Appendix

The issue of small quantities of biological and chemical warfare agents

Chemical area

1. The United Nations Monitoring, Verification and Inspection Commission (UNMOVIC) reported on the initial stage of the study of the issue of small quantities in its report to the Security Council of February 2005 (S/2005/129). In both the chemical and biological areas, the study was to identify any possible proliferation implications from all the changes in post-2003 Iraq. Since that report, all known chemical warfare agents and all dual-use compounds acquired and used by Iraq for its past chemical weapons programme, including chlorine, were considered. Other toxic chemicals that could be obtained as poisonous industrial by-products, for example dioxins, which are not covered under the terms of Council resolutions, were excluded from consideration.

2. The interpretation of how small the "small quantities" of toxic chemicals should be is complicated. Nevertheless, this question was approached based on the UNMOVIC knowledge of Iraq's chemical weapons activities, rather than on the knowledge of chemical weapons-related programmes of other States possessors. Iraq (and other States) in the past used such terms as "military significant quantity of chemical weapons". This term, however, does not have a universal definition owing to differences in the military doctrines of States that have acquired chemical weapons stockpiles. According to Iraq, it produced chemical weapons both for first strikes and as retaliation weapons. Iraq declared the production of nearly 4,000 tons of chemical weapons agents (for comparison, the chemical weapons stockpiles of some other States possessors were about 10 times this quantity).

3. The evaluation of small quantities of toxic agents for monitoring purposes (well below the military significant level), has been conducted only in an empirical way. Such an evaluation was made based on the estimated quantities used by Iraq in the past for research and development purposes. For example, Iraq declared that its past research and development projects at the main chemical weapons production site, Muthanna State Establishment, resulted in the synthesis of chemical weapons agents or their precursors within the range of a few grams to a few hundred kilograms. Therefore, the term "small quantities" of chemical weapons agents in the case of Iraq should be understood to mean quantities within the range of grams to kilograms, rather than tons.

4. Four critical elements related to the possible acquisition of toxic agents in small quantities were identified. The first is production capability, comprised of raw materials, equipment and associated sites/locations. Large-scale production of chemical weapons agents or their immediate precursors is usually associated with industrial-scale plants with specific process and physical configurations. However, small quantities of such chemicals can be produced at nuclear, biological and chemical laboratories, analytical and quality control laboratories, commercial research and development centres, universities or pilot-scale units installed at both chemical and non- and chemical facilities. Small-scale process equipment used for chemical weapons synthesis does not usually require any specific features, since it is

mostly standard glass equipment. It can easily be destroyed, replaced or disassembled, if necessary.

5. The second element deals with the possibility of finding pre-1991 chemical munitions in Iraq. In its twenty-sixth report to the Security Council (S/2006/701), UNMOVIC[a] noted that various data on past production, filling and storage of Iraqi chemical weapons suggest that any remaining mustard-filled artillery shells could still contain viable agent, as Iraq consistently produced mustard of high purity. It is unlikely that any rocket warheads filled with nerve agents would still contain viable agent, as they were less robust than the artillery shells and their content of lesser purity was subject to degradation. However, because of the varying quality of the nerve agent produced, it is possible that, even degraded, it can still pose a health hazard associated with the toxic effects of chemical agents or their degradation products.

6. The third element is the procurement, both legitimate and illegitimate, of small quantities of dual-use chemicals or even chemical weapons agents. The quantities of dual-use chemicals traded worldwide for research and development purposes, unlike quantities at the level of industrial-scale trade, are not as highly regulated internationally. The worldwide trade of small quantities has unknown trends involving comprehensive procurement networks. The networks are largely comprised of private individuals — scientists who are capable of synthesizing chemicals on demand in their own laboratories. The shipment of small quantities of dual-use chemicals by individual suppliers, even via commercial courier companies, does not pose any significant difficulty, given that the name and basic properties of the chemical being shipped in the packaging documents can be falsified. It should be noted that, since March 2003, neither Member States nor Iraq have been providing UNMOVIC with notifications of the sale or supply to Iraq of dual-use items as required by the export/import monitoring mechanism created by Security Council resolution 1051 (1996). Council resolution 715 (1991) requires that dual-use items be under monitoring.

7. The fourth element related to the acquisition of small quantities is the proliferation of chemical weapons knowledge. Iraq possessed an extensive chemical-weapons-related cadre of scientists experienced not only in production but also in the delivery and dissemination of chemical weapons agents. The number and current location of the remaining chemical weapons experts in Iraq are not known to UNMOVIC. This factor, combined with the technical know-how of chemical weapons production technologies that could still be available in Iraq, and the potential interest of non-State actors, poses a proliferation risk in terms of small quantities of toxic agents (for both their acquisition and use). In its addendum of March 2005, the United States-led Iraq Survey Group, searching for weapons of mass destruction in Iraq, concluded that while the danger remains that insurgents may seek Iraqi expertise, the subset of individuals who possess the unique weapons

[a] During the war between Iraq and the Islamic Republic of Iran, Iraqi regular military units in areas of operation received and used both conventional and chemical weapons. Because of the rapid relocation of many of these units after the war and the dozens of locations involved in the handling of the weapons, there is a possibility that chemical munitions became inadvertently mixed with conventional weapons. Moreover, some chemical munitions filled with chemical warfare agents did not differ in their markings from standard conventional weapons, which made their identification as chemical munitions problematic, not only for United Nations inspectors and later personnel of the Iraq Survey Group, but also for Iraq.

of mass destruction skills of proliferation concern is numerically low. But it should be noted that there are a large number of scientists who have been associated with Iraq's chemical weapons programme, in the UNMOVIC database. Nevertheless, the Iraq Survey Group concluded that because a single individual can advance certain weapons of mass destruction activities, it remains an important concern.

8. Unlike the military use of chemical weapons agents, the application of toxic compounds by non-State actors does not require special delivery means such as chemical bombs, artillery projectiles, spray tanks, rocket warheads or missile warheads. Primitive devices, such as plastic bags, smoke generators and aerosol cans, filled with toxic compounds, have been known to be used against an unprotected population by terrorists in the past. Also, it cannot be excluded that pre-1991 chemical munitions, especially mustard projectiles, if found, could be used, knowingly or unknowingly, by non-State actors in Iraq.

9. By its design, the chemical monitoring system implemented by the Commission in Iraq was capable of dealing with a number of key tasks. It involved the verification of Iraq's declared activities on both the industrial and research and development scale, involving the monitoring of dual-use chemicals, equipment and technologies. In addition, the verification of the end use of such dual-use items, irrespective of their origin, was implemented through a combination of the export/import monitoring mechanism (notifications from Iraq and Member States) and on-site inspections.

10. The ongoing monitoring and verification system implemented in Iraq under Security Council resolution 715 (1991) aimed to deter and/or detect the diversion of industrial-scale dual-use capabilities for prohibited purposes. This task was implemented through both the monitoring of declared activities and the examination or verification of information about activities that had been provided to the Commission by intelligence, found by inspectors, or identified through other sources. During the period from 1993 to 1998, and a few months in 2002 and 2003, when the monitoring system was implemented in Iraq, the Commission was able to conclude with a high level of confidence that no diversion of industrial-scale dual-use items for proscribed activities had occurred. A similar conclusion could be drawn with regard to Iraq's smaller-scale dual-use capabilities (such as research and development), which had also been subject to monitoring and inspections. The export/import monitoring mechanism provided an additional assurance that Iraq was complying with its obligations not to acquire items and materials proscribed to it, for both research and development and industrial-scale chemical activities.

11. However, Iraq's declarations under Security Council resolution 715 (1991) and export/import monitoring notifications under resolution 1051 (1996), have thresholds below which declarations are not required. For dual-use chemicals covered by the monitoring plan (including chlorine and other industrial compounds) which could be used for chemical weapons purposes but also have wide commercial applications, there is a declaration threshold of 1 ton or more of production, processing, consumption, storage and export/import per year, at a specific site. The declaration of quantities below 1 ton is not required under the ongoing monitoring and verification plan. However, information on such smaller quantities was previously declared based on practical arrangements between the United Nations Special Commission and Iraq. According to that arrangement, all production activities above 100 kilograms (kg) per year were declared. All research and

development activities involving dual-use chemicals in quantities of 50 kg and more per year were also declared. According to the 2002 semi-annual monitoring declarations provided by Iraq, about 90 per cent of the activities involving dual-use chemicals fell in the range of between 50 kg and 1 ton. The ongoing monitoring and verification plan also provides that all mixtures and forms of dual-use chemicals (i.e., those permitted to Iraq, but subject to United Nations monitoring) in all possible concentrations are declarable.

12. Under the terms of the export/import monitoring mechanism, there is a quantity-independent approach requiring that UNMOVIC be notified of dual-use chemicals. No quantities of any prohibited chemicals can be procured by Iraq unless authorized by UNMOVIC.[b] The export or import of dual-use chemicals should be reported regardless of quantity. However, according to the 2001 revised version of the export/import lists, mixtures with less than 10 per cent of dual-use chemicals are exempted from the notification mechanism. This has implications from the standpoint of verification of the acquisition of small quantities of dual-use chemicals. Mixtures containing dual-use chemicals are usually easier to produce and then to separate at a small scale rather than at an industrial scale, since the technological parameters of such separation can be easily controlled. Additionally, the exemption of mixtures with less than 10 per cent of dual-use chemicals does not allow for the cross-checking of information from both Iraq and the foreign supplier.

13. The current versions of the lists of chemicals covered by the export/import monitoring mechanism and those covered by the ongoing monitoring and verification plan are slightly different from the export/import lists, which were updated in 2001. As a result of the convening of a panel of international experts to examine the issue of revising the lists, certain chemicals, for example chlorine, were removed from the export/import lists, but no changes were made in respect to the chemicals listed under the ongoing monitoring and verification plan.

14. With respect to equipment, according to both the ongoing monitoring and verification plan and the export/import monitoring mechanism, certain thresholds are applicable for the declaration or notification of dual-use chemical process equipment. For example, a 50 litre threshold has been set for certain chemical reactor vessels. However, inspectors used a practical approach for monitoring dual-use process equipment installed in Iraq's facilities, where important equipment was identified and tagged, irrespective of their capacity or other specifications (such as material of construction). In general, the monitoring of chemical process equipment allowed inspectors to obtain additional information on activities involving dual-use chemicals at the particular site.

15. The past implementation of the ongoing monitoring and verification plan in the chemical area in Iraq allowed the monitoring of small-scale activities (production, processing, consumption, storage and export/import) involving dual-use chemicals, equipment and technologies. The ongoing monitoring and verification plan also has the flexibility to address the new factors that have emerged in Iraq since 2003, given the set of the rights allocated by the Security Council to the United Nations inspectors, especially the right of immediate and

[b] The ongoing monitoring and verification plan has two lists of chemicals; List A are dual-use chemicals permitted to Iraq but subject to declaration and monitoring, while List B are those proscribed to Iraq. However, the plan lays out procedures for Iraq to request exemptions from List B if it can make a sufficient case for their import.

unconditional access to a site, location or vehicle that might be suspected of involvement in undeclared/prohibited activities, as well as to personnel and documents.

16. There are new factors to consider in the post-2003 Iraq, which are related to the small quantities issue. The first factor relates to the probable increase in the number and scope of legitimate research and development activities involving small quantities of dual-use chemicals, including their procurement from abroad. In the past, Iraq was largely isolated from the international scientific community and therefore the number and scope of such activities remained restricted. An additional factor relates to the change of ownership of industry in Iraq. All institutions, including joint ventures and private companies in Iraq previously declared by Iraq as engaged in activities with dual-use chemicals or equipment on any scale had been either State-controlled or closely supervised by the State authorities and monitored by United Nations inspectors. This included the food, petrochemical, fertilizer, pesticide and explosives industries. Governmental control over non-State-owned establishments similar to that under the previous regime may no longer be in place. Therefore, it may be difficult for Iraq's authorities to collect a complete set of data on activities in the chemical area in the country without appropriate national regulations and/or requirements on its facilities and other entities. Additional sources of information regarding export/import activities on, for example, equipment and material as well as other information would be needed by the national authorities.

Biological area

17. Biological warfare agents may produce mass casualties in humans under certain conditions. The expression "small quantity of weapons of mass destruction" is open to debate. However, for this analysis, it is assumed to be the smallest quantity of biological agent that is capable of inflicting significant damage if disseminated in an efficient way.

18. There are only a few reported actual attacks with small quantities of biological warfare agents. Of these, two were bioterror and five biocrime incidents, which resulted in multiple casualties. Several other cases that resulted in casualties were individual assassinations or assassination attempts using biological agents or toxins, which are not included in this analysis.

19. With the exception of the so-called anthrax letters incident in the United States of America in 2001, all cases of bioterror/biocrime attacks that resulted in multiple casualties used agents that were not typical biological warfare agents. The agents used were mostly pathogenic micro-organisms available to the perpetrator through their profession and/or study.

20. Two biological warfare agents, botulinum toxin and ricin, were used in several unsuccessful bioterror attacks. In most of the incidents, it was difficult to ascertain if biological agents and/or toxins were used deliberately even in the cases with multiple casualties. Furthermore, it was often difficult to trace the source of agent and/or perpetrator. For example, in 1984, the deliberate contamination of food (known as the Oregon case) was not uncovered for more than a year after the actual incident, when the leader of a cult voluntarily admitted its involvement in the deliberate release. The perpetrator of the anthrax letters in the United States has yet to be found and there has been a lot of conflicting information published about the quality of the anthrax powder and the identity of the possible perpetrator(s).

21. It is widely believed that non-State actors can obtain biological agents and/or toxins from countries with biological weapons potential or by isolation from natural sources. It is also believed that if they involve personnel with some training and widely available equipment, and that the agents are used against highly populated areas, they may have devastating effects. However, a careful analysis of the bioterror attacks by the cult Aum Shinrikyo leads to a different conclusion.

- Aum Shinrikyo had at least four years time and considerable financial resources and well-equipped laboratories to support its biological projects, but it failed to inflict a single casualty despite about 10 attempts to disseminate botulinum toxin and anthrax in densely inhabited areas of Tokyo.
- For the project, they recruited qualified people with at least a graduate level of training in microbiology and molecular biology. The head of the cult's bioterror activities was a molecular biologist.
- The cult's biological team attempted to isolate toxigenic clostridium botulinum bacteria from natural sources without success. Their best isolate did not produce enough toxin to kill experimental animals. In addition, the cult failed to obtain a sample of ebola in 1992.
- The cult's members also tried to obtain biological-weapons-related knowledge and material from outside of Japan. Despite considerable financial resources, this attempt also failed.
- The cult's members attempted to buy coxiella burnetii (the causal agent of Q fever) from a Japanese scientist, but he declined to provide the micro-organism.
- Their biologists were not able to prepare enough concentrated slurry of bacillus anthracis or disperse it in an efficient way, as the dissemination device clogged and it produced a very large particle size. Additionally, they had only produced a harmless, non-pathogenic strain of bacillus anthracis.

22. Except for the anthrax letters case in the United States in 2001, the amounts of biological agents or toxins used in bioterror/biocrime attacks are not openly available. In the United States anthrax case, the letter sent to one addressee contained approximately 1 to 2 grams of powder containing bacillus anthracis spores. It is assumed that the other letters possibly contained about the same amount of anthrax powder. Thus, the total amount of the anthrax powder used in the incident may have been between 7 and 14 grams. This amount could have been prepared in one batch using a bench-top fermenter with a total working volume of about 10 litres.

23. The most critical step in known bioterror/biocrime incidents is the acquisition of biological agents or toxins. This acquisition is not as easy as it is widely asserted.[c] Access to reference strains of relevant micro-organisms from culture collections has been restricted and is now subject to regulation; as a consequence, their acquisition has become more difficult.

[c] The isolation of a disease causing micro-organism from natural sources is a complex task. For example, in former known biological weapons programmes, it was necessary to evaluate hundreds of strains of clostridium botulinum to obtain a strain with high toxin production. Ricin may be obtained by isolation from natural sources; however, its use in small quantities will not inflict multiple casualties unless it is repeatedly used against several individuals for assassination.

24. Small amounts of biological agents for bioterror/biocrime purposes can be produced in research or diagnostic microbiology laboratories given the intent, access to the material, equipment and technical know-how, although this is not normal laboratory practice and might raise suspicions. The undeclared production of small amounts of biological agents and/or toxins can be performed in such laboratories at any time, while the possibility of detecting such production is rather limited. The incidental finding of many petri dishes with growing cultures of some pathogen relevant to bioterrorism may be indicative, if found in a diagnostic laboratory when there is no epidemic of the disease caused by that agent. However, in a research laboratory, such finding may have no value.

25. Small amounts of biological agent may be produced clandestinely in laboratories built for legitimate purposes. Such clandestine activity could be found through sampling and analysis. The monitoring agency must possess the necessary capabilities of experts, sampling kits and laboratory analysis to assess whether a laboratory could have been used for the production of biological threat agents.

26. It is difficult to maintain an efficient monitoring system based on the continuity of knowledge regarding dual-use equipment that would be suitable for the small-scale production of biological agents at the national level. Such equipment is widely used in the microbiology, biochemistry, cell biology and molecular biology laboratories in academia, industry and Government. The collection of data related to the acquisition, transfer and utilization of this equipment at the national level would certainly overload any monitoring regime with information. An alternative approach would be if the manufacturers and sellers of such equipment were to adopt measures necessary to ensure that only registered institutions with legitimate needs would be able to acquire such equipment. Many manufacturers of sensitive technology equipment (for example spray driers) have already adopted these measures.

27. The amounts of biological agent necessary to inflict mass casualties are not as small as it is often presented in open sources. For mass casualties, a biological attack requires the preparation of large volumes of raw materials that must be processed in pilot or industrial-scale equipment. Results from tests of biological munitions have shown that most biological agents will incapacitate or kill 50 per cent of people in an area of 1 square kilometre if about 1 to 5 kg of these agents is disseminated over this area evenly, with 100 per cent efficiency. For the preparation of this amount of anthrax powder, for example, it would be necessary to prepare 1,000 litres of unconcentrated suspension of anthrax spores, which can be done in a large fermentation vessel. Such an amount would require an industrial-scale production fermenter that could not be easily concealed and the operation of which would require specific experience and infrastructure support. In addition, dissemination efficiency is not 100 per cent; more realistically, it is rarely over 10 per cent. Thus such an attack would require at least 10 kg of anthrax powder. To be produced in one batch, this amount would require a very large fermenter, or a number of successful batches of 1,000 litres.

28. UNMOVIC has established effective monitoring procedures, which could identify the production of relatively small quantities of biological agents, provided that fermenters of a volume of more than 10 litres are used. However, under certain circumstances, work with even smaller quantities of biological threat agents can be identified by sampling and analysis.

29. The amounts of the final preparation of biological agents and toxins necessary to inflict mass casualties may seem small. Their production, however, inevitably requires pilot or industrial-scale operations. UNMOVIC has established an effective system for monitoring such facilities.

30. Under certain conditions, multiple casualties can be deliberately caused by the use of micro-organisms in quantities of around a gram and less. The use of some agents may require the decontamination of buildings and the administration of prophylactics to many potentially affected people.

31. It would not be feasible to monitor the small amount of biological agents that may be produced in research or diagnostic laboratories (microbiology, biochemistry, molecular biology or cellular biology) unless a very intrusive monitoring regime with a high-frequency presence of inspectors, coupled with on-site sampling and analysis, were employed.

32. Such amounts of biological agent may also be produced in dedicated clandestine laboratories and the monitoring authority can, upon finding such laboratories, assess their capabilities and identify whether a particular laboratory was involved in the production of biological agent. UNMOVIC has improved its capabilities for assessing whether a biological agent was produced in a particular laboratory, by now having access to the forensic microbiology capabilities of its international network of reference laboratories. This capability can assist in the genetic identification of micro-organisms and can enable the tracing of its source.