Sina General Company and Al Basil State Company.

Assessment

Concerning the R&D activities before December 1998 it is assessed that the SA-2 based SLVs Iraq studied during 1994-1995 were not viable. All of the different scenarios calculated by Iraq used nine SA-2 engines strapped together for the first stage, which is not technically or militarily feasible. The Scud-based three-stage SLV that Iraq had simulated in 1992 was based on a more technically rational design than the SA-2 based SLVs. Iraq did not, however, seem to have sufficient knowledge of the guidance and control (G&C) component of cluster and multistage missiles, nor did it have any known engine test facilities capable of testing second and upper stage missile engines in a vacuum, or in an assumed vacuum. In this context, Iraq could not have been able to produce missile systems only on the basis of such theoretical designs and computer simulations.

What is of concern is the apparent intent behind such activities and, in particular, the conscious decision to act in contravention of resolution 687 (1991) and to conceal these activities from UNSCOM. The results of the R&D arising from these activities could provide a suitable foundation from which Iraq could design less ambitious and less complex proscribed missile systems that would be within its technical and resource capabilities.

IV. Munitions for Chemical and Biological Agent Fill

i) R-400 and R-400A Bombs

Introduction

Prior to 1988, Iraq designed and produced all of its aerial munitions designated for CW use for high altitude delivery. In 1990, however, the R-400 type bombs were indigenously produced especially for low altitude CBW delivery. The bomb has a 90 litre capacity with a steel body, longitudinal burster tube, nose fuse and tail fin assembly with a retarding parachute mechanism. The R-400 type bombs were intended for external carriage on fighter or attack aircraft.

Background

According to Iraq's 1996 CW FFCD and 2002 CAFCD, the Military Industrial Commission (MIC) and the Air Force selected an imported conventional 400 kilogram aerial bomb, which Iraq referred to as the BRIP-400, as a model for the CBW bomb. The Iraqi Air Force was familiar with the BRIP-400, which it had in stock and had tested with airburst and impact fuses.

The CW bomb designed and produced by Iraq consisted of the imported tail section of the BRIP-400 attached to a locally manufactured body, base plate and nose section which included a burster tube. Iraq eventually designated this new bomb as R-400. Iraq declared that MIC had ordered Al Nasr State Establishment (NSE) to produce 1,000 bodies and nose and base sections for CW purposes. The Air Force supplied the tail assemblies and fuses from its stocks. According to Iraq's CW declarations, the prototypes of the R-400 aerial bombs were produced in April 1990. The R-400 bomb was the first, and according to Iraq's declarations the only, special aerial bomb that met the new Air Force requirements for the deployment of special munitions from low altitudes that allowed the aircraft to operate in areas protected by a modern air defence system.

Iraq stated that, in August 1990, NSE was ordered to produce an additional 200 R-400 bodies for BW use: each body was to have an internal epoxy coating and a black stripe painted on the outer casing to differentiate it from the previous CW-related order. These bombs were designated as R-400A. Iraq stated, however, that because of the lengthy process required for application of the internal coating, 25 R-400 bombs designated for aflatoxin fill had no internal coating and no black stripe.

During the period 1992-1998, Iraq changed its declarations on the quantity of bombs it had produced several times. For example, in 1992, Iraq declared in its FFCD that it had produced a total of 1200 R-400 bombs. With the admission of the offensive BW programme in 1995, this number was subsequently changed to a total of 1,550. Given the lack of specific information from Iraq, UNSCOM could not calculate the total number of R-400 bombs that Iraq had produced for its BW/CW programmes.

With respect to its CW programme, Iraq declared in its 1996 CW FFCD and also in its 2002 CAFCD that, in total, 1,024 bombs had been filled with an alcohol at the Muthanna

State Establishment (MSE). Iraq stated that it had planned to use the alcohol in the bombs as a component of binary Sarin, with the other major component added just prior to use. However, documentary evidence showed that another 165 unfilled bombs and 35 possibly unitary Sarin/Cyclosarin bombs had been produced but remained outside the scope of the initial order. Iraq stated that the R-400 bombs were transferred to various air bases during the period July to August 1990.

For its BW programme, Iraq stated in 1995 that, during December 1990, 200 tail assemblies were sent to Al Hakam to be integrated with the body. According to Iraq, it had filled 157 BW bombs and the completed bombs were marked at Al Hakam with the Arabic letters equivalent to A (for botulinum toxin), B (anthrax) and C (aflatoxin) to designate agent content. Iraq declared that, in January 1991, R-400A BW bombs were equally divided and sent to Airstrip 37 and Al Azzizziyah firing range and stored there until July 1991.

Iraq stated that coalition bombing destroyed some of its CW R-400 bombs. The remaining R-400 and its BW R-400A bombs were said to have been either unilaterally destroyed in 1991 by burning and explosion or destroyed under UNSCOM supervision. In addition, Iraq declared that rejected and surplus bombs were melted down at NSE. In total, at least 300 to 350 R-400 and R-400A bombs remained unaccounted for by UNSCOM. Lieutenant General Sa'adi, counselor to the Presidency, informed UNSCOM that documentation on the inventory (a list of bombs with agent fill and serial numbers) of R-400 and R-400A bombs had also been destroyed.

UNSCOM found that the accounting for some of the unilaterally destroyed bombs was not possible given the hazardous conditions created by the method of destruction. In addition, Iraq has produced no documentation that could have substantiated its statements that the surplus and rejected R-400 bombs had been melted at NSE. The one document submitted as evidence of the meltdown did not specifically refer to R-400s. In addition, photographic evidence shows that biological R-400A bombs had been located at Al Walid Air base in October 1991, which is not consistent with Iraq's FFCD and CAFCD.

Through sampling of excavated bombs at Al Azzizziyah in 1997, UNSCOM found botulinum toxin in an R-400 bomb. Iraq had never declared that it had filled R-400 bombs with this agent. Sampling of R-400 chemical bombs did confirm the presence of the alcohol component for binary Sarin/Cyclosarin.

Assessment

During the period 1992-1998, Iraq changed its declaration on the quantity of bombs it had produced from 1,200 to 1,550. Over the same period, Iraq changed its declaration as to the types of CBW agent fill, leaving UNMOVIC with little confidence in either the numbers produced or types of agent filled. It is not clear from Iraqi statements and documentation how many R-400 bombs had been ordered for CW purposes and the fill between unitary weapons and binary components. Although Iraq has stated that it ordered the production of 200 R-400A bombs, this may not have been the only order.

In addition, photographic evidence shows that R-400A bombs had been located at Al Walid Airbase in October 1991. This contradicts the declaration by Iraq that R-400A bombs had only been deployed to Al Azzizziyah and Airfield 37 and that all such bombs had been destroyed in July or August 1991.

UNMOVIC does not have a complete understanding of the coding system for the R-400 bombs. Iraq's explanation that this was in some way random or based on materials available is not credible. The classification and marking of the R-400s, which indicated the agent fill, should have been fundamental to their deployment and use.

By its design and technical parameters, the R-400 bombs could be quite suitable as a delivery means for some chemical warfare agents, but less so for the proper aerosolization of biological agents. With an impact fuse, the R-400 could have been effective for delivering a Sarin weapon; fitted with an air burst fuse it could have been suitable for delivering persistent agents, such as VX and Mustard. With respect to biological agents, the relatively large volume of liquid agent together with the small burster tube and thick bomb walls means that much of the agent would not be dispersed as respirable particles but as relatively large droplets. However, any use of biological weapons by Iraq, regardless of their technical efficiencies, could have a significant political and psychological impact.

Al Azzizziyah firing range was declared as the destruction area for all of the filled biological R-400 bombs and was excavated under the supervision of UNSCOM in 1997. UNSCOM identified three intact bombs and fragments of about another 20 R-400 bombs. Excavation was stopped because of the risk of unexploded ordnance in the area. In February 2003, Iraq notified UNMOVIC that it had recommenced excavation of R-400 bomb fragments at Al Azzizziyah firing range. As at 03 March 2003, Iraq had recovered eight complete bombs, 94 base plates and over 250 bomb fragments from a number of excavation sites at the range. Analysis of samples taken from the intact bombs as well as from the bomb fragments cannot confirm the content of the bombs although further analysis continues. Some fragments had a black stripe and there was evidence on some fragments of an epoxy coating, both indicative of biological agent-filled bomb.

It should be noted that, given the uncertainties surrounding R-400 production and the fact that the base plates from R-400A bombs are indistinguishable from R-400 bombs (and may be exactly the same as the BRIP-400) it is unlikely that the results from the excavation will enable this issue to be resolved.

As it has proved impossible to verify the production and destruction details of R-400 bombs, UNMOVIC cannot discount the possibility that some CW and BW filled R-400 bombs remain in Iraq.

It is known that Iraq already possesses the technical knowledge and infrastructure for producing R-400 type bombs, and could easily construct bomb bodies from existing resources. Any moulds that may have been destroyed could have been reconstituted, photographic analysis of the tail assemblies supports the conclusion that Iraq used only

one type of tail assembly and parachute system for the new bomb and Iraq probably has a number of tail assemblies from existing stocks of conventional bombs available for use.

ii). Major Aerial Bombs

Introduction
Bombs dropped from aircraft can be used to disseminate large quantities of chemical or biological agents. They are typically compatible with either impact or airburst fuzing (proximity or time delay) and can be configured as either bulk (single mass of agent) or cluster (multiple sub-munitions) munitions. Although bombs are an efficient means to disseminate most chemical agents, bulk bombs are an inefficient means to disseminate biological agents. Bombs are also compatible with the production of certain chemical agents in-flight via the reaction of binary components, i.e., binary bombs.

Chemical and biological bombs are typically configured to disseminate their agent fill via explosive aerosolization. Alternatively, chemical bombs can rely on a frangible body and the forces of impact to scatter their agent fill. Lastly, bombs can be configured to rapidly release their contents during flight.

Background
Iraq produced or procured a number of bomb types capable of being filled with chemical or biological agents. These included the various imported and domestically produced napalm bombs, bombs intended for use with white phosphorus or similar smoke producing compounds and other conventional bombs that can be configured in a way that permits the insertion of a burster tube. Representative examples include the LD-250, BR-250, AALD-500, BR-500, R-400, Qaa Qaa-500 and the SDN-750. These are all fundamentally similar in that they all incorporate steel bodies, longitudinal bursters, and tail fins. They differ in size, dimensions and exact shape. Some of these bombs were imported and some were domestically assembled. All of the bombs (in this class) were meant for external carriage on fighter/attack aircraft.

Iraq also produced the DB series of aluminum bombs, including the DB-0, DB-1 and DB-2. There is some uncertainty regarding the configuration of the DB-0 and DB-1 bombs. Although designed for use with an incendiary material such as napalm, these bombs were either tested or intended (DB-2) for use with toxic agents.

Aerial chemical bombs constituted a major part of Iraq's arsenal of chemical munitions with approximately two-thirds of all weaponized agent being loaded into six types of bombs. Between 1983 and 1990, Iraq produced or procured over 30,000 aerial bombs for use with chemical or biological agents.

Iraq provided some documentary evidence to support its declarations (the 1996 FFCD and the 2002 CAFCD) concerning the procurement, production, filling and consumption of these bombs. However, these declarations are, in part, contradicted by an Air Force document detailing consumption of chemical bombs during the Iran-Iraq war.

UNSCOM accounted for, and supervised the destruction by Iraq of, more than 2,000 filled and some 10,000 empty bombs. UNSCOM also supervised the destruction by Iraq of some 100 pieces of equipment and machinery constituting the aerial bomb production plant, including rolling and welding machines, mechanical presses, moulds, etc. However, due to the absence of credible evidence, UNSCOM was not able to fully verify Iraq's declared unilateral destruction of some 2,000 empty bombs and some 450 mustard bombs destroyed as declared by Iraq in a fire accident.

Assessment
Due to the lack of complete and verifiable information regarding import, production and consumption, UNMOVIC cannot verify Iraq's declarations regarding aerial bombs.

The "Air Force document" recently received by UNMOVIC introduces additional uncertainty in accounting as it indicates that 6,526 fewer aerial CW bombs (of gauges 250, 500 and DB-2 types) had been "consumed" during the Iraq Iran War. Iraq has explained that the "Air Force" document, which had been complied by one of its officers in 1995, was incomplete. According to Iraq, data on consumption of CW filled munitions positioned at three airbases was not included as the airbases had been occupied in 1991 and the records destroyed. This explanation is being reviewed by UNMOVIC.

Iraq's declarations of its biological test results with bombs were inconsistent with its declared programme actions that followed these tests.

Iraq's use of a variety of aerial bombs for BW and CW purposes is important because it demonstrates the following abilities: conversion of indigenously produced conventional bombs for chemical use (e.g. Qaa Qaa-500), procurement of foreign munitions intended for use with smoke compounds and instead loading them with either chemical or biological agents (e.g. BR-250, LD-250, AALD-500 and BR-500), adapting foreign munition designs for use with prohibited agents (DB-0, DB-1, DB-2 and R-400 series).

By 1998, known stocks of bombs specifically associated with chemical or biological agents had been destroyed along with the moulds and equipment used to manufacture these munitions. However, Iraq's indigenous chemical and biological bombs were largely unsophisticated designs and were not particularly difficult to fabricate. Additionally, the personnel needed to design and fabricate these munitions remained available. Therefore, while Iraq's inventory of aerial chemical and biological bombs was presumably eliminated, its ability to reconstitute that inventory remains largely intact.

iii). Major Rockets and Artillery Projectiles

Introduction
Artillery and multiple rocket launcher systems (MRLS) can be used to deliver large quantities of chemical or biological agents to targets within a few tens of kilometers of the firing point. Artillery projectiles and rocket warheads can be configured to contain

bulk liquid agent, binary chemical agent components or sub-munitions that contain an agent. Additionally, projectiles and warheads can be configured to disseminate their agent load as an aerosol or to eject sub-munitions. Projectiles differ from warheads in that projectiles are typically of much heavier construction and therefore contain less agent than would a warhead of similar diameter. Projectiles and warheads are both compatible with impact and airburst fuzes. While projectiles and warheads are both suitable for use with a wide range of chemical agents, neither is as well suited for use with biological agents.

Background

Iraq's chemical arsenal included artillery projectiles and rocket warheads for a variety of guns/howitzers and multiple rocket launching systems. 122-mm MRLS systems and 155-mm howitzers were major systems in Iraq's ground forces, and thus, the corresponding warheads and projectiles were selected for filling with chemical agents. Iraq also declared prior work with other projectiles.

Iraq did not provide full documentation to support its declarations concerning the total number of rocket warheads and projectiles produced, procured, filled and consumed. In addition, on several occasions from 1991 to 1997, Iraq's declarations concerning munitions changed significantly. In an attempt to compensate for the insufficiency and ambiguity of the declarations, UNSCOM requested Iraq's principal suppliers to provide information concerning Iraqi munition procurements. Unfortunately, the requested information was not provided, thus UNSCOM was unable to validate Iraq's declarations regarding the disposition of 122-mm rocket warheads and 155-mm artillery projectiles. This issue is further complicated by Iraq's procurement of large quantities of similar munitions for conventional military purposes from the same suppliers.

<u>Artillery projectiles</u>

Although Iraq had the capability to produce 155-mm chemical projectiles, it declared that some 85,000 suitable empty projectiles were imported for subsequent filling. Of the 70,000 projectiles filled with chemical agents, principally Mustard, more than 54,000 were declared as expended between 1984 and 1988 and 13,500 as remaining before the Gulf War.

Iraq primarily filled 155-mm projectiles with high purity Mustard that remained stable during long-term storage. However, Iraq also provided some information and documents on the development and tests of 155-mm binary nerve agent (Sarin and Cycolosarin) projectiles. UNSCOM found several examples of these munitions at the Muthanna State Establishment. Iraq stated that, despite positive test results, no industrial-scale production of binary 155-mm projectiles occurred.

Iraq declared that it had unilaterally converted approximately 15,500 empty 155-mm artillery projectiles, purchased for chemical warfare use, into conventional high explosive munitions in 1992-93. UNSCOM attempted to verify the disposition of these munitions and found approximately 1,800 of these projectiles at the Babylon Ammunition Depot. UNSCOM was satisfied with its findings and did not pursue the matter further.

Iraq has provided a number of explanations regarding the disposition of approximately 550 unaccounted for Mustard filled 155-mm projectiles. UNSCOM, having determined that the Mustard contained in Iraq's 155-mm projectiles was likely to remain stable for a long period, treated this issue as a serious matter. The high purity of Sulphur Mustard contained in artillery shells, after over 12 years of storage, was recently confirmed by UNMOVIC.

Rocket warheads

Iraq declared the procurement or indigenous production of more than 100,000 122-mm chemical warheads from 1985 to 1990, making it the most numerous of Iraq's chemical munitions. At least seven distinct models of warheads were procured or produced. In excess of 36,000 warheads were declared as having been filled with nerve agents. Iraq declared that tens of thousands of 122-mm chemical warheads were either consumed between 1986 and 1988 or were destroyed in 1991 during the Gulf War. Over 14,000 warheads or warhead and rocket motor combinations were handed over to UNSCOM. Additionally, Iraq declared the unilateral destruction of more than 26,000 warheads.

Iraq declared that all 122-mm chemical warheads were filled with nerve agents. Iraqi quality control records excavated by UNSCOM showed that 122-mm warheads were filled in anticipation of immediate use rather than for long-term storage. According to the documents, Iraq had experienced technical difficulties in storing warheads filled with nerve agents, including degradation of the agent within months and several cases of leakage.

UNSCOM did not find any evidence to support Iraq's declarations concerning the unilateral destruction of some 15,000 empty aluminum 122-mm warheads. However, UNSCOM did find evidence that supported some of Iraq's declarations regarding the destruction (both unilateral and as a result of bombing during the Gulf War) of tens of thousands of other 122-mm warheads. Accounting was not possible due to the circumstances of the destruction.

During UNMOVIC inspections in January 2003, 12 empty 122-mm chemical rocket warheads were found in a storehouse at a storage depot 170 km southwest of Baghdad. Iraq later provided four additional from a building in another storage depot. Two more 122-mm rocket warheads were found later at the same depot by an UNMOVIC inspection team. A Commission of Inquiry has been set up by Iraq to investigate why these warheads were stored at these sites or whether any more such warheads or other proscribed munitions are stored at other locations in Iraq. According to a document from the Commission, which was handed over to UNMOVIC in February 2003, the 12 warheads were part of a batch of less than 20 warheads received by Al Muthana in 1989 for training and reverse engineering purposes.

Assessment

122-mm warheads and 155-mm projectiles are a militarily efficient means for the dissemination of a variety of chemical agents. While 155-mm projectiles filled with Mustard could be stored for decades, it is less likely that any remaining warheads filled with nerve agents would still be viable combat munitions. However, any remaining unfilled projectiles or warheads, if properly stored and maintained, could still be used for future chemical warfare applications.

Regarding the missing 550 Mustard filled 155-mm projectiles, UNMOVIC has been unable to resolve the status of these items and remains concerned due to their probable military utility. According to an investigation made by the Iraqi "Depot Inspection Commission", the results of which were reported to UNMOVIC in March 2003, the discrepancy in the accounting for the mustard filled shells could be explained by the fact that Iraq had based its accounting in the 2002 CAFCD on approximations. The new accounting will be reviewed by UNMOVIC.

It is noted that UNSCOM was satisfied with Iraq's declaration that it had converted over 15,000 155-mm projectiles, originally intended for use with chemical agents, to conventional munitions by filling them with high explosives. Because of the original proscribed nature of these items, UNSCOM would have been justified in destroying these munitions.

The 122-mm chemical rocket warheads found by UNMOVIC in January 2003 were stored in a storehouse that Iraq claims were overlooked from 1991, when a batch of some 2000 were deployed there during the Gulf war. Sealed casings containing some of the rocket warheads were dated April 1988 (4/88). The one rocket warhead with a liquid content has been sampled and analysed by UNMOVIC. The liquid was found to be water contaminated by hydrogen sulphide, which seems to be consistent with the fact that coloured water was used for trial purposes to simulate a CW agent. However, the finding of these 16 rocket warheads could be taken as a demonstration for the absence of a complete and accurate inventory for this type of munition in Iraq.

Iraq has been vague as to exactly how many field tests with 122-mm rocket warheads occurred and the number of warheads involved. UNMOVIC shares UNSCOM's view that it seems likely that Iraq would have documented the results of these tests and that it may have conducted more warhead tests than declared. For example, video tapes from the Haidar Farm cache shows Muthanna personnel conducting tests of a cluster bomb that appears to utilize submunitions based, in part, on 122-mm warhead components.

Iraq met its pre-1991 requirements for artillery projectiles and rocket warheads through a combination of importation and indigenous production. It is unlikely that gaps and uncertainties in the accounting for the thousands of unfilled chemical munitions can be solved without the presentation by Iraq of additional evidence concerning the disposition of these items. Additionally, as of 1998, Iraq still had significant stocks of conventional 122-mm warheads and 155-mm projectiles similar to those previously modified for use with chemical agents. Iraq's industries appear fully capable of modifying these

conventional munitions for use with chemical agents as well as the indigenous production of most or all of their components.

iv). Other Chemical and Biological munitions

Introduction
Chemical and biological warfare (CBW) agents can be filled into a variety of munitions including cluster bombs, fragmentation weapons, spray tanks, missile warheads, bombs, rockets, mortar projectiles and artillery shells.

It is possible to modify a range of conventional munitions to make them suitable for a chemical or biological agent fill. The modification usually involves replacing the high explosive with the chemical or biological agent and an explosive-filled burster tube with an appropriate fuse. In addition, the munition must be leak proof and made of material that does not adversely react with the chemical or biological agent. Some munitions, because of their design or size, are more suited for chemical or biological agents; for example, fragmentation weapons or flechettes (a munition similar in size and shape to a dart) are well suited for a BW agents like *Clostridium perfringens* while rocket propelled grenades are suited to a Sarin fill.

Background
In its 1996 chemical FFCD and its CAFCD, Iraq acknowledged an interest in chemical agent filled cluster bombs. It also declared that it had conducted two tests of the CB-250 cluster bomb in 1987. Iraq stated that, because of the negative results (attributed to incorrect fusing), further tests were abandoned. In August 1996, a high-ranking Iraqi official interviewed by UNSCOM stated that cluster bombs were part of the BW programme. Later the same day, in the presence of his superior officers, he retracted the statement. In October 1996, a senior Iraqi official admitted to UNSCOM that the head of the Technical Research Centre, the organization responsible for directing Iraq's production of BW agent, had directed him to visit the Al Noaman cluster bomb factory, to evaluate the use of cluster bombs for BW purposes. In its 1997 BW FFCD (and repeated in the CAFCD), Iraq did not acknowledge any interest in cluster bombs for BW purposes and an UNSCOM biological inspection team, which visited the Al Noaman factory in 1997, reported that no evidence had been found linking the factory to biological weapons. However, in February 2003, an UNMOVIC inspection team found a component of a 122mm CBW cluster submunition in a warehouse at the Al Noaman Factory. Iraq stated that this was a leftover from the past declared chemical simulant test program that was abandoned.

With regard to fragmentation weapons, a senior Iraqi official had acknowledged experimental laboratory work on the sub-dermal introduction of *Clostridium perfringens* resulting in gas gangrene. Iraq has denied that this research was exploited for weapons development, such as for use in fragmentation weapons or flechettes. According to Iraq, it also considered the possible use of land mines for BW. However, one Iraqi scientist noted that the antipersonnel land mines at Al-Qa'a Qa'a had been considered unsuitable

for filling with liquid BW agent. UNSCOM had no evidence of Iraq filling chemical or biological agents in land mines.

Iraq declared that it did some basic research using tear gas in rocket-propelled grenades (RPG) and in explosive canisters. However, UNSCOM found no evidence that Iraq actually developed RPGs filled with chemical agent.

Assessment

During the 1980's, Iraq showed considerable interest in developing cluster munitions filled with "special agents". Cluster munitions are well suited to dispersing CBW agent. Iraq's interest in cluster munitions for chemical agent in particular, may have been linked to its need to counter "human wave" tactics Iran had used in its conflict with Iraq. The ceasefire in the Iraq/Iran war, in August 1988, rather than the lack of technical success, may have lessened the urgency to develop chemical and biological cluster munitions.

The involvement of the Muthanna State Establishment (MSE) Iraq's main CW production facility, with the Al Noaman factory in the development and testing of special (chemical or biological) sub-munitions, confirm Iraq's interest in cluster bombs. Video evidence from the Haidar Farm suggests that Iraq was modifying existing munitions to be compatible with the locally made cluster bombs. In particular, Iraq used elements from the 122-mm special warheads to produce sub-munitions for the cluster bomb. From early 1987 to mid-1988, Muthanna continued with the development and testing of various components of 122-mm warheads including an all-way fuse and an aluminium casing. Iraq tested the fuse and dispersion pattern by dropping the 122-mm canisters from an aircraft and a crane. A component of such a sub-munition was found at the Al Noaman Factory in February 2003.

UNSCOM discovered in some of the Haidar Farm documents mention of an agreement between MSE and the same foreign company that supplied the Al Noaman cluster bomb factory to Iraq. It is unclear whether the project, codenamed Project 101, was related to the development or production of cluster bombs suited to CBW agents. When questioned on this Project during a February 2003 inspection, the Al Noaman Factory manager, NMD representatives and representatives from the past CW program all denied any knowledge of such a project.

During an interview with UNSCOM in August 1996, a high-ranking Iraqi official with extensive knowledge of the BW programme stated that not more than two conventional cluster bombs had been modified for BW purposes. UNMOVIC notes that the official had unequivocally repeated his statement linking cluster bombs to the BW programme. The retraction of this statement the same day in the presence of his superior officers was never adequately explained to UNSCOM. Other evidence of Iraqi interest in developing cluster munitions for BW agents exists, such as the visit to the cluster bomb factory by a senior Iraqi official in the BW programme.

The foregoing suggests that Iraq's interest in cluster munitions, and the developments it did make, may have progressed well beyond what it had declared.

Iraq produced 340 litres of concentrated *Clostridium perfringens*, the causative agent of gas gangrene, in 1990. *Clostridium perfringens* is most effective as a BW agent when it comes in contact with open wounds. It would, therefore, be expected that Iraq would have tested (or had the intention to test) the agent with fragmentation devices or flechettes.

v). FROG (Luna) Special Warheads

Introduction

The 9K52 Luna rocket, also known as Free Rocket Over the Ground ("FROG"), is an unguided, spin-stabilized, short-range, battlefield support artillery rocket with a range between 70 to 90 kilometres, depending on its configuration. The FROG was originally conceived to be fitted with a 450-kilogramme high explosive (HE), nuclear or chemical warhead. An improved version of the FROG can also carry a cargo warhead for delivering bomblets or mines. During the Cold War it was one of the most common rockets in the Short-Range Nuclear Force (SRNF) at the division level in the Warsaw Pact. Iraq had only received the conventional warhead version.

Background

The FROG rocket system is not proscribed under resolution 687 (1991). However, it was subject to monitoring under paragraph 43 of the OMV plan.

In its 1996 FFCD, Iraq stated that, in May 1988, a project designated "*Luna S*" was initiated to convert the FROG rocket warhead into a cluster warhead constructed of aluminum and certain components of the Ababil 50 rocket. According to Iraq, Al Muthanna State Establishment rejected the proposal to use an aluminum shell as a container for CW agents and the project was abandoned in July 1988. Iraq stated that only sketches had been produced and that no prototypes had been built.

Documents found at the Haidar Farm in 1995 were sent to a supporting Government for analysis in April 1996. In June 1997, the supporting Government provided a written assessment that the documentation contained all the necessary files and specifications to build a non-conventional warhead, probably a chemical warhead for the FROG rocket. The assessment also stated that some documents had been dated in March 1989 and in August 1990, which contradicted Iraq's statement that all work relating to non-conventional warheads for such rockets had been abandoned in 1988.

Assessment

Iraq had the capability to develop indigenously and produce non-conventional warheads for weapons system such as the Scud missile. It can, therefore, be assumed that Iraq also had the same capability for a short-range rocket like the FROG. In addition, documentary evidence suggests that Iraq had worked on developing this capability at least until August 1990.

While there is no evidence that Iraq continued such work after 1990, given the inconsistencies and inaccuracies in Iraq's missile declarations, the possibility cannot be ruled out.

V. Spray devices and Remote Piloted Vehicles (RPVs)/Unmanned Aerial Vehicles (UAVs)

Introduction

A spray device can be an efficient and effective means to disperse wet or dry chemical or biological warfare agents (CBW) over a large area. Such a delivery system does not involve the extreme temperatures and pressures associated with explosive dissemination. In general, spraying achieves a higher dissemination efficiency than explosive aerosolisation. Spray dissemination may be either along a line trajectory or from a point source, upwind or directly over the target. Spray devices can be employed with a variety of delivery systems such as fixed wing aircraft (manned and unmanned), helicopters, trucks, boats, special operations personnel and cruise missiles.

Two types of spray devices were acknowledged to have been considered by Iraq: modified auxiliary fuel tanks (tanks used to extend the range of an aircraft, known as "drop-tanks") and modified agricultural sprayers. Drop-tanks can be modified by the addition of spray nozzles to convert them to CBW dispersal devices. Iraq had imported a large number of drop-tanks for a variety of aircraft and some of these tanks were observed during inspections. Iraq also had available domestically manufactured drop-tanks, spray and other devices.

Background

In its 1996 CW FFCD and its 2002 CAFCD, Iraq declared that, in 1988, it had worked on the modification of drop-tanks for CW use. Iraq stated that the work had turned out to be *"inconclusive"* and was abandoned that same year. However, the CW FFCD mentioned that, in 1990, personnel from its chemical weapons production facility, Al Muthanna State Establishment (MSE), took part in a *"task"* to modify Mirage F1 drop-tanks for the dispersion of Biological Warfare (BW) agents. The CW FFCD also cited a letter dated 10 December 1990 from the Director General of MSE to the Deputy Director of the Military Industrialisation Commission (MIC), which referred to *"successful tests of spraying mustard gas by planes which proved to be very effective"* and stated that Mustard agent was stockpiled for that purpose. Iraq declared that it had possessed 295 tonnes of bulk Mustard agent. (UNSCOM supervised the destruction of the Mustard during the period 1992 to 1993).

However, in its 1997 BW FFCD and its 2002 CAFCD, Iraq associated the same tests with its work on a BW drop-tank, explaining that MSE staff had worked on the BW tank in the belief that it was for CW purposes. The BW FFCD and CAFCD also stated that, as part of the Mirage drop-tank project, four Mirage F1 drop-tanks, each having a capacity of 2,200 litres, had been modified by the addition of venturis and valves. The valve controls the flow of agent out of the tank into the venturi where the agent is reduced to a stream of small droplets.

According to Iraq, the project had commenced in November 1990. The first flight test with a prototype tank was conducted in the second week of December, followed by three further tests conducted by 13 January 1991. The tests used a mixture of different

materials - potassium permanganate, water, glycerine and non-pathogenic *Bacillus subtilis* spores as a BW simulant. Iraq declared that, although it had planned to modify a total of 12 drop-tanks, due to lack of valves, it was only able to modify three tanks in addition to the prototype tank. Documents provided by Iraq support its statement that, by July 1991, it had possessed at least three modified BW drop-tanks. However, the documents make no reference to the prototype drop-tank. Work on these tanks continued throughout the Gulf War and was completed in March 1991. Iraq stated that it had unilaterally destroyed the three drop-tanks in the summer of 1991 and that the prototype and the associated Mirage F1 aircraft had been destroyed by aerial bombardment during the Gulf War. Iraq stated the tanks were never deployed or used.

UNSCOM inspected and verified the remains of the three modified drop-tanks Iraq stated it had unilaterally destroyed. The venturi dissemination devices were not found among the remains. However, one such device was presented by Iraq to UNSCOM in April 1998. An inspection of the airbase where the prototype drop-tank was said to have been destroyed failed to yield evidence of either the prototype modified drop-tank or the associated Mirage F-1.

In its June 1996 BW FFCD, Iraq declared another project to investigate the modification of a MiG-21 fighter aircraft. This declaration stated that the MiG-21 remotely piloted vehicle (RPV) was to deliver a BW agent in a Mirage F-1 drop tank to an area without losing a pilot. The June 1996 FFCD details a project to modify a Mirage F1 drop tank *"for the dissemination of BW agents from fighter aircraft"*.

Despite this earlier declaration, Iraq declared in its September 1997 BW FFCD and in the CAFCD the modification of a MiG-21 fighter plane into a RPV *"to deliver a munition"* to a target as well as a separate project to modify Mirage F1 drop tanks for the dissemination of BW agent.

In addition to the drop-tanks and the MiG-21 RPV, Iraq declared that research and development on several BW aerosol generators took place from July 1987 to September 1988. The work culminated in a series of field trials using the so-called "Zubaidy" device on a modified crop dusting helicopter to spray non-pathogenic *Bacillus subtilis* spores. Iraq stated that it had assessed the results of field trials to be inconclusive and that no attempts were made to create a weapons system based on this work. According to Iraq, no further work was conducted on the helicopter device beyond September 1988. In March 1996, Iraq turned over to UNSCOM various items related to the project.

However, an Iraqi report of the field tests stated that the modified crop dusting device was *"useful for spraying fluids containing micro-organisms and their products (bacteria, fungi and their toxins)"*. This is contrary to Iraq's declaration that the results had been inconclusive. Based on interviews and the test report, UNSCOM considered that the tests had actually been successful. Given that components of the system were unaccounted for, UNSCOM questioned whether the development had continued beyond 1988, possibly to deployment.

UNSCOM also reported evidence of another aerosol generator that appeared to be based on the modified crop duster. Its development began in the same timeframe as the development of the helicopter device but continued after that work was said to have been completed. UNSCOM found the objectives of this "parallel" aerosol project unclear and that it was uncertain whether development had continued to deployment. Iraq has denied the existence of any "parallel" development.

In its July 1998 semi-annual missile declaration, Iraq provided information on a project called Al Bai'aa for the conversion of an L-29 aircraft into an RPV, which it stated was intended for air defense training. The declared design goal was to achieve a range of 30 kilometres with a 100 kilogramme payload. However, in its CAFCD, Iraq declared that the Al Bai'aa project stopped in the year 2000.

Assessment

There is a clear contradiction in Iraq's explanation of its development of spray tanks. Iraq has maintained that it started its development work by producing a spray tank for biological agents and has denied that it had developed a similar system for chemical agents. This explanation is contradicted by a letter dated 10 December 1990 from the Director General of MSE to the Deputy Director of the Military Industrialization Commission (MIC), a copy of which was given to UNSCOM by Iraq to support a different matter relating to VX. The letter, however, also contains a reference to the stockpiling of Mustard agent for a successfully tested aircraft spray system. This indicates that also had a well-developed drop-tank for chemical agent. By the date of the letter, 10 December 1990, it is also clear that the CW drop-tank was developed before the BW drop-tank. Therefore, Iraq's further explanation that the reference in the letter to Mustard agent was associated with BW drop-tanks cannot be correct.

The conclusion therefore drawn from the MSE letter is that, by December 1990, Iraq had a design for a separate device capable of spraying Mustard agent. The specifications of this CW delivery device, for example whether it was based on a modified Mirage drop-tank or other spraying device, are unknown to UNMOVIC. It is known that Iraq had tested different types of aerial spray or other devices capable of disseminating Mustard agent.

Given that the group that had successfully developed the CW spraying device was later engaged in the modification of the BW drop-tank, the likelihood of success of that project was greatly increased. The development of tanks for CW and BW uses should not be considered as two separate projects but rather as one continued project.

Iraq's assertion that it was unable to modify 12 drop-tanks for BW purposes because of a shortage of valves is contradicted by a letter dated 25 August 1991 from the Department of Aeronautical Engineering to Al Muthanna. The letter requests the return of unused valves, thus indicating that such components had not been in short supply as claimed by Iraq. It is therefore possible that additional tanks were modified. While Iraq has provided documents showing that, as of July 1991, it had at least three modified BW drop-tanks,

they do not address the prototype drop-tank. Since no remnants of the prototype tank have been found, it has not been possible to verify its destruction.

Spraying devices modified for CBW purposes may still exist in Iraq. A large number of drop tanks of various kinds, both imported and locally manufactured, are available and could be modified. Since spraying devices are an efficient means of disseminating CBW agents, and since Iraq declared continued research after January 1991, it is likely to have been a high priority in the CBW program.

With respect to aerosol generators, the modified crop duster Iraq developed had potential as a BW dissemination device. There are many agricultural aircraft spray systems in Iraq. These units are identical to the devices that were modified for BW dissemination. In addition, components imported for these or other spray devices were available in Iraq in 2003. Modified aircraft fuel tanks were found at Khan Bani Sa'ad Airfield in December 2002. These tanks were stated to have been part of an indigenously manufactured agricultural spray system that was stated to have been produced by the Air Force. The expertise gained in the development of the generators and the evidence of "parallel" work on a similar device that was not declared, is of some concern.

Unmanned Aerial Vehicles (UAVs) that fly autonomously to pre-programmed targets, and Remotely Piloted Vehicles (RPVs), that are controlled from the ground or another aircraft, are of particular interest to UNMOVIC because of their potential to deliver a weapon to a remote target.

Although Iraq's September 1997 BW FFCD referred to the MiG-21 RPV project as intended for the delivery of a munition, in earlier declarations and in discussion, Iraq stated that the project was for the delivery of BW agent from a modified Mirage drop tank. The use of a Mirage drop tank on a MiG aircraft, although possible, would pose considerable aviation engineering problems.

Given its payload and range, the MiG-21 RPV could have been intended for the delivery of either CW or BW agents. In addition, the spray system would have most likely have been based on a MiG-21 fuel tank as opposed to the fuel tank of a Mirage F-1. Given that Iraq had already successfully conducted spraying of Mustard from planes, it is possible that it was a MiG system that had been used in the tests and that the RPV project was an extension of this programme. Further information is required to determine the extent and the objectives of the project and whether it was terminated in April 1991 as declared by Iraq.

Work on another aircraft, the L-29 jet trainer, to convert it to a RPV started in November 1995 and continued until at least 2000. The L-29, although smaller and less capable than the MiG, could still be used to deliver CBW agent in quantities that would pose a significant threat to neighbouring countries. Iraq has declared that the work on the L-29 has stopped but that work continues on smaller RPVs. Iraq has also declared in its BW CAFCD a number of smaller RPVs that are capable of carrying a payload of up to 20

kilograms to a range of less than 30 kilometres. This payload could represent a significant biological payload if dry agent is used.

UAVs/RPVs with a BW or CW payload are, of course, proscribed, as is any UAV/RPV with a range greater than 150 kilometres. UNMOVIC has received intelligence reports of the development, during the past four years, of UAVs and RPVs that exceed the 150 kilometres limit. In fact, one report describes a UAV with a range of 500 kilometres.

Iraq has not declared the development of any UAV. However, it has declared that it developed during the past few years, two new RPVs with a range of 100 kilometres. The stated design goal for one of the RPVs, designated by Iraq as “RPV-20”, was to create a drone with an endurance of one hour that had an autonomous system for guidance and control with GPS navigation. Recent inspections have also revealed the existence of a drone with a wingspan of 7.45 metres. Officials at the inspection site stated that the drone had been test flown. Further investigation is required to establish the actual specifications and capabilities of these RPVs and whether Iraq has UAVs/RPVs that exceed the 150 kilometers limit.

VI. VX and its Precursors

Introduction

The term VX is used to refer to O-ethyl S-[2-(diisopropylamino)ethyl] methylphosphonothiolate, which is one member of a class of chemicals known as V-agents that have similar chemical structures. VX is a colourless and odourless liquid when pure; with impurities, it resembles motor oil in appearance and has a smell reminiscent of rotten fish.

VX is a lethal nerve agent and is one of the most toxic known CW agents. Nerve agents primarily interfere with the transfer of nerve impulses, which may ultimately lead to death. VX is readily absorbed through the skin, which is the main exposure route in combat use. VX is not very volatile and is, therefore, considered a persistent CW agent.

The first chemicals belonging to the V-agent class were synthesized and identified in the period 1952 to 1953. Shortly after, systematic investigation of this class of chemicals began. As a result, VX was developed and weaponized in both unitary and binary configuration. There are several synthetic routes for the production of VX, although those that yield high quality VX are longer and/or more sophisticated than for most other CW agents.

Background

Until 1995, Iraq had only admitted to having produced lab-scale quantities (grams) of VX. Thus, in its March 1995 FFCD, Iraq declared the production of 0.26 tonnes of VX using readily available pilot-scale equipment at the R&D department of the Samara site of the Muthanna State Establishment (MSE). However, in its declarations, Iraq declared that, in total, 3.9 tonnes of VX had been produced at industrial-scale plants at MSE.

Iraq declared that initial laboratory experiments on V-agents had taken place around 1975-76, but that the first serious research work had only started in 1985. This work focused on VX in particular. By late 1987, a synthetic method had been selected, which will be referred to as “route A”. A production trial using this route was carried out at one of the existing multi-purpose plants at MSE. Iraq stated that it had considered the resulting VX to be of unsatisfactory quality.

In February 1988, Iraq carried out intense research on VX to come up with a better method. This included work with stabilizers, which are chemicals used to preserve the quality of the VX produced. In March 1988, Iraq developed another method to produce VX, which will be referred to as “route B”. That same month, a production trial was carried out at a second multi-purpose plant at MSE. In the following weeks, a third plant at MSE was specifically modified for the production of VX using route B. During May 1988, three production trials were carried out at this plant. The resulting VX, as well as that produced in March, was analysed over a period of time and found to degrade rapidly. There is documentary evidence to support Iraq’s declarations on all the aforementioned events that occurred between 1985 and the end of May 1988.

Iraq declared that, 2.4 tonnes of VX had been produced in the five production trials that had taken place between late 1987 and the end of May 1988. Iraq declared that it had weaponized 0.4 tonnes of VX in three aerial bombs for the purpose of corrosion and stability tests and noted that an artillery rocket was filled with VX to study corrosion and stability. Iraq further declared that all the VX produced between late 1987 and the end of May 1988, had been destroyed later in 1988 because it had degraded. There is documentary evidence to support that MSE had filled three aerial bombs with VX during 1988. Other documents indicate that the quantities of VX declared to have been produced between late 1987 and the end of May 1988 are approximately correct. UNSCOM sampled locations where Iraq stated it had disposed of VX. The sampling could not determine the quantities of destroyed VX that had been discarded, but it did reveal the presence of degradation products of VX and a degradation product of a chemical known to be a stabilizer for VX.

In April 1988, Iraq conducted research on the stability of the semi-final product (which Iraq refers to as *"dibis"*), obtained using route B. Iraq apparently reasoned that, if this precursor was stable, strategic stocks could be built up and converted to VX when required, thus circumventing the instability problems associated with storage of the final VX product. Data from Iraq's research showed that after eight months of storage, there was practically no decrease in the stability of dibis. Consequently, the research department recommended that dibis be produced in quantity as a strategic source of VX. This is confirmed from documentary evidence and interviews conducted with Iraq. Iraq also declared work on a dibis based binary weapons system.

Other research carried out in 1988 includes work on two more synthetic routes to produce VX. These routes will be referred to as "route C" and "route D". Route D was described by Iraqi researchers as *"the optimum method for obtaining high purity and yield. However, its procedure requires a longer time."* The researchers noted that there is a *"production problem concerning the application of this research"* because it involves *"a process that requires special technology not available in the production sites"*. Route C was referred to as a method of producing VX directly or as a binary weapons system. Work on the application of route C as a binary weapons system continued in 1989. The research got as far as tests *"in cooperation with the section on munitions research to set up a technique that fits the munition specific to the binary system."* Although Iraq declared a small amount of this work in its 1996 FFCD, and provided some more details in subsequent letters and interviews, information of this work has mostly been derived from documents obtained from the Haidar Farm.

Iraq declared that, in April 1990, it had produced a quantity of dibis using route B. It appears that this dibis was later converted into 1.5 tonnes of VX. Iraq declared that the resulting VX degraded rapidly and was destroyed in the summer of 1991. As with VX destroyed in 1988, UNSCOM took samples but was unable to determine the exact quantities of VX that had been declared destroyed by Iraq on either occasion. Iraq has provided practically no evidence to support its VX related activities, for the year of 1990, stating that all such information had been destroyed. To support this latter assertion, Iraq provided UNSCOM with handwritten notes that recorded the issuance of oral

instructions, *inter alia*, to destroy any evidence indicating the presence of VX and a key precursor of VX, "*Iraqi choline*".

In its declarations, Iraq supports its statement that, by the end of 1990, there was no VX remaining from its past CW activities, by providing the following documents: a memorandum listing munitions, final agents and other materials at MSE, as well as at various stores and munitions depots as of 18 December 1990; an inventory of the final and intermediate substances stored at MSE as of 31 December 1990; a memorandum listing munitions that MSE had ready for removal as of 31 December 1990; a memorandum listing munitions and final agents available at MSE as of 5 January 1991. No VX or dibis is mentioned in any of these documents. However, two VX precursors ("Iraqi choline" and "MPS") are present on the inventory of final and intermediate substances stored at MSE, as of 31 December 1990. Iraq also provided a document from the 10th of December 1990 that reviews the *"essential activity"* carried out at MSE in that year. No achievements relating to VX are detailed, but the document mentions work on the production of the *"essential substance MPC from which VX and other agents can be prepared"*. The document also contains a handwritten annotation by Lieutenant-General Hussein Kamal directing MSE to *"concentrate on producing the intermediate substance of the nerve agents as well as on producing VX as a final product"*.

UNSCOM found that the production plant specifically modified at MSE to produce VX had been heavily damaged during the Gulf War. UNSCOM's inspection reports document that Iraq made an attempt to retain the remaining equipment from this plant by providing incorrect declarations with respect to its past use. UNSCOM subsequently determined that this equipment originated from a plant involved in VX production and the equipment was destroyed by Iraq under UNSCOM supervision in late 1997. UNSCOM also found that the two multi-purpose plants used for VX production had been completely destroyed during the Gulf War. However, UNSCOM was unable to verify the status of pilot-scale equipment declared in 1995 as having been used for VX production at the R&D department of MSE because the buildings associated with this department were heavily damaged during the Gulf War.

Iraq declared that significant quantities of precursors for VX production were destroyed through aerial bombardment during the Gulf War (thionyl chloride, phosphorus pentasulphide, diisopropyl amine and chloroethanol), lost due to improper storage (phosphorus trichloride) or destroyed by Iraq in the absence of UNSCOM inspectors ("*Iraqi choline*"). UNSCOM was not able to verify these declarations in full.

UNSCOM hosted a Technical Evaluation Meeting (TEM) attended by a number of international experts in February 1998 to discuss the issue of VX. The TEM concluded "*Iraq was capable of producing significant quantities of VX before January 1991. This may have been as much as 50 to 100 tonnes of VX, albeit of an uncertain quality."* Regarding weaponization, the team concluded it did not have sufficient information to reach any specific conclusion.

Except for the artillery rocket and three aerial bombs filled with VX for corrosion and stability tests, Iraq declared that VX had not been weaponized. However, in April/May 1998, UNSCOM took remnants of missile warheads that had been unilaterally destroyed by Iraq for analysis. The analysis showed traces of VX degradation products, and a chemical known to be a stabilizer for VX. Iraq has repeatedly denied the authenticity of these findings. In a second set of analyses (June 1988) one of the laboratories reported the presence of a degradation product of nerve agents (G- or V-agents) in one sample. (This chemical could also originate from other compounds such as precursors or, according to some experts, a detergent). Two other laboratories found no nerve agent degradation products. Documentation available to UNMOVIC suggests that Iraq, at least, had had far reaching plans to weaponize VX.

Assessment

Iraq's VX programme included extensive efforts in a number of areas such as synthetic routes, stabilizers, and binary munitions. Given Iraq's history of concealment with respect to its VX programme it cannot be excluded that it has retained some capability with regard to VX.

Iraq has pointed to original storage inventory documents as evidence that it had not weaponized VX or produced VX after April 1990. It is noted that, in addition to other indications to the contrary mentioned in this cluster, the inventory and memoranda do not provide an exhaustive list of sites where CW munitions could have been stored. It is also noted that the quantity of VX/dibis Iraq declared it had produced in 1990, and unilaterally destroyed in 1991, is not recorded in any of the storage inventory documents or memoranda provided by Iraq. This should have been recorded in the 31 December 1990 "*Inventory of Final and Intermediate Substances at MSE*". VX is a final agent and dibis is an intermediate. The inventory records, for example, stocks of Iraqi Choline, which is a precursor required to produce dibis.

The information available to UNMOVIC at present suggests that Iraq did not carry out industrial-scale production of VX in the latter half of 1988 or in 1989. At that time there did not appear to be any military requirement for it. Research on VX did however continue, with one of its objectives being to improve its stability.

During times of war, or imminent war, it would make sense for Iraq to produce VX through route B, which involves only about half as many process steps as route D. VX produced through route B must be used relatively quickly after production (about 1 to 8 weeks), which would probably be satisfactory for wartime requirements. However, if no war were imminent or underway, it would make more sense for Iraq to produce VX that can be stabilised and stored for long periods of time until needed. Of the routes that Iraq is known to have studied at the R&D level, and obtained a fair degree of success, route D would seem to be the route of choice to produce high purity VX.

Iraq had produced high purity VX using route D in laboratory/pilot-scale equipment. Based upon the documents provided by Iraq, it is doubtful that any significant quantities of VX were produced using this route before the Gulf war. In the case of VX produced

through route D, if Iraq's quality control and process technology has been improved, then Iraq may be able to stabilise the product (Iraq informed UNSCOM that it had not attempted to stabilise VX produced through route D). VX thus stabilised, may be weaponised and stored, or stored as bulk agent. VX produced through route D, and stabilized, could still be viable today.

As regards binary weapons, it is not certain how far Iraq progressed using route C or dibis without further documentation. Based upon its absence from MSE's report of the essential activity carried out in 1990, it is unlikely that the work progressed very far up until that time.

It would have made no sense for Iraq to conceal a programme that in its estimation was a failure and in which it had no future interest. It is possible the programme was not quite the failure claimed by Iraq or Iraq wished to retain some capability to restart the programme in the future, for example through the retention of key precursors and know-how.

The major remaining issue relating to Iraq's VX production capability is the fact that there are significant discrepancies in the accounting for all the key precursors (phosphorus trichloride, thionyl chloride, phosphorus pentasulphide and "Iraqi Choline") required to produce VX. A few other chemicals are required to produce VX, using any of the routes Iraq focused on in the past, these are however readily available.

The only precursors useful for VX production that Iraq was known to be indigenously capable of producing were absolute ethanol and possibly, thionyl chloride. In the case of thionyl chloride, the starting materials and know-how were available. While the chemical process equipment to construct plants for VX, or its precursors, could have been obtained by removing equipment from various facilities in Iraq, no such plants have been identified by UNMOVIC.

To measure the quantity of VX unilaterally destroyed in 1990, Iraq in February 2003 proposed a procedure to quantify the discarded VX. Iraq also suggested a method to measure the quantity of "Iraqi Choline" unilaterally destroyed by Iraq in 1991. UNMOVIC has held an initial round of discussions with Iraq on this subject and will continue to assess the feasibility of the proposal. There are some concerns, however, that the accounting cannot be done with a reasonable margin of error. Furthermore, even if quantification of the choline could be achieved, it would not resolve the issue of potential retention of precursors for VX production. There are significant unaccounted for quantities of the choline precursor diisopropylamine (DIPA). The total quantity of VX produced remains to be determined. In addition questions remain whether the VX produced in 1990 was of storable quality, i.e. of high purity and stabilized.

VII. Mustard and its Precursors

Introduction

In military terminology, the common names "Mustard" or "Mustard Gas" refer to a specific family of chemical warfare agents comprising a variety of compounds that are similar in chemical structure. Sulphur Mustard, bis(2-chloroethyl)sulphide, is one member of this family of chemicals. Sulphur Mustard, an oily liquid, has a characteristic garlic smell and yellow to dark-brown colour.

Sulphur Mustard is a systemic poison that affects all human tissues. It is a strong blistering agent when in contact with the skin and lethal when inhaled. Due to its low volatility, it is a persistent CW agent.

Sulphur Mustard was first synthesized and identified in 1854, and later became one of the most important chemical warfare agents. Despite a century of research, there is still no antidote against it. This is one of the reasons why it is still considered to be one of the most important chemical warfare agents.

There are two major synthetic routes for the production of Sulphur Mustard. The first one includes thiodiglycol and a chlorinating agent, and the second involves ethylene and sulphur chloride. Both these synthetic routes lead to the same principal chemical, but with different composition of by-products.

Background

Of the total of 3,950 tonnes of CW agents declared produced during the period 1982 to 1990, 2,850 tonnes were Sulphur Mustard. According to Iraq, 2,443 tonnes of this Mustard were weaponized in artillery projectiles and aerial bombs. In the 1996 FFCD, and in the 2002 CAFCD, Iraq further declared that 2070 tonnes of Mustard were consumed from 1983 to1988 and 100 tonnes were discarded during production. Iraq destroyed 596 tonnes of Mustard under UNSCOM supervision: 295 tonnes in bulk and 301 tonnes from munitions.

The uncertainties in the accounting of Mustard declared as remaining in 1991 include up to 550 artillery projectiles and up to 450 aerial bombs filled with this agent, which would constitute up to about 80 tonnes of Mustard. However, based on a document recently received from Iraq, this quantity could be substantially higher.

Iraq did not provide complete documentation on the production and disposition of Mustard for the entire period of its production, weaponization and consumption, which is what would be required to assess the accuracy of the declared remaining quantities in 1999. Nonetheless, Iraq provided some records on the production and weaponization of CW agents for the years 1987 and 1988. These records support Iraq's declarations on Mustard production and weaponization for these two years. However, the record of the consumption of chemical munitions, including those filled with Mustard, contained in the Air Force document recently handed over to UNMOVIC, does not support Iraq's declarations on the consumption of these munitions during the period 1983 to 1988.

Iraq declared that all its Mustard had been produced from imported thiodiglycol, thionyl chloride and phosphorus trichloride at a dedicated production plant located at the Samarra site of the Muthanna State Establishment. According to the documents provided by Iraq, by the end of 1990, the Samarra site was able to produce Mustard at a rate of 10 tonnes per day. UNSCOM found the declared Mustard production plant had been heavily damaged by aerial bombardment during the Gulf War. Remaining chemical process equipment from its dedicated plant was destroyed by Iraq under UNSCOM supervision. Iraq declared that significant quantities of precursors for Mustard production were either destroyed through aerial bombardment during the Gulf War (thiodiglycol and thionyl chloride) or lost due to improper storage (phosphorus trichloride). UNSCOM was not able to fully verify these declarations.

Iraq studied other alternative routes for the production of Sulphur Mustard from locally available materials. According to the documents received from Iraq, it had considered to produce Mustard using another process that involved the starting materials ethylene, sulphur and chlorine. However, UNSCOM did not find evidence suggesting that this process had actually been used by Iraq on an industrial scale, most likely because the process it had followed was somewhat simpler and an adequate supply of precursors was available.

From multiple sources of evidence, UNSCOM determined that Iraq was able to produce good quality Sulphur Mustard, suitable for long-term storage. According to UNSCOM, while there were no recorded problems in storing bulk agents, Iraq's documents referred to many cases of leakage of aerial bombs filled with Mustard, due to the growing internal pressure inside munitions, caused by degradation of the agent. UNMOVIC analysed the contents of artillery shells that had been stored for at least twelve years. The results revealed that the shells still contained high purity Sulphur Mustard.

Assessment

Production of high quality Mustard was achieved through the acquisition of high quality starting materials, use of high quality chemical process equipment and practical experience gained by Iraqi personnel over several years of continuous Mustard production. Judging by the quantities produced, weaponized and used, Mustard constituted an important part (about 70%) of Iraq's CW arsenal.

There is much evidence, including documents provided by Iraq and information collected by UNSCOM, to suggest that most quantities of Mustard remaining in 1991, as declared by Iraq, were destroyed under UNSCOM supervision. The remaining gaps are related to the accounting for Mustard filled aerial bombs and artillery projectiles. There are 550 Mustard filled shells and up to 450 mustard filled aerial bombs unaccounted for since 1998. The mustard filled shells account for a couple of tonnes of agent while the aerial bombs account for approximately 70 tonnes. According to an investigation made by the Iraqi "Depot Inspection Commission", the results of which were reported to UNMOVIC in March 2003, the discrepancy in the accounting for the mustard filled shells could be explained by the fact that Iraq had based its accounting on approximations.

The "Air Force document" recently received by UNMOVIC introduces additional uncertainty in accounting as it indicates that 6,526 fewer aerial CW bombs had been "consumed" during the Iraq Iran War. This would mean that approximately 1000 tonnes of agent (predominantly Mustard, but also Sarin and Tabun) had not consumed as previously thought. Iraq has explained that the "Air Force" document, which had been complied by one of its officers in 1995, was incomplete. According to Iraq, data on consumption of CW filled munitions positioned at three airbases was not included as the airbases had been occupied in 1991 and the records destroyed. This explanation is being reviewed by UNMOVIC. The Sulphur Mustard contained in artillery shells that had been stored for over 12 years, had been found by UNMOVIC to be still of high purity. It is possible that viable Mustard filled artillery shells and aerial bombs still remain in Iraq.

UNMOVIC cannot verify Iraq's statements that all quantities of Mustard remaining in 1991 were fully declared and destroyed, without explicit documentary evidence on its total production and disposition. Neither can UNMOVIC ascertain the completeness of the accounting for major precursors acquired by Iraq for Mustard production due to uncertainties in their disposition. With the quantities of precursors physically unaccounted for as of 1998 (about 190 tonnes thiodiglycol, 100 tonnes thionylchloride and an undeterminable portion of 1772 tonnes phosphorous trichloride PCl_3) Iraq could have the chemicals to produce limited quantities of high quality Mustard. Imported chemicals such as thionyl chloride and thiodiglycol could still be usable, if properly stored in the original manufacturer's packaging. PCl_3 may also be usable after years in storage, if redistilled.

The acquisition of the foregoing chemicals should have been difficult for Iraq from 1988 onwards due to international export/import control restrictions introduced by the Australia Group. These chemicals were subsequently included in the UN export/import monitoring list. Ethylene oxide and chloroethanol, alternative starting materials for the production of the major precursor thiodiglycol, are also on the export/import monitoring list.

Iraq does not appear to have a dedicated facility capable of producing Mustard and its key precursors. Significant modifications would be required to convert existing chemical production facilities for this purpose. Iraq would have to utilize "corrosion resistant" equipment (for the processing of the chlorinating agent), which it possesses in limited quantities. However, Iraq had some items of dual-use equipment distributed all over the country at legitimate facilities that could be removed and assembled for the construction of a dedicated Mustard production plant.

Iraq is self-sufficient with respect to the availability of starting materials required for production of Mustard (i.e. ethylene, sulphur and chlorine) from its petrochemical complex and sulphur mines. Thus, Mustard would be the easiest agent for Iraq to produce indigenously. While no industrial-scale production was ever known to have taken place using this process, this would be the most likely choice for Iraq. A sulphur chloride plant would have to be constructed, which should not be an obstacle as Iraq had done so in the past to indigenously produce thionyl chloride.

VIII. Sarin, Cyclosarin and their Precursors

Introduction

Sarin (GB) has the chemical name O-isopropyl methylphosphonofluoridate. Cyclosarin (GF) is a closely related chemical and has the chemical name O-cyclohexyl methylphosphonofluoridate. Sarin is a colourless liquid that gives off a colourless vapour and a weakly fruity smell. Cyclosarin is a colourless and odourless liquid when pure.

Sarin and Cyclosarin are lethal nerve agents. The toxicity of nerve agents is mainly due to their interference with the transfer of nerve impulses, which may ultimately lead to death. Sarin is highly volatile (non-persistent) and therefore, in combat use the respiratory system is its main exposure route. Cyclosarin is less volatile (more persistent) than Sarin and significant hazards exist through the respiratory system and skin exposure.

Sarin was developed in Europe in the late 1930s, and later stockpiled and weaponized. A Sarin binary weapons system based upon the mixing of two precursors, methylphosphonyl difluoride (MPF) and isopropanol, has been developed. The practical routes used to produce Sarin and Cyclosarin are identical up to the final step. The final step differs in the type of alcohol (isopropanol or cyclohexanol) that is used to produce the final agent. A mixture of Sarin and Cyclosarin results in a product having properties from both agents.

Background

In its 1996 FFCD, and in the 2002 CAFCD, Iraq declared that it carried out R&D work on several compounds that are closely related to Sarin. However, Iraq declared that only Sarin and Cyclosarin were produced on an industrial-scale and weaponized. Iraq declared that, during the period 1984 to 1990, 795 tonnes of Sarin-type agents (GB, GF and a mixture of GB/GF) were produced. According to Iraq, approximately 732 tonnes of these agents were weaponized in aerial bombs, rocket and missile warheads. Iraq further declared that about 650 tonnes were consumed, during the period 1985 to 1988 and 35 tonnes were destroyed through aerial bombardment during the Gulf War. Iraq destroyed 127 tonnes of Sarin-type agents under UNSCOM supervision, including 76 tonnes in bulk and 51 tonnes from munitions. The figure of weaponized agent was based on an estimate of the average payloads of munitions and the quantity of agents produced represents crude quantities. Therefore, the figures given here of agent produced and their subsequent disposition do not precisely balance.

In addition, Iraq declared that 1024 aerial bombs and 34 missile warheads were filled with alcohols (isopropanol and cyclohexanol) in 1990, as a crude type of binary system for Sarin-type agents. This binary-type system involved filling a munition with alcohol and then manually adding the other precursor (MPF) just prior to the munition being required. Iraq destroyed 337 alcohol-filled aerial bombs and 14 alcohol-filled missile warheads under UNSCOM supervision. UNSCOM was able to verify the unilateral destruction of 527 alcohol-filled aerial bombs and 20 alcohol-filled missile warheads through documentary evidence and observation of remnants. UNSCOM has reported that

remnants consistent with 160 aerial bombs that Iraq declared as destroyed during the Gulf War were seen but the circumstances of destruction were not fully verified.

Discrepancies in the accounting of the Sarin-type agents declared as remaining in 1991 include about 4,800 rocket warheads and 12 aerial bombs filled with these agents, which constitutes about 40 tonnes of Sarin-type agents.

Iraq has declared that it carried out experiments on true binary weapons systems using artillery shells and rockets between 1983 and 1990. These binary weapons systems involved the precursors MPF and alcohol being kept separate in the munition. The physical forces associated with the firing of the weapon cause the precursors to mix and react with one another during flight. This work was carried out at Muthana State Establishment (MSE) and the Technical Research Centre (TRC). Iraq further declared that, while in 1989 and 1990 it had obtained some encouraging results, they were not reliable enough to warrant a move to the production stage. Iraq has provided documentary evidence that details the successful testing of a binary munition for Sarin in 1989, in a report of the TRC *"On the progress of research into Binary Chemical Weapons"*, in conjunction with MSE. Further information about Iraq's work on a binary weapon for Sarin was obtained from documents from the Haidar farm, and from interviews carried out with Iraqi personnel.

Iraq declared that it had used two methods to produce all of its Sarin-type agents. From 1984 to 1987, Sarin was produced at a dedicated plant at the Samarra site of MSE by reacting isopropanol with a mixture of two precursors known as methylphosphonyl dichloride (MPC) and MPF. From 1988, Sarin-type agents were produced at a multi-purpose plant at MSE in addition to the dedicated plant, by the reaction of the appropriate alcohol(s) with MPF. The precursors MPC and MPF were ultimately produced from imported precursors. According to documents provided by Iraq, by the end of 1990 the Samarra site was producing Sarin-type agents at the rate of 1 tonne per day.

The production plants declared by Iraq to have been involved in Sarin-type agents production were found by UNSCOM to be damaged by aerial bombardment during the Gulf war. Remaining chemical process equipment from these plants was subsequently destroyed by Iraq under UNSCOM supervision.

Some precursors that can be used for the production of Sarin-type agents, which were declared by Iraq as having been destroyed through aerial bombardment during the Gulf War (MPF, thionyl chloride and cyclohexanol) or lost due to improper storage (phosphorus trichloride), could not be fully verified by UNSCOM. Others (hydrogen fluoride (HF) and cyclohexanol) were returned to Iraq for civilian use, under UNSCOM monitoring.

According to documents discovered by UNSCOM in Iraq, the purity of Sarin-type agents produced by Iraq were on average below 60%, and dropped below Iraq's established quality control acceptance level of 40% by purity some 3 to 12 months after production.

Assessment

Sarin-type agents constituted a significant part of Iraq's CW arsenal - about 20% of all CW agents that Iraq declared it had produced - and thus an extensive amount of experience and know-how was gathered during production.

There is no evidence that any bulk Sarin-type agents remain in Iraq - gaps in accounting of these agents are related to Sarin-type agents weaponized in rocket warheads and aerial bombs. Based on the documentation found by UNSCOM during inspections in Iraq, Sarin-type agents produced by Iraq were largely of low quality and as such, degraded shortly after production. Therefore, with respect to the unaccounted for weaponized Sarin-type agents, it is unlikely that they would still be viable today.

The short lifetime of the Sarin-type agents produced was one reason why, in 1988, Iraq switched to a binary-type system. Using this system, Sarin-type agents would not be produced until shortly before required, thus the quality of the agent at the time of use would be much higher than if it had been produced and stored for a long period. Accounting for all munitions filled with alcohol has been verified by UNSCOM. However, questions remained with regard to the manner of the destruction of 160 aerial bombs that Iraq declared as having been destroyed during the Gulf War. These questions may have implications on the accounting of aerial bombs filled with biological agents.

In the absence of further documentation, it cannot be ascertained whether Iraq developed its true binary weapons system for Sarin into large-scale production of binary artillery shells and rockets. To help resolve this issue, Iraq should identify all facilities (in addition to MSE and TRC) that had been involved in production/modification of artillery shells and rockets as true binary weapons. In addition, Iraq should also provide clarification of all details concerning its design for binary weapons systems.

To produce Sarin-type agents, Iraq must have the key precursor MPC as well as hydrogen fluoride (HF) and alcohols. No MPC has been declared or noted during inspections. The alcohols are widely available and have legitimate civilian uses in Iraq. Some 300 tonnes of HF was declared stored at the Arab Detergent Company (ARADET) in December 2002. This represents a significant increase from the amount declared stored there in 1988.

UNSCOM could not fully verify Iraq's accounting for precursors it had acquired for the production of Sarin-type agents due to the manner in which they were destroyed and stored. Iraq may have retained imported chemicals to produce MPC, which is stable if properly stored. Such imported chemicals, thionyl chloride and phosphorus trichloride (PCl_3) (if redistilled), may be viable after years in storage. Documentary evidence and the properties of PCl_3, support to some extent Iraq's assertion that the chemical was lost during storage. However, it cannot be excluded that Iraq has retained some portion of the 1772 tonnes UNSCOM could not account for. The import of thionyl chloride and PCl_3 became problematic for Iraq, from 1988 onwards, due to export/import restrictions introduced by the Australia Group. Thionyl chloride and PCl_3 were subsequently included in the UN export/import monitoring lists.

To UNMOVIC's knowledge, the only precursors for Sarin-type agent production that Iraq may have been capable of producing indigenously (although no such production had been declared) were cyclohexanol and thionyl chloride, as the starting materials for production of these precursors are available in Iraq. While the specific chemical process equipment required to construct such plants could be obtained by removing them from various facilities in Iraq, to UNMOVIC's knowledge, there is no such plant. Therefore, unless precursors remain from Iraq's CW programme before the Gulf War, or are clandestinely acquired since then, Iraq would not possess all of the chemicals required to produce Sarin-type agents. Iraq would also need to use "corrosion resistant" process equipment for some processes involved in this production sequence. The bottleneck for Sarin-type agent production would then be the limited amount of such process equipment available to Iraq.

Assuming improvements in its quality control and process to produce the agent, it is possible that Iraq today has the capability to produce Sarin-type agents of a storable quality. If not, Iraq might instead produce readily storable precursors such as MPC, which can be used for Sarin production when needed. However, no evidence of precursors has so far been observed by UNMOVIC inspection teams.

IX. Anthrax and its Drying

i) Anthrax

Introduction

Bacillus anthracis (anthrax) is a spore forming bacteria that is commonly found in the soil and causes disease in cattle, sheep and other animals. Humans are also highly susceptible to certain anthrax strains through inhalation and ingestion of the spores or through infection of cuts or other skin abrasions. By far the most dangerous route of infection is by inhalation and death rates in humans of untreated victims may be 90% or more, depending on the strain. Treatment by antibiotics may be effective if taken early in the course of the disease. Vaccines against some anthrax strains are also available.

Since anthrax is a disease of both animals and humans it has been well studied in a civilian context. The durability of the spores, their ease of production and their effectiveness also makes anthrax highly suited for use as a BW agent and it has, therefore, been researched and developed for military purposes by a number of countries.

Background

Iraq has declared that anthrax production was limited to 20 litres produced at Al Salman in 1989 and 8,425 litres at Al Hakam in 1990 for a total production of 8445 litres. Iraq said that no other facilities were involved and that there was no production of anthrax in 1991.

Contrary to Iraq's assertion that no other facilities had been used to produce anthrax, UNSCOM found evidence of anthrax in two fermenters and a mobile storage tank at the Foot and Mouth Disease Vaccine (FMDV) plant at Al Daura. The strain was said by UNSCOM *"to be consistent with the strain used in Iraq's BW programme"*. Two of the three pieces of equipment that had previously tested positive for anthrax were destroyed in June 1996 pursuant to resolution 687 (1991). A follow up sampling mission to FMDV in November 1996 did not detect anthrax on any remaining equipment.

UNSCOM assessed Iraq's production capability on the basis of two potentially limiting factors: equipment and growth media. UNSCOM assessed that, based on its estimate of the available equipment to the BW programme at that time, and the known capacity of such equipment, Iraq's potential production of anthrax could have been in the range of about 22,000 to 39,000 litres. UNSCOM also estimated that based on unaccounted for growth media, Iraq's potential production of anthrax could have been in the range of about 15,000 to 25,000 litres.

Iraq declared that anthrax had been filled into 50 R-400 aerial bombs and five Al Hussein warheads. In addition, Iraq stated that, just prior to the Gulf War, it had been developing a BW agent spray system by modifying aircraft auxiliary fuel tanks (drop tanks). Initially, Iraq stated that the tanks were to be filled with anthrax and that they were tested with an anthrax simulant, but later said it was possible the fill could have included other agents.

Twelve such tanks were planned, but only four were said to have been completed by the end of the Gulf War and the system was said not to have been deployed.

Iraq's account of the number of bombs and warheads filled with anthrax has changed on several occasions. All biological bombs and warheads filled with BW agent were said by Iraq to have been unilaterally destroyed in July 1991. UNSCOM was able to confirm that bombs and warheads were destroyed at the sites declared by Iraq: three intact BW bomb bodies and fragments of 20 others, and a number of destroyed warheads were recovered.

Samples from destroyed Al Hussein missile warheads have confirmed that at least some Al Hussein warheads contained anthrax. However the analysis suggested to UNSCOM that at least seven Al Hussein warheads were filled with anthrax and not five as declared by Iraq.

Iraq declared that all bulk agent, including anthrax, remaining after the filling of weapons, had been stored at Al Hakam and was unilaterally destroyed there in July and August 1991. Laboratory analysis of samples collected by UNSCOM detected live anthrax at Iraq's declared disposal site. However, UNSCOM considered that the evidence was insufficient to support Iraq's statements on the quantity of anthrax destroyed and where or when it was destroyed.

Iraq also declared that no drying of anthrax had occurred. Iraq reiterated this in papers provided, in February 2003, to the Executive Chairman of UNMOVIC.

Assessment

Production

Iraq's declaration that it produced 8,425 litres of anthrax in 1990 is supported by a 1990 Al Hakam annual report, which UNSCOM found to be a credible document. However, there is evidence that contradicts Iraq's assertion that total production for all years, was limited to 8,445 litres.

UNMOVIC has credible information that the total quantity of BW agent in bombs, warheads and in bulk at the time of the Gulf War was 7,000 litres more than declared by Iraq. This additional agent was most likely all anthrax. Iraq has indicated that, after August 1990, anthrax production was given a high priority: up to August 1990 it had produced only 170 litres of anthrax compared with 14,000 litres of botulinum toxin. However, the drop-tank project, which UNMOVIC assesses was for use with anthrax, placed a high demand for the agent. According to Iraq, after the filling of bombs and warheads only about 3,400 litres of anthrax remained. The drop tank project as planned at the end of 1990, involved 12 tanks, each with a capacity of over 2,000 litres, and in total would have required over 24,000 litres of agent.

Iraq's claim that anthrax production ceased at the end of 1990, therefore, does not seem plausible. Indeed, there is evidence to indicate that the agent was, in fact, produced in 1991. The traces of anthrax found on equipment at FMDV suggest this facility was also used for the production of this agent. From the 1990 Al Hakam annual report it is evident

that anthrax was not produced at FMDV in that year and, therefore, it seems likely that production actually occurred between 1 and 15 January 1991, prior to the Gulf War. In fact, interview testimony from one senior Iraqi scientist at the plant indicates that, contrary to Iraq's declaration, the fermenters at that site did operate in the first half of January 1991, although the scientist was unable to provide information on what was being produced.

Because of the stated requirement for anthrax, it seems likely that fermenters at Al Hakam also operated in early 1991 for this purpose. Together, the fermenters at FMDV and Al Hakam would have had a capacity to produce about 7,000 litres of anthrax in the first two weeks of 1991. This quantity closely corresponds to the additional amount of agent indicated from other information available to UNMOVIC. The production of 7,000 litres of anthrax would consume about 140 kilogrammes of the growth medium, yeast extract, compared with the quantity (167 kilogrammes) that Iraq declared was lost or stolen.

UNMOVIC's estimate of the quantity of yeast extract unaccounted for is considered further in the clustered issue on bacterial BW agents.

Movement of Bulk Agent

Iraq's statement that all bulk BW agent remaining after the filling of weapons was stored at Al Hakam during the Gulf War, is not convincing. Iraq has declared that "*all dangerous munitions and materials and essential assets*" were instructed to be evacuated from BW programme establishments by 15 January 1991. Accordingly, equipment including fermenters, and materials, such as bacterial growth media, were said to have been removed from Al Hakam facilities. It would have been logical for all bulk agent also to have been evacuated: it was the most valuable item at Al Hakam and could not readily be replaced, it had great strategic significance and anthrax, in particular, was required for the drop tank project. Perhaps, more importantly, if Al Hakam had been bombed, bulk agent and, in particular, anthrax would have posed a contamination hazard possibly even as far away as Baghdad.

Indeed, there is credible information available to UNMOVIC that indicates that bulk agent, including anthrax, was in fact deployed during the Gulf War. Based on this information, UNMOVIC estimates that about 21,000 litres of BW agent was stored in bulk at locations remote from Al Hakam; about half of this (about 10,000 litres) was anthrax.

Destruction

As indicated above, there is persuasive evidence that bulk anthrax was deployed during the Gulf War. The question then arises as to what happened to it after the War.

Iraq declared that the decision to destroy bulk BW agent unilaterally was made in early July 1991, and the actual destruction of the agent was said to have been carried out at Al Hakam in July/August 1991. However, it seems improbable that the bulk agent that had been deployed out in the field would have been returned to Al Hakam for destruction in

July 1991. The first UNSCOM CW inspection was conducted at Al Muthanna in early June 1991 and, according to Iraq, Al Hakam was busily being cleaned at that time to remove or cover up any signs of a BW programme. Iraq would have reasonably expected a BW team to arrive at Al Hakam at any time from June 1991 onwards, and to have had any agent there after that date would have posed a high risk of discovery.

It, therefore, seems highly probable that the destruction of bulk agent, including anthrax, stated by Iraq to be at Al Hakam in July/August 1991, did not occur.

Based on all the available evidence, the strong presumption is that about 10,000 litres of anthrax was not destroyed and may still exist.

As a liquid suspension, anthrax spores produced 15 years ago could still be viable today if properly stored. Iraq experimented with the drying of anthrax simulants and if anthrax had been dried, then it could be stored indefinitely.

The suggestion that Iraq made in papers provided, in February 2003, to UNMOVIC, that investigation of the destruction site could be made using advanced technology, is noted. However, it is uncertain whether such an investigation would resolve this issue.

Iraq currently possesses the technology and materials, including fermenters, bacterial growth media and seed stock, to enable it to produce anthrax. Many of the skilled personnel familiar with anthrax production have been transferred to civilian industries. There does not appear to be any choke points, which would prevent Iraq from producing anthrax on at least the scale of its pre-1991 level.

ii. Drying of BW Agents

Introduction

BW agents are produced by a process that usually results in a liquid product, for example bacteria in an aqueous suspension, or toxins in an aqueous or organic solution. The storage life of BW agents in liquid form is usually significantly less than in the dried form and, therefore, the agents are sometimes dried. There are also other advantages to drying BW agents, including a reduction in bulk, ease of dissemination and the facilitation of a particle size that would present an optimum inhalation hazard.

There are several methods of drying BW agents. Commercially available dryers, including freeze dryers and spray dryers, may be used for this purpose. Depending on the method used, the drying of BW agents may create a contamination hazard. Special industrial dryers with containment features exist that can overcome this hazard. Alternatively, standard dryers that have been appropriately modified may be used.

Background

Iraq's interest in drying of BW agents appeared to focus on anthrax (agent B). Iraq stated that it was aware of the fact that the persistency of spores in dried form was much longer

than in liquid form. To this end, a foreign company was approached in 1989 in an attempt to acquire a special dust-free spray dryer suitable for the safe drying of anthrax spores. Documentation shows that, in 1990, the company could not obtain an export license for the dryer and the order lapsed. Iraq declared that no bulk spray drying was carried out, either of pathogenic or of non-pathogenic bacteria.

Iraq declared that a spray dryer was transferred to Al Hakam, Iraq's main BW production facility, from a civilian facility in 1988. However, Iraq stated that no attempt was made to use this dryer in its BW programme because of the unsuitability of its dust filters and its inability to produce appropriate particle sizes. In addition, Iraq stated that its Al Hakam staff lacked experience in the operation of such equipment.

UNSCOM assessed that Iraq had not fully reported its work on the drying of BW agents and that Iraq's expertise in drying was greater than declared. However, it concluded that it was not possible to determine if BW agents had been dried.

In 1996, three industrial spray dryers were destroyed, under UNSCOM supervision, during the destruction of Al Hakam. Elsewhere in Iraq there were other dryers including industrial spray dryers, drum dryers and freeze-dryers, that may have been suitable for the drying of BW agents; Iraq's interest, however, appears to have been in spray dryers.

Assessment

It is clear that from the start of the BW programme, Iraqi scientists understood the importance of drying BW agents to enhance their long term storability. In 1986, laboratory freeze-drying equipment was obtained and used to preserve laboratory stocks of bacteria. In 1988, a small quantity of anthrax was dried for inhalation experiments. In the same year, Iraq decided that industrial dryers for the large-scale drying of anthrax needed to be obtained.

It is most likely that, as it had declared, Iraq was unsuccessful in 1989/90 in acquiring a special dust-free spray dryer to safely dry large quantities of anthrax.

There was at least one spray dryer present at Al Hakam from 1988 onwards. This dryer would have been suitable for drying BW agent if safety modifications had been made. Whether this dryer, or other suitable dryers that were available in the country, were so modified, and used for drying of BW agent is unknown.

In any event, it seems likely that no bulk drying of agent took place in either 1989 or 1990. Apparently, in 1989, large-scale BW agent production was in its initial phase and Iraq was expecting to obtain from an overseas company a special dryer for its future requirements. Therefore, there seemed to be little reason, at that time, to modify existing dryers to make them safe for BW agent drying. An Al Hakam annual report for 1990 makes no reference to large scale drying of BW agents, implying that no drying occurred in that year either. The annual report, which UNMOVIC considers reliable, indicates that research into the drying of anthrax continued in 1990, but even this ceased for that year when the foreign company failed to supply the special dryer.

It is not certain, however, that no drying of BW agents was conducted in 1991. Given that Iraq then knew it could not obtain the special dryer it had sought, it may have modified existing dryers at Al Hakam, or elsewhere, for this purpose. It is noteworthy that, by 1993, Iraq was successfully drying large quantities of bacterial insecticide (using a non-pathogenic spore forming bacteria related to anthrax) at Al Hakam. Evidently, the technology for drying bulk quantities of spore-forming bacteria had been gained at some time prior to this date.

In December 1998, there were over 20 spray dryers and 70 freeze dryers under inventory control including some of these items that could be used for the drying of bulk BW agent. In addition, there was evidence that Iraq was developing the capability of indigenously manufacturing spray dryers. If bulk agent were available, Iraq would have had the capability after 1991, to process this using available equipment modified to reduce the risk of contamination.

UNMOVIC has no evidence that drying of anthrax or any other agent in bulk was conducted. But given Iraq's interest in drying, the existence of large quantities of liquid bulk agent in 1991, the availability of suitable dryers and the expertise that Iraq had developed, UNMOVIC cannot be certain that Iraq did not dry agent.

In February 2003, Iraq provided UNMOVIC with a paper repeating its arguments that it did not dry BW agents. No new information was disclosed in this paper and, therefore, it does not affect the above assessment.

Iraq has available to it many dryers of different types, that with modification could be made safe for the drying of BW agents.

X. Botulinum Toxin

Introduction

Clostridium botulinum is a species of spore forming bacteria, which grow in the absence of oxygen, and is commonly found in soil. There are a number of strains of *Clostridium botulinum* each producing an immunologically distinct neurotoxin: letters A through G designate the types of botulinum toxin. Botulinum toxin type A is the most lethal bacterial toxin known per weight of agent and is approximately 15,000 times more toxic than the nerve agent VX.

The most common form of botulinum toxin poisoning in humans is generally associated with types A, B, and E. Botulinum toxin is the causative agent of botulism. It is a food contaminant occurring in low concentrations in some canned foods. Botulinum toxin in very low concentration also has a number of medical applications and is the subject of legitimate civilian research.

Historically, botulinum toxin is well documented internationally as a BW agent: Iraq declared that it produced botulinum toxin type A as a BW agent. The most likely route of infection for this toxin on the battlefield is through inhalation.

Background

Iraq stated that research and development work commenced on botulinum toxin (which it referred to as Agent A) at Muthanna State Establishment (MSE) in April 1986, which drew upon basic research conducted at the Al Hazen Institute in the 1970's. In 1987, the research and development work was transferred from MSE to Al Salman. A small quantity of the toxin was produced for laboratory evaluation during that year. After successful evaluation, Iraq declared that it produced about 800 litres of concentrated toxin between January and October 1988. Iraq also stated that bulk production of botulinum toxin began at Al Hakam in 1989 following the transfer of fermenters from Al Taji and the Veterinary Research Laboratory at Abu Ghraib to the Al Hakam facility at the end of 1988.

In 1995, Iraq declared that, between January 1989 and August 1990, Al Hakam produced about 13,600 litres of concentrated toxin. In addition, Iraq also stated that, in November and December 1990, part of the Foot and Mouth Disease Vaccine (FMDV) plant at Daura was taken over for the production of the toxin and, during this period, produced around 5,000 litres of concentrated botulinum toxin. Total production of the toxin from all facilities, according to Iraq, was about 19,000 litres (concentrated 20 times).

UNSCOM concluded that, while it was possible that large-scale production of botulinum toxin began in 1989 as Iraq had declared, because of incomplete records, the amount of agent produced could not be verified. According to UNSCOM, Iraq could have produced at least double the amount declared.

Iraq declared that field tests with botulinum toxin occurred in March and April 1988 using LD-250 bombs, and, in November 1989 and May 1990, using 122mm warheads.

Some documentary and video evidence from the Haidar Farm cache suggest that these tests occurred as declared. Iraq states that about 500 litres of the toxin was used in weapons tests.

Iraq declared that it tested a modified 2,200-litre Mirage drop tank as a method of dispersing BW agents. Tests were undertaken separately with glycerin, potassium permanganate, water and *Bacillus subtilis*, an anthrax simulant, in January 1991. During the Technical Evaluation Meeting (TEM) in 1998, Lieutenant General Amer Al-Sa'adi referred to Iraq not discounting the possibility of using botulinum toxin in modified drop tanks. Prior to this statement, Iraqi officials, when interviewed by UNSCOM, had consistently indicated that they believed that anthrax was the agent of choice for the drop tanks. In its 1997 FFCD and its 2002 CAFCD, Iraq stated that drop tanks were developed for BW agents but never filled with agent and never used.

In its FFCD and repeated in its CAFCD, Iraq stated that one hundred R-400 aerial bombs and sixteen Al Hussein warheads were filled with botulinum toxin between December 1990 and 11 January 1991. Iraq acknowledged that the numbers of bombs it declared filled with particular BW agents were estimates. According to Iraq, these filled munitions were unilaterally destroyed in July 1991 along with 7,565 litres of agent stored in bulk.

UNSCOM assessed that Iraq had provided insufficient information on the production and weaponisation of botulinum toxin. In addition there were inconsistencies between the information provided in its FFCD and testimony by Iraqi officials relating to production and destruction. UNSCOM could therefore not verify the amounts of agent produced and destroyed as declared by Iraq.

The finding of botulinum type B toxin (as opposed to type A toxin) on a fermenter probe at Al Hakam also added to the uncertainty UNSCOM had of Iraq's declarations since Iraq had denied that type B was investigated or produced.

Assessment

With respect to production, Iraq has declared that it destroyed its records. Without such evidence there is very little prospect of verifying the quantities of agent A Iraq may have produced. Although the 1990 Al Hakam Annual Report supports Iraq's statements for the Al Hakam and FMDV production sites for that year, production, especially for 1989 and 1991, could have been much different than declared by Iraq. In this regard, based on fermenter capacity and on available bacterial growth media, production of botulinum toxin could have been greatly in excess of that declared by Iraq.

The significance of the finding of botulinum toxin type B on a fermenter probe at Al Hakam remains unclear. There is no evidence available to UNMOVIC that Iraq imported *Clostridium botulinum* type B strain. Given that type A is more toxic, it is difficult to explain the need for this strain. Contamination from local sources is one possible explanation.

However, UNMOVIC does not question Iraq's statement that botulinum toxin type A was weaponized in the Al Hussein warhead and R-400 bombs. Iraq's inconsistent statements with regard to the numbers of weapons filled and the destruction of agent, together with the lack of documentary evidence for production of agent in 1989 and 1991, makes overall quantitative verification impossible. According to Iraq, the numbers of bombs filled with botulinum toxin are only estimates, and, as such, it is not possible to verify an exact number.

It is significant that a high-ranking Iraqi official at the TEM indicated the drop tank may have been for agents other than anthrax. This is contrary to statements made by lower ranking Iraqi officials.

Any botulinum toxin that was produced and stored according to the methods described by Iraq and in the time period declared is unlikely to retain much, if any, of its potency. Therefore, any such stockpiles of botulinum toxin, whether in bulk storage or in weapons that remained in 1991, would not be active today.

Determining the quantity of botulinum toxin that Iraq produced and the implication that this had on fermenter availability, however, is important as an unresolved disarmament issue. It impacts on the assessment of the quantities that Iraq may have produced of other agents, in particular, anthrax.

A document submitted by Iraq to UNMOVIC in February 2003 relating to the production of *Clostridium botulinum* toxin, the equipment and media used and the production process involved, restated information available in previous declarations. There was no new information in this document.

Since Iraq produced more botulinum toxin than other agents and it still possesses the expertise and possibly the seed stock, material inputs (such as growth media), and equipment (fermenters), then production at least at the scale of its pre-1991 level could be rapidly recommenced.

XI. Undeclared agents, including Smallpox

i) Undeclared Agents

Introduction

There are a number of microorganisms and toxins that have been developed as BW agents by several countries, including *Bacillus anthracis* (anthrax), *Clostridium botulinum* toxin, *Yersinia pestis* (plague), *Francisella tularensis* (tularemia), *Brucella* species (Brucellosis) *Coxiella burnetii* (Q fever) and Variola major (smallpox).

Iraq declared that it had produced and weaponized three BW agents: *Bacillus anthracis* spores, *Clostridium botulinum* toxin and aflatoxin. It also declared that it investigated a number of other agents for BW purposes, including *Clostridium perfringens*, wheat cover smut, ricin, and trichothecene mycotoxins.

Background

In 1985, a biological weapons group was established at the Muthanna State Establishment (MSE), Iraq's main CW production agency. Iraq declared that, starting in April 1986, it acquired a range of biological isolates (seed stocks) both locally and abroad for its BW programme.

Iraq stated that after the biological weapons group had moved from MSE to Al Salman (~1987/88), the Technical Research Centre (TRC), which was responsible for managing the BW programme, became interested in other potential BW agents (including viruses and different toxins). It became the policy of TRC to expand the programme into these other fields. Subsequently, Iraq revealed that other agents had been investigated and that in 1990, viral and genetic engineering units were established.

UNSCOM determined from a review of supplier information that Iraq had attempted to acquire more strains of microorganisms than it had declared for its BW programme.

In 1991, the first UNSCOM BW inspection team was provided with a declaration of the number and the types of microorganisms that had been acquired by Iraq as part of its biological research for military purposes. Iraq provided the team with a number of unopened vials of these strains. The only strain not handed to the team, that was said by Iraq not to have been used in the BW programme, was a vial of *Brucella melitensis*. This strain was declared as having been provided to a member of the BW programme for use in a Master of Science (MSc.) project. However, the strain was declared to have been destroyed before it could be used in the project. The validity of the statements concerning the fate of this strain could not be confirmed by UNSCOM.

UNSCOM also expressed concern over the accounting of growth media and its relation to the possibility of undeclared BW agents. UNSCOM stated that it had no information regarding the fate of unaccounted for media. UNSCOM found that *"it is not possible to determine if bacterial or toxin agents other than those stated in the 1997 FFCD were produced"*.

Assessment
This issue relates to the question whether Iraq declared the full range of BW agents it had investigated, produced or weaponized.

While UNSCOM did not find any substantial evidence that agents other than those disclosed by Iraq had been part of the BW programme, there are some indications suggesting an interest in other agents. One of these concerns has been addressed in the virus research assessment, namely smallpox.

UNMOVIC assesses that neither peptone or tryptone soya broth (TSB) growth media have been adequately accounted for by Iraq. It is not possible to be definitive about the amount of peptone and TSB that may be unaccounted for, but the amount would appear to be significant. TSB is particularly suitable for the growth of *"fastidious organisms"* (including gram negative microorganisms such as *Brucella, Yersinia* and *Francisella*). Iraq has not declared that it produced such organisms. It is therefore a matter of concern that Iraq had obtained bulk quanties of such media. In this regard, it is noted that the declared destruction of the *Brucella* isolate which was acquired in 1986 was not supported by evidence, which adds to the concern surrounding the accounting for TSB.

Accounting for the outstanding media, in particular TSB, would greatly reduce the uncertainty surrounding this issue. In the absence of such accounting or verified account of the R&D, production and weaponisation aspects of Iraq's BW programme, questions will remain concerning the possibility that Iraq worked on agents that it did not declare to UNSCOM.

ii). Viral Research

Introduction
Iraq stated that its brief viral research programme had focused on three incapacitating but generally not lethal, agents: enterovirus 70, rotavirus and the camel pox virus. Enterovirus 70 can cause severe eye pain, blurred vision, photophobia and sub-conjunctival hemorrhage. The symptoms appear suddenly and recovery can take up to 10 days. The rotavirus causes diarrhea, dehydration and cramps. The effects normally last for about 48 hours and some strains are lethal for the very young and old. The World Health Organization does not rule out the possibility of the camel pox virus being transmissible to humans even though actual cases seem rare. None of these viruses are considered traditional BW agents.

Background
During 1990, Iraq expanded its BW programme to include viral research.

With regard to its viral programme, Iraq declared that, apart from some basic research at the Al Hazen Institute between 1974 and 1978, no other viral research for BW purposes took place between 1974 and 1990. Following a scientific literature survey in July 1990,

research was initiated in September 1990. Iraq produced documentation supporting these statements.

In its 1997 FFCD, Iraq declared that, on 1 December 1990, laboratory work commenced with camel pox virus, infectious hemorrhagic conjunctivitis virus (enterovirus 70) and rotavirus, all of which were locally acquired. Iraq provided UNSCOM with a daily logbook covering the period 1 December 1990 to 17 January 1991 that described Iraq's research on rotavirus and enterovirus 70. Iraq stated that all research work had been terminated on 17 January 1991 and that all viral agent specimens were destroyed. Iraq declared that the objective of the virus research was to study viral agents suitable as incapacitating BW agents.

With regard to the viral research programme, the head virologist stated to UNSCOM that the camel pox virus was chosen in the belief that it would selectively infect "non-Arabs". UNSCOM was told that it had not been pursued as a model for the smallpox virus. In addition, UNSCOM was told that the head virologist had attempted to acquire a 5,000 egg incubator with a view to producing the camel pox virus for weaponisation.

UNSCOM found two foreign scientific publications among the Haidar Farm documents that related to smallpox and smallpox vaccination. These publications referred to production and storage of smallpox vaccine in the 1980s and the storage of smallpox vaccine seed stock. While retention of these publications could reflect legitimate medical concerns, they were considered by UNSCOM to be indicative of Iraq's interest in smallpox.

Assessment

Although in the lead up to the Gulf War, Iraq's BW programme was focused on the production of bulk agents and weaponization, some attention was given to diversifying the BW programme and making it more robust. In fact, the BW effort was expanding, as evidenced by the establishment of a number of genetic engineering facilities and the commencement of the viral research programme. Although both of these programmes seemed short-lived, and probably achieved little, it does demonstrate intent and commitment to a more diversified and dynamic BW programme.

The direction which Iraq's BW viral research programme took seemed to have been the initiative of the head virologist. His interest in the camel pox virus may have been prompted by a study at the University of Baghdad in the 1970s which mentioned the possibility that *"viruses like camel pox, buffalo pox and monkey pox may establish themselves in a less immune human population"* and cause smallpox-like disease. It is conceivable that this paper may have influenced the head virologist to think that camel pox could be an incapacitating BW agent that could selectively infect "*aliens*" (non-Arabs). Whether the intention was to weaponise this agent remains unclear. However, according to the head virologist, one concept of production, weaponization and use of viruses involved the breeding of vectors for their dissemination.

Whether Iraq was using the camel pox virus as a simulant for smallpox has not been established. While UNSCOM had some concern and there was some related scientific literature in the Haidar Farm cache, there is no evidence that Iraq had possessed seed stocks for smallpox or had been actively engaged in smallpox research. Whether that was the eventual intention cannot be determined as the viral programme was said to have stopped at an early stage.

In the absence of supporting evidence and further explanation, such as instructions covering the viral research plan and the logbook covering the work done for camel pox, the scope of the viral research undertaken by Iraq remains unclear. Scientific literature describing the symptoms and infectivity of the viral agents selected by Iraq confirm that, enterovirus 70 and rotavirus could theoretically be used as incapacitating agents. Despite Iraq's apparent belief that camel pox virus could be an incapacitating agent, this is not supported by scientific literature. Although these viruses are not considered as serious BW candidates in the open literature, Iraq was in the embryonic stages of its research and it is conceivable that more potent viral agents would have been selected as the programme matured.

According to Iraq's declarations, its BW virus research work lasted only 47 days and the logbook provided to UNSCOM addressed work conducted on rotavirus and enterovirus 70 appears to confirm this. Other documentation provided by Iraq also supports the short time-frame for its BW viral research programme.

Although UNMOVIC assesses that probably little would have been achieved in Iraq's BW viral research programme prior to the Gulf War, but, these areas of research identify the possible future directions of a BW programme and should be followed up.

XII. Any other proscribed activities post 1998

For a period of almost four years, from the end of 1998 until November 2002, there were no UN weapon inspectors in Iraq. Iraq has maintained that no proscribed activities took place during this interval.

In 1991, Iraq declared its chemical and missile weapons programmes, and made available a number of proscribed facilities and items for UNSCOM to inspect, verify and deal with. These declarations provided a basis on which to question Iraq and to probe its explanations for consistency, etc. Often, this led to the uncovering of more proscribed activities and material. However, with respect to biological and nuclear weapons programmes, Iraq initially declared in 1991 that it did not have such programmes. Consequently, UNSCOM and the IAEA had to take a different approach in order to verify whether this was indeed the case. Inspections in these fields were based on, for example, intelligence reports, supplier information, selective searches for documents and material, and interviews. Iraq was driven to declare its biological and nuclear programmes, although much remains to be explained and verified in the biological area.

For the period 1998 to present, UNMOVIC now faces the same situation in all three disciplines that UNSCOM and the IAEA faced in 1991 regarding biological and nuclear weapons issues. There are no leads, such as stocks of proscribed items, or WMD production facilities for UNMOVIC to inspect. Instead, UNMOVIC must verify the absence of any new activities or proscribed items, new or retained. The onus is clearly on Iraq to provide the requisite information or devise other ways in which UNMOVIC can gain confidence that Iraq's declarations are correct and comprehensive. At the same time, UNMOVIC will avail itself of intelligence reports, supplier information, selective searches for documents and material, aerial imagery from satellites and different aircraft platforms, interviews, remote monitoring with video and other sensors, etc. to gain information that could be used to evaluate various aspects of Iraq's declarations.

Four years without inspection is a significant period. Given the history of Iraq's proscribed weapons programmes, Iraq potentially could have made considerable advancements in that time, particularly in the biological and chemical fields. For example, within a period of about three years, Iraq built most of its chemical weapons plant at Al Muthanna and went into large-scale production of a variety of CW agents and munitions. And it took just two years to build its BW production plant at Al Hakam and produce over 27,000 litres of BW agent. Plants of such a size would of course be easy to detect, but they could also be disguised as dual-purpose plants now producing some civilian product. In fact, that is exactly how Iraq presented its BW production facilities to UNSCOM inspectors from 1991 to 1995. Smaller plants and underground or mobile facilities would be harder to detect.

UNMOVIC has received many reports suggesting that Iraq has been engaged in a range of proscribed activities during the absence of inspectors. The information has been of a variety of types, from general assertions to detailed and precise intelligence. Some of it

has been presented publicly, much of it has not. It has included overhead imagery, reports from defectors and other sources such as communications intercepts.

Mobile BW agent production facilities

Several governments have provided UNMOVIC with information relating to truck-mounted BW agent production facilities. The reports, which are reasonably consistent, refer to a series of usually three large articulated trucks that together comprise a complete, but small, biological factory. The reports indicate that one truck would carry fermenters, another the mixing and preparation tanks and the third, equipment to process and store the product. Several such mobile factories are said to exist and BW agent was reported to have been produced in them from 1998 to 2002, with some reports suggesting that production continues.

UNMOVIC has not had direct access to the originators of these reports, some of whom are persons claiming to have been directly involved in the design and manufacture of mobile facilities in Iraq. In theory, such facilities are possible and, indeed, Iraq has acknowledged that in the late 1980s such facilities were seriously considered. Senior Iraqi officials informed UNSCOM that the concept was ultimately rejected because it was considered to be impractical.

The investigation of mobile facilities is inherently difficult. Most of the transport of goods around Iraq is by truck and there are many thousands of vehicles in Iraq that potentially could be used. In any case, if such factories existed, they would not necessarily be on the roads of Iraq after the start of inspections in November 2002. Furthermore, such factories would be easy to dismantle and the components used for innocent purposes. Nevertheless, UNMOVIC has studied ways by which mobile facilities could be investigated and has conducted some initial inspections in this connection. This is an area where Iraq's active assistance and cooperation will be required, both in the development by UNMOVIC of a system of road/rail traffic monitoring and in its implementation. Such a system could be based, for example, on strategically placed vehicle checkpoints that could be moved as required. These checkpoints could be supported by aerial platforms such as helicopters and drones to monitor traffic activity surrounding the checkpoints and track vehicles identified for more scrutiny. Freight trains could be searched at random, not only at loading platforms, but also between stations at, for example, railway crossings. The more comprehensive the system, the better Iraq will be able to address the concerns consistently and repeatedly voiced that it has such facilities and does move proscribed materials by road and rail to evade detection.

Underground Facilities

UNMOVIC has also received many reports of underground facilities involved in a range of proscribed activities from research to the production of CW and BW agents. Such facilities have been reported to be at locations throughout Iraq, from the mountains in the north, to buildings in Baghdad, including a Baghdad hospital.

In some cases, where the location could be positively identified, inspectors have investigated the site using the tools available to them, including ground penetrating radar. However, in many cases, the locations have not been specific and, in such circumstances, further intelligence has been sought.

The result, so far, is that no underground facility of special interest has been found. Although they may be easier to find than mobile facilities, they are still a difficult target and it is always possible that inspectors have missed a hidden entrance. Like mobile facilities, any dedicated underground CW or BW facility could also have been dismantled prior to inspection. UNMOVIC does not dismiss the possibility that such facilities exist and will continue to investigate reports as appropriate. Given the vast number of potential underground "sites" capable of hosting CW or BW production or storage facilities in Iraq, inspections in this area will have to be dynamic and rely on specific intelligence information.

Movement of proscribed material

There have been many reports claiming that there have been movements of proscribed materials around Iraq, with some such moves reported to have occurred immediately before the resumption of inspections. Such items have variously been stated to be documents, missiles and chemical and biological weapons. As before, the evidence for this has been of variable credibility and in some cases is subject to different interpretations.

Proscribed items may well have been moved around Iraq before inspectors arrived, and possibly continued after their return. However, based on inspections and the information UNMOVIC has seen so far, it is not possible for UNMOVIC to reach any conclusions on the matter. This is another area where Iraq's active assistance and cooperation will be required in UNMOVIC developing and implementing a system of road/rail traffic monitoring to help dispel concerns that movements of proscribed materials are taking place.

Non-Proscribed Developments 1998 to present

While possible proscribed activities over the past four years are difficult for UNMOVIC to detect, UNMOVIC is reasonably knowledgeable of the non-proscribed scientific and technical developments that occurred during this period. Iraq listed such activities in its declaration of 7 December 2002 and in its semi-annual declarations. Most of the locations and activities so declared have now been inspected by UNMOVIC.

Chemical and biological

In the chemical and biological fields, Iraq's civilian scientific and technical capabilities have only slowly increased in the past four years. Iraq has demonstrated the ability to manufacture both chemical and biological equipment, such as simple process equipment and fermenters.

In the chemical area, Iraq has repaired some equipment destroyed under UNSCOM supervision, and has installed such equipment in plants producing chlorine and phenols. Iraq has also refurbished some chemical facilities, and others have undergone a modest expansion. No significant new plants have been constructed.

In the biological field, there has been a new emphasis on higher education in biotechnology and a new genetic engineering facility has been established. Overall, in biological industries, there has been a modest expansion, reflected in an increase in staffing of 10 to 20 %. One new biological fermentation plant has been built for the production of alcohol.

In general, there is little evidence of change in the chemical and biological disciplines beyond that noted above. No proscribed activities, or the result of such activities from the period of 1998-2002 have, so far, been detected through inspections. . There are a number of chemical and biological facilities or production units that could be used for both proscribed and non-proscribed purposes. In order to verify and monitor the status of such facilities, information such as original documents concerning budgets, the employment of certain individuals, planning, imports and logbooks of key items of equipment should be provided to UNMOVIC.

Supplier information

Although there have been some inconsistencies and discrepancies in Iraq's semi-annual declarations, the largest failing is the lack of information on suppliers. UNMOVIC has noted in the biological area about 40 cases where insufficient information is provided on the supplier, and in the chemical area, about 70. In the missile area however there are almost 500 examples of imports where the supplier has been inadequately identified. On many occasions the imports are simply referred to as coming from the "local market" or from "Iraq" when it is clear that the items actually originated from overseas. In such cases, the actual supplier and country of origin have not been identified. Items have included gyroscopes, chemicals and laboratory equipment. There is evidence to indicate that many of components for Iraq's declared RPVs and missiles originated from overseas and the supplier has been inadequately identified.

Names Supplied by Iraq

So far, Iraq has submitted lists of names on four separate occasions. Most of these have concerned Iraq's past programmes and explicitly state that they end in 1991. An exception to this was a submission of 685 names associated with the current Iraqi missile programmes. There are doubts as to the completeness of these lists. For instance, Iraq lists less than 132 "experts, specialists, and technicians," to use Iraq's term, as having worked in the entire chemical weapons programme. UNMOVIC databases, on the other hand, indicate that over 325 individuals were engaged in chemical weapons related research or had responsible positions associated with agent production at the Muthanna State Establishment alone. In a direct response to this observation, Iraq submitted a new list of 183 names associated with the former chemical programme. Iraq also indicated in a letter dated 14 March 2003 its willingness to submit additional names in the future.

Such lists of names as well as employment records are important for the conduct of interviews to help resolve outstanding issues relating to Iraq's past weapons of mass destruction programmes as well as existing doubts about what has occurred during the absence of inspectors from 1998 to 2002.