

Biological Warfare

I need these germs to be fixed on the missiles, and tell him to hit, because starting the 15th, everyone should be ready for the action to happen at anytime....

Saddam Husyan, January 1991

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Key Findings

The Biological Warfare (BW) program was born of the Iraqi Intelligence Service (IIS) and this service retained its connections with the program either directly or indirectly throughout its existence.

- The IIS provided the BW program with security and participated in biological research, probably for its own purposes, from the beginning of Iraq's BW effort in the early 1970s until the final days of Saddam Husayn's Regime.

In 1991, Saddam Husayn regarded BW as an integral element of his arsenal of WMD weapons, and would have used it if the need arose.

- At a meeting of the Iraqi leadership immediately prior to the Gulf war in 1991, Saddam Husayn personally authorized the use of BW weapons against Israel, Saudi Arabia and US forces. Although the exact nature of the circumstances that would trigger use was not spelled out, they would appear to be a threat to the leadership itself or the US resorting to “unconventional harmful types of weapons.”
- Saddam envisaged all-out use. For example, all Israeli cities were to be struck and all the BW weapons at his disposal were to be used. Saddam specified that the “many years” agents, presumably anthrax spores, were to be employed against his foes.

ISG judges that Iraq's actions between 1991 and 1996 demonstrate that the state intended to preserve its BW capability and return to a steady, methodical progress toward a mature BW program when and if the opportunity arose.

- ISG assesses that in 1991, Iraq clung to the objective of gaining war-winning weapons with the strategic intention of achieving the ability to project its power over much of the Middle East and beyond. Biological weapons were part of that plan. With an eye to the future and aiming to preserve some measure of its BW capability, Baghdad in the years immediately after Desert Storm sought to save what it could of its BW infrastructure and covertly continue BW research, hide evidence of that and earlier efforts, and dispose of its existing weapons stocks.
- From 1992 to 1994, Iraq greatly expanded the capability of its Al Hakam facility. Indigenously produced 5 cubic meter fermentors were installed, electrical and water utilities were expanded, and massive new construction to house its desired 50 cubic meter fermentors were completed.
- With the economy at rock bottom in late 1995, ISG judges that Baghdad abandoned its existing BW program in the belief that it constituted a potential embarrassment, whose discovery would undercut Baghdad's ability to reach its overarching goal of obtaining relief from UN sanctions.

In practical terms, with the destruction of the Al Hakam facility, Iraq abandoned its ambition to obtain advanced BW weapons quickly. ISG found no direct evidence that Iraq, after 1996, had plans for a new BW program or was conducting BW-specific work for military purposes. Indeed, from the mid-1990s, despite evidence of continuing interest in nuclear and chemical weapons, there appears to be a complete absence of discussion or even interest in BW at the Presidential level.

Iraq would have faced great difficulty in re-establishing an effective BW agent production capability. Nevertheless, after 1996 Iraq still had a significant dual-use capability—some declared—readily useful for BW if the Regime chose to use it to pursue a BW program. Moreover, Iraq still possessed its most important BW asset, the scientific know-how of its BW cadre.

- Any attempt to create a new BW program after 1996 would have encountered a range of major hurdles. The years following Desert Storm wrought a steady degradation of Iraq's industrial base: new equipment and spare parts for existing machinery became difficult and expensive to obtain, standards of maintenance

declined, staff could not receive training abroad, and foreign technical assistance was almost impossible to get. Additionally, Iraq's infrastructure and public utilities were crumbling. New large projects, particularly if they required special foreign equipment and expertise, would attract international attention. UN monitoring of dual-use facilities up to the end of 1998, made their use for clandestine purpose complicated and risk laden.

Depending on its scale, Iraq could have re-established an elementary BW program within a few weeks to a few months of a decision to do so, but ISG discovered no indications that the Regime was pursuing such a course.

- In spite of the difficulties noted above, a BW capability is technically the easiest WMD to attain. Although equipment and facilities were destroyed under UN supervision in 1996, Iraq retained technical BW know-how through the scientists that were involved in the former program. ISG has also identified civilian facilities and equipment in Iraq that have dual-use application that could be used for the production of agent.

ISG judges that in 1991 and 1992, Iraq appears to have destroyed its undeclared stocks of BW weapons and probably destroyed remaining holdings of bulk BW agent. However ISG lacks evidence to document complete destruction. Iraq retained some BW-related seed stocks until their discovery after Operation Iraqi Freedom (OIF).

- After the passage of UN Security Council Resolution (UNSCR) 687 in April 1991, Iraqi leaders decided not to declare the offensive BW program and in consequence ordered all evidence of the program erased. Iraq declared that BW program personnel sanitized the facilities and destroyed the weapons and their contents.
- Iraq declared the possession of 157 aerial bombs and 25 missile warheads containing BW agent. ISG assesses that the evidence for the original number of bombs is uncertain. ISG judges that Iraq clandestinely destroyed at least 132 bombs and 25 missiles. ISG continued the efforts of the UN at the destruction site but found no remnants of further weapons. This leaves the possibility that the fragments of up to 25 bombs may remain undiscovered. Of these, any that escaped destruction would probably now only contain degraded agent.
- ISG does not have a clear account of bulk agent destruction. Official Iraqi sources and BW personnel, state that Al Hakam staff destroyed stocks of bulk agent in mid 1991. However, the same personnel admit concealing details of the movement and destruction of bulk BW agent in the first half of 1991. Iraq continued to present information known to be untrue to the UN up to OIF. Those involved did not reveal this until several months after the conflict.
- Dr. Rihab Rashid Taha Al 'Azzawi, head of the bacterial program claims she retained BW seed stocks until early 1992 when she destroyed them. ISG has not found a means of verifying this. Some seed stocks were retained by another Iraqi official until 2003 when they were recovered by ISG.

ISG is aware of BW-applicable research since 1996, but ISG judges it was not conducted in connection with a BW program.

- ISG has uncovered no evidence of illicit research conducted into BW agents by universities or research organizations.
- The work conducted on a biopesticide (*Bacillus thuringiensis*) at Al Hakam until 1995 would serve to maintain the basic skills required by scientists to produce and dry anthrax spores (*Bacillus anthracis*) but ISG has not discovered evidence suggesting this was the Regime's intention. However in 1991, research and production on biopesticide and single cell protein (SCP) was selected by Iraq to provide cover for Al Hakam's role in Iraq's BW program. Similar work conducted at the Tuwaittha Agricultural and Biological Research Center (TABRC) up to OIF also maintained skills that were applicable to BW, but again, ISG found no evidence to suggest that this was the intention.

- Similarly, ISG found no information to indicate that the work carried out by TABRC into Single Cell Protein (SCP) was a cover story for continuing research into the production of BW agents, such as *C. botulinum* and *B. anthracis*, after the destruction of Al Hakam through to OIF.
- TABRC conducted research and development (R&D) programs to enable indigenous manufacture of bacterial growth media. Although these media are suitable for the bulk production of BW agents, ISG has found no evidence to indicate that their development and testing were specifically for this purpose.
- Although Iraq had the basic capability to work with variola major (smallpox), ISG found no evidence that it retained any stocks of smallpox or actively conducted research into this agent for BW intentions.

The IIS had a series of laboratories that conducted biological work including research into BW agents for assassination purposes until the mid-1990s. ISG has not been able to establish the scope and nature of the work at these laboratories or determine whether any of the work was related to military development of BW agent.

- The security services operated a series of laboratories in the Baghdad area. Iraq should have declared these facilities and their equipment to the UN, but they did not. Neither the UN Special Commission (UNSCOM) nor the UN Monitoring, Verification, and Inspection Commission (UNMOVIC) were aware of their existence or inspected them.
- Some of the laboratories possessed equipment capable of supporting research into BW agents for military purposes, but ISG does not know whether this occurred although there is no evidence of it. The laboratories were probably the successors of the Al Salman facility, located three kilometers south of Salman Pak, which was destroyed in 1991, and they carried on many of the same activities, including forensic work.
- Under the aegis of the intelligence service, a secretive team developed assassination instruments using poisons or toxins for the Iraqi state. A small group of scientists, doctors and technicians conducted secret experiments on human beings, resulting in their deaths. The aim was probably the development of poisons, including ricin and aflatoxin to eliminate or debilitate the Regime's opponents. It appears that testing on humans continued until the mid 1990s. There is no evidence to link these tests with the development of BW agents for military use.

In spite of exhaustive investigation, ISG found no evidence that Iraq possessed, or was developing BW agent production systems mounted on road vehicles or railway wagons.

- Prior to OIF there was information indicating Iraq had planned and built a breakout BW capability, in the form of a set of mobile production units, capable of producing BW agent at short notice in sufficient quantities to weaponize. Although ISG has conducted a thorough investigation of every aspect of this information, it has not found any equipment suitable for such a program, nor has ISG positively identified any sites. No documents have been uncovered. Interviews with individuals suspected of involvement have all proved negative.
- ISG harbors severe doubts about the source's credibility in regards to the breakout program.
- ISG thoroughly examined two trailers captured in 2003, suspected of being mobile BW agent production units, and investigated the associated evidence. ISG judges that its Iraqi makers almost certainly designed and built the equipment exclusively for the generation of hydrogen. It is impractical to use the equipment for the production and weaponization of BW agent. ISG judges that it cannot therefore be part of any BW program.

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Evolution of the Biological Warfare Program

The Regime Strategy and WMD Timeline

For an overview of Iraqi WMD programs and policy choices, readers should consult the Regime Strategy and WMD Timeline chart, enclosed as a separate foldout and in tabular form at the back of Volume I. Covering the period from 1980-2003, the timeline shows specific events bearing on the Regime's efforts in the BW, CW, delivery systems and nuclear realms and their chronological relationship with political and military developments that had direct bearing on the Regime's policy choices.

Readers should also be aware that, at the conclusion of each volume of text, ISG has included a foldout summary chart that relate, inflection points—critical turning points in the Regime's WMD policymaking—to particular events, initiatives, or decisions the Regime took with respect to specific WMD programs. Inflection points are marked in the margins of the text with a gray triangle.



Evolution of the Biological Warfare Program

For more than 20 years Iraq pursued a program of secret research, development and production in a bid to acquire a BW capability with which to defend its interests and project its influence beyond Iraq's borders. A well-kept secret known to only a handful of leaders, Iraq's BW program—approved by Saddam Husayn, overseen by Husayn Kamil Hasan Al Majid, guided by Dr. 'Amir Hamudi Hasan Al Sa'adi, and closely linked to the IIS—culminated in the first Gulf war in January 1991, by which point Iraq had developed a small but impressive arsenal of BW weapons comprising over 100 bombs, at least 25 Al Husayn warheads filled with anthrax spores, botulinum toxin and aflatoxin, as well as many thousands of liters of these agents stored in bulk, for use in Iraq's unsophisticated delivery systems. Iraq's BW infrastructure emerged from that conflict damaged,

but not destroyed, and the in the wake of the war the Regime tried to preserve what it could of its BW program. Aiming to leave open the option of restarting BW activities once UN inspections were over and sanctions were lifted, Baghdad attempted to remove all possible signatures of its past offensive activities. Simultaneously, Iraq undertook a significant denial and deception effort intended to conceal from the UN the true nature, scope, and ultimate objectives of the program. By 1995, these efforts had failed, and Iraq admitted its offensive program, leading in 1996 to the destruction, at Saddam's orders and under UN supervision, of most of the Iraq's BW physical infrastructure.

The destruction of the BW infrastructure in the mid-1990s halted Iraq's BW activities, with the exception of its efforts to preserve intellectual know-how, the Regime's most valuable asset. BW programs are primarily the product of trained innovative scientific minds. Extensive scientific laboratories and vast industrial complexes are unnecessary. A handful of dedicated, bright scientists, supported by dexterous, intelligent, and experienced technicians working with simple but effective equipment, materials, and animals in a secure environment can accomplish most of what is required to lay the foundations of a BW program. In comparison to nuclear and chemical weapons (CW) programs, individuals' intellectual capabilities play a far greater role in determining the success or failure of a program than the physical resources to which they may have access. Thus, any account of Iraq's BW program is largely a story of the key experts who are involved, and only secondarily a history of facilities and equipment (see Figure 1).

Ambition: The Early Years, 1960-1985.

Iraq's first foray into chemical and biological warfare (CBW) was rooted in the nationalist wave that swept the Middle East in the 1960s under Egypt's president, Gamal Abdul Nasser, when Arab military leaders concluded the time had come to increase their understanding of the technology of modern warfare. Select junior officers in Iraq's armed forces traveled overseas for CBW training, among them Lt.



Nizar Al Attar, who attended the CBW courses at Fort McClellan in the US and was later to head Iraq's CW program and introduce BW to Al Muthanna State Establishment (MSE). In 1964, the Iraqi Army established a Chemical Corps, thus taking the first step that led to the acquisition of CBW. Following the Ba'athist revolution of 17 July 1968 that brought Ahmad Hasan Al Bakr to power, senior army officers, encouraged by their technologically aware subordinates, decided to embark on a CW program. It was an amateur affair consisting of small groups trying to develop agent. By the early 1970s, the attempt had failed.

In 1974, a charismatic officer, Ghassan Ibrahim founded a laboratory, nominally a respectable academic body run by the Ministry of Higher Education and Scientific Research carrying out legitimate scientific research, named the Al Hasan Ibn-al-Haytham [Al Hazen Ibn-al-Haithem] Research Institute (see Figure 2). In reality, the institute was a front for clandestine activity in CW, BW, electronics, and optics under the patronage of the IIS. Ibrahim's assistant was an intelligence officer, Fa'iz 'Abdallah Al Shahin, who would later oversee Iraq's production of CW agents during the Iran-Iraq war and play a key role in the development of other nonconventional weapons, such as radiological bombs. He would also briefly supervise part of the BW program. Later still, Fa'iz would become Deputy Minister of Oil.

Al Hasan was a large, coordinated effort to master the technologies associated with several aspects of modern warfare. Quickly Al Hasan established chemical laboratories at Al Rashad, NE of Baghdad, posing as 'The Center for Medical Diagnostics' and a temporary biological center in the Al 'Amiriyah suburb of Baghdad. A purpose built closed-institute soon followed: the Ibn-Sina Center at Al Salman occupying a peninsula formed by the River Tigris 30km south of Baghdad. The Ibn-Sina Center masqueraded as 'The Center for Medical Agriculture'. After occupying a temporary headquarters in Sadun Street in the center of Baghdad, Al Hasan built a new headquarters and physics laboratory at Masbah nearby and later added an electronics laboratory at Tajiyat, north of Baghdad.

The generation of scientists trained and employed at Al Hasan, many of whom devoted more than 20 years of their careers to the pursuit of WMD, formed the backbone of Iraq's later CW and BW programs. Ini-

tially, a group of nine scientists drawn from the Ministries of Higher Education, Defense and Health led the original offensive BW effort, conducting research into bacteria, toxins, and viruses, emphasizing production, pathogenicity, dissemination and storage of agents, such as *Clostridium botulinum*, spores of *Bacillus anthracis*, cholera, polio, and influenza virus. Later, in both chemical and biological disciplines, the Al Hasan Institute engaged prominent scientists to train and guide more junior staff and chemical corps officers. Dr. Muhammad 'Abd-al-Mun'im Al Azmirli, an Egyptian, mentored the chemists and Dr. Muzhir [Mudher, Modher] Al Falluji led the biologists. The Institute sponsored its staff to study abroad for PhDs in subjects appropriate for the CW or BW effort. The Iraqi Regime rewarded success with promotion, high status, money, and material goods.

The second attempt to develop BW also faltered despite considerable effort. The Minister of Defense and Dr. 'Amir Al Sa'adi concluded in a 1978 investigation that Al Hasan had failed to deliver what it promised and that there had been academic and financial fraud. Arrests and imprisonment of several researchers followed for fraud and embezzlement surrounding the purported development of influenza as a BW agent. Al Sa'adi decided that project was a failure, not having made enough progress toward industrial scale BW production and should be shut down, which the Iraqi government did on 16 January 1979, exactly 6 months before President Ahmad Hasan Al Bakr resigned in favor of his Vice President, Saddam Husayn. The facilities and staff were parceled out to various government establishments such as State Organization for Technical Industries (SOTI). The best personnel went to the IIS. Between 1979 and 1985, Iraq rebuilt and expanded the dual-use infrastructure for BW research, but undertook little work of significance.

- In 1979, a presidential decree created the Scientific and Technical Research Directorate (STRD) which later became the Technical Research Center (TRC), as a technical support agency for the IIS and to replace the Al Hasan as a cover mechanism for continued work on the development of chemical and biological agents.

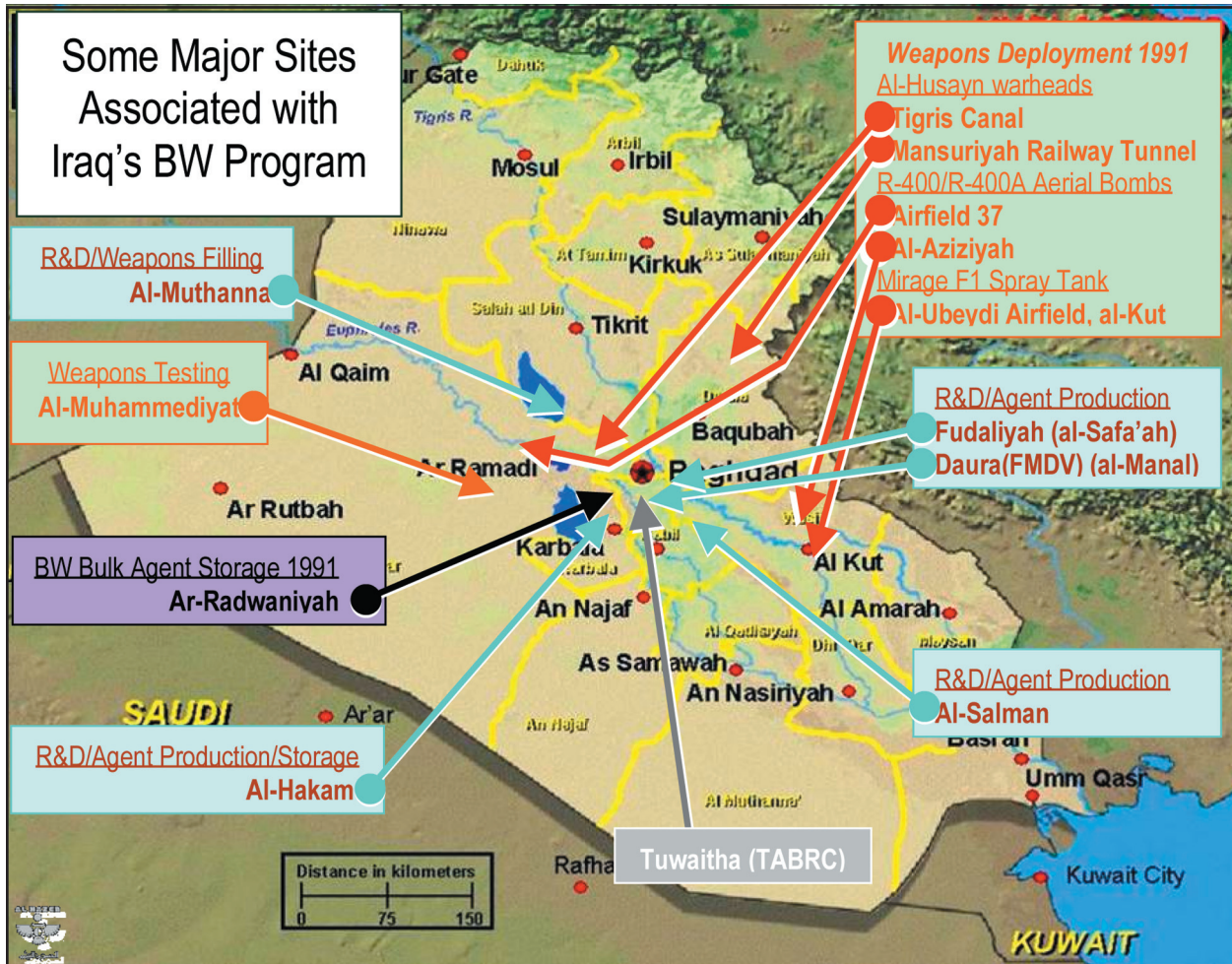



Figure 1. Some major sites associated with Iraq's BW Program.



Figure 2. Al Hazen emblem.

- The IIS continued small-scale CBW activities, recruiting chemists and scientists from universities and private laboratories and assigning them to Al Salman to conduct research.
- In 1983, a militarily relevant BW program restarted at the CW facility at Al Muthanna. UN inspectors were told that the initiative for this came from the Director General (DG) of Al Muthanna, Lt. Gen. Nizar Al Attar, who then received endorsement from the Minister of Defense. ISG has been unable to establish the veracity of this story, although it is apparent that a BW program started there in 1984 under the auspices of the MOD, funded by the State Organization for Technical Industries (SOTI), and headed at the research level by a new recruit, Dr. Rihab. Her direction, at least at the working level, was at this time given by Lt. Gen. Nizar who instructed her that he “*did not want research to put on a shelf. He wanted applied research to put in a bomb.*”

Renewed Ambition and Near-Realization: 1985-1991

 ***The outbreak of the Iran-Iraq war in 1980 altered Baghdad's perception of the value of WMD and led to a reinvigoration of the BW program.*** In the view of Iraqi leaders, Iraq's CW halted Iranian ground offensives and ballistic missile attacks on Tehran broke its political will.

- According to Brig. Dr. Mahmud Farraj Bilal Al Samarra'i, Iraq's war with Iran was the catalyst to reactivate Iraq's BW efforts. Iraq's success with CW during its war with Iran only reaffirmed the potential value of unconventional capabilities like BW. He opined that, “if the Iran war lasted beyond 1988, Saddam would have used BW.” Further, Iraq's concerns about Israel and their WMD capabilities provided additional impetus to seek a strategic counterbalance to deter foreign threats.
- Dr. Bilal added additional perspectives on the strategic intent of Iraqi's BW program, which he described as a strategic capability that would

compliment Iraq's CW efforts with great potential for achieving surprise. Bilal also commented that Iraq considered BW a potential counterbalance to the Israeli threat, but acknowledged that Iraq lacked an effective delivery system to mount a BW attack against Israel.

- After the outbreak of the Iran-Iraq war, one of the country's most eminent microbiologists and one of its few experts in fermentation, Professor Nassir Al Hindawi of Mustansiriyah University, submitted a proposal for BW research to the Presidential Diwan. The leadership directed his proposal to Lt. Gen. Nizar, the DG of Al Muthanna. Al Hindawi convinced Saddam to utilize disease-causing agents to aid the war effort against Iran. The focus of his interest was developing botulinum toxin as tactical nerve-like BW agent and anthrax as a strategic and tactical weapon.

In the early 1980s Baghdad stepped up the pace of its BW program significantly. In 1983, the remnants of the first BW effort became formally part of Al Muthanna under the direction of Lt. Gen. Nizar Al Attar. According to UNSCOM reporting, a formal research plan was drafted that year committing to BW research. Meanwhile, close by at the old facilities of the Al Hasan Institute, Al Salman was conducting a parallel BW research program under the authority of the intelligence services that included research into an anti-crop fungal agent, *Tilletia*, and the development of a bacterial spray device (known as the Zubaydi device, after its inventor). Al Salman tested the spray device, mounted on a helicopter, with reportedly inconclusive results, at Khan Bani Sa'ad in August 1988.

In late 1984, on returning from completing her PhD in the UK, Dr. Rihab was contacted by Lt. Gen. Nizar and directed to report to Al Muthanna, where she took over technical leadership of the BW program and led it to a series of achievements. ***According to Dr. Rihab, in 1983, there was an informal decision made to revitalize the BW program. Three years later, a 5-year plan was drawn up that would lead to BW weaponization,*** a course Dr. Rihab and her group implemented with urgency, authority, and great secrecy demonstrating considerable planning. Dr.

Rihab formed a team and commenced extensive literature surveys, based initially on the citation indices of the Stockholm Peace Research Institute (SIPRI) publications of the 1960 and 1970s. The team also started conducting toxicological investigations. Under her leadership of the technical elements, the program moved steadily through a series of discrete phases.

- In 1985, Dr. Rihab ordered reference strains of several pathogenic organisms from a variety of foreign sources and began basic research on candidate BW agents. Al Hindawi became an advisor to her in 1986.
- In 1986, under the guise of work at Baghdad University, she successfully ordered multiple isolates of pathogens from the American Type Culture Collection (ATCC), such as *B. anthracis* for use in the early BW agent research effort.
- In 1987, the program moved from Al Muthanna to Al Salman. The group now under the control of Ahmad Murtada, DG of the TRC, recruited new staff and broadened its range of agents. Murtada was an acolyte of Husayn Kamil and relied on the Military Industrialization Commission (MIC) and its Senior Deputy, Dr. 'Amir Al Sa'adi, for the weapons aspects of the program. Equipment from the At Taji SCP Plant was transferred to Al Salman in August that year.
- Also in 1987, Dr. Rihab and Dr. 'Amir Al Sa'adi discussed the possibility of developing a transportable system for the production of BW agents. She claims that the idea was largely 'Amir Al Sa'adi's and that she rejected the proposal in favor of a fixed production site at Al Hakam.
- In 1988, they opened the facility at Al Hakam. Production of anthrax, botulinum toxin and *Clostridium perfringens* started. Weapon development and testing followed.
- In May 1988, TRC broadened the base of the BW program by adding a mycologist, Dr. 'Imad Dhiyab, with a team that researched fungal toxins, including trichothecene mycotoxins and later aflatoxin. The connection, if any, of this work with the earlier fungal work at Al Salman, is unknown.

- When Iraq tried to expand the production capacity of Al Hakam by importing three 5 cubic meter fermentation vessels from the Swiss company Chemap in 1988, the export license was denied; this, despite implementing an elaborate deception plan involving a fake production building at Al Qa'qa'a. However, fermentors and other equipment were requisitioned from an Iraqi veterinary vaccine plant at Al Kindi and transferred to Al Hakam in November 1988.
- In 1989, Dr. Rihab sought to have a spray dryer manufactured in Iraq for work at Al Hakam. Iraqi companies were able to fabricate the body of a dryer but not the other components. In fact, there was already a dryer at Al Hakam that would, with some safety modifications, have been suitable for drying BW agent. This dryer had been transferred from the At Taji SCP Plant to Al Hakam in 1988. Nevertheless, she sought from overseas a commercial dryer that could, without modification, safely dry anthrax. In 1989, Iraq approached a foreign manufacturer of dryers with a sample of *Bacillus thuringiensis* (Bt) to be dried for biopesticide purposes as a cover for the true purpose. The company did not supply Iraq with the special dryer.

By early 1990, Iraq was methodically advancing toward the acquisition of a BW component to its arsenal of WMD. Iraq had conducted laboratory and environmental static and dynamic explosive field tests of wheat cover smut, aflatoxin, anthrax simulants (*Bacillus subtilis* and *thuringiensis*), botulinum toxin, *Clostridium perfringens* and ricin. Following Saddam Husayn's speech on 2 April 1990 that identified Israel as a threat, Husayn Kamil ordered the BW program to go all out for weaponization. The program took on a sudden urgency and its direction changed dramatically; frenetic and convulsive efforts to adapt new weapons and acquire and expand BW agent production replaced the years of orderly progress.

By the time of Iraq's invasion of Kuwait on 2 August 1990, the BW program had moved into high gear with the aim of fielding filled weapons as quickly as possible. Also in August 1990, Al Hakam commenced production of *Clostridium perfringens*, the causative agent of gas gangrene. There is no evidence of the weaponization of this material and details of its disposal remain uncertain.



- Botulinum toxin and anthrax were the backbone of the Iraqi pre-1991 BW program. In addition to the production activities at Al Hakam, the Foot and Mouth Disease Vaccine plant (FMDV) at Al Dawrah was adapted for the production of botulinum toxin and continued to produce the agent until they evacuated the site on 15 January 1991, two days before the start of Desert Storm. While senior Iraqi officials deny production of anthrax at FMDV, the UN found traces of anthrax on two fermentors and a mobile storage tank in the facility. One source has informed ISG that the site did produce anthrax. ISG concludes that FMDV produced anthrax. ISG does not know whether the fate of this anthrax was the same as that produced at Al Hakam.
- Dr. Hazim 'Ali, recruited in July 1990 to lead the development of viral agents, took over the FMDV Plant at Al Dawrah in September of that year, renaming it 'Al Manal'. He commenced work on viruses including hemorrhagic conjunctivitis, human rotavirus, and camel pox with a view to weaponization. Hazim's viral work was still in its infancy by the time of Desert Storm and very little had actually been achieved.

In parallel with the production of BW agents, other facilities were manufacturing R-400 aerial bombs and warheads for the Al Husayn missile. Husayn Kamil had the final say over which agents to weaponize. Although in November 1990, Al Muthanna started adapting an aircraft auxiliary fuel tank as a means of dispersing BW agent, a few days after the invasion of Kuwait, Husayn Kamil chose to use the R-400 aerial bomb and the Al Husayn missile warhead because they were already in use for CW agents. There was no discussion of how to weaponize BW agents because of lack of time and the pressing need to make decisions quickly. Additional weapons testing of R-400 bombs using an anthrax simulant, *B. subtilis*, occurred leading up to the war. In addition, there is an unconfirmed report that Bt was used in explosive testing of an unidentified BW munition at Al Hakam between September 1990 and January 1991.

- In November 1990, Al Muthanna started adapting an aircraft auxiliary fuel tank as a means of dispersing BW agents. Iraq had previously attempted a

similar development in the CW field and in a letter, dated 10 December 1990, to Husayn Kamil, Gen. Fa'iz Shahin, DG of Al Muthanna, had referred to "successful tests of spraying mustard gas by planes which proved to be very effective." It appears that the BW spray device was a continuation of this earlier effort. Sometime in early January 1991, at a meeting of the Iraqi leadership, Husayn Kamil told Saddam: "Sir, the best way to transport this weapon (BW) and achieve the most harmful effects would come by using planes, like a crop duster, to scatter it. This is, Sir, a thousand times more harmful." Saddam responded that he wanted all options of delivering BW agent to the targets. The Iraqi Air Force flew the tanks with anthrax simulants to optimize the dispersion characteristics. The Air Force also experimented with a remotely piloted MiG-21 aircraft as a possible delivery platform for a similar tank system. These trials only ceased when Desert Storm started.

By January 1991, reflecting the huge exertion of the previous months, Iraq had produced large quantities of anthrax, botulinum toxin, Clostridium perfringens, aflatoxin, and small quantities of ricin, and had more than 180 BW weapons deployed to five hide sites. In addition, Al Hakam protected caches of bulk BW agent containers by moving them from site to site during the hostilities. The weapons and agent were guarded and ready for use. The Iraqi leadership decided policy for their use and targeting. Iraq states that the opening bombardment of 17 January 1991 destroyed the only aircraft and spray tank ready for use. Despite this, work continued to complete another three tanks, with plans for a further eight in preparation.

- Iraq had filled ballistic missiles and aerial bombs, and was modifying aircraft fuel tanks to spray BW agents.
- The weapons, though not agent production, were not well designed technically and the result of an immature development program. In ISG's view, the weapons were suboptimal but could have been effective in certain circumstances.

- The Iraqis were well aware of the shortcomings of the Al Husayn missile and the R-400. Lt. Gen. Hazim, commander of the Surface-to-Surface Missile Forces openly admitted that the Al Husayn, with a BW agent filled warhead, would fulfill its purpose if after impact in an enemy country sufficient material survived to enable its detection as a BW agent. It was a weapon of terror. They were for use in extremis and only if an enemy directly threatened the existence of the Regime in its heartland in and around Baghdad. Except for those *in the know*, Iraqi armed forces treated BW weapons as ‘special chemical’, a more toxic type of CW weapon.

Saddam himself exercised control over Iraq’s BW arsenal, and he was prepared to use it against US and allied forces in the event of war. At a meeting in early January 1991, he identified the targets for the BW weapons. Israel was to be first and all Israeli cities were targets, but he ordered that strikes concentrate on Tel Aviv. US forces were to be targets if they attacked with unconventional forces. He also identified Riyadh and Jeddah as targets. In a transcript of discussions held at the time Saddam ordered the use of the more persistent (presumably anthrax) BW agents: “we want the long term, the many years kind.”

- Saddam envisaged all out use of the weapons. He said “*we don’t want to depend on one option*” and that Iraqi forces must use all means, bombs, missiles and spray aircraft, to deliver the BW agent. He pointed out that this was “*a life and death issue and all the orders about targets are sealed in writing and authenticated*” in case something happened to him.
- The stockpiles of weapons and bulk agents remained in their hide sites unused and undamaged. Two officials shared the day-to-day responsibility; Dr. Bilal for the bombs and missiles and Dr. Rihab for the bulk BW agent.

The Beginning of the Decline: Opportunity Through Ambiguity and the End of the Game (1991-1996)

ISG assesses that in 1991, Iraq clung to the objective of gaining war-winning weapons with strategic intent that would enable the projection of its power over much of the Middle East and beyond. BW was part of that plan. With an eye to the future and aiming to preserve some measure of its BW capability, Baghdad in the years immediately after Desert Storm sought to save what it could of its BW infrastructure, hide evidence of the program, and dispose of its existing weapons stocks. Following Baghdad’s formal acceptance of UNSCR 687 of 3 April 1991, Iraq had 15 days to declare its stocks of WMD. ***It did not do so, and in a letter dated 18 April 1991, to the Secretary General of the UN, Foreign Minister Tariq Aziz even denied that Iraq had any BW program.*** Baghdad’s action in the following months and years indicate that it intended to preserve its BW capability and return to the steady, methodical progress toward a mature BW capability when inspections ended and sanctions were lifted. The biopesticide program that was established after the 1991 Gulf war, temporarily preserved Iraq’s research, development and production base at Al Hakam and, whether intentionally or otherwise, achieved several objectives set out in the original Iraqi BW strategic plan drafted in 1985. These included industrial-scale production of biological agents, albeit nonpathogenic ones, and perfecting development of dry agent formulation.

Baghdad took early steps to protect what remained of the BW physical plant and equipment. During the first Gulf war, the only facilities directly relevant to Iraq’s BW program that were destroyed were the research laboratories at Al Salman and the munitions filling station at Al Muthanna. Neither was critical to the BW program that was centered on Al Hakam. Al Hakam at that time was unknown to the Coalition and therefore was not attacked during the war, unlike the Abu Ghurayb Infant Formula Plant (the *Baby Milk Factory*) that the Coalition destroyed by bombing in the mistaken belief that it was a key BW facility. ***Following approval of UNSCR 687 in early April 1991, Saddam Husayn endorsed Husayn Kamil’s decision not to declare Al Hakam as part***


of the BW program and decided to convert the plant to commercial use prior to the arrival of the second UNSCOM BW team in September 1991. Husayn Kamil pressured Dr. Rihab to complete this transition quickly to save equipment and the jobs of the scientists and technicians.

- Saddam wanted to keep scientists employed, according to ‘Amir Muhammad Rashid Al ‘Ubaydi. Moreover, he initially expected the sanctions would last no more than three years, and many Iraqis doubted the sanctions would be so comprehensive, according to several interviews with former officials. These perceptions probably persuaded senior Regime leaders that they could weather a short-lived sanctions regime by making limited concessions, hiding much of their pre-existing weapons and documentation, and even expanding BW potential by enhancing dual-use facilities.

The advent of postwar UN inspections posed serious problems for Iraq, and in a bid to hide the true uses of the remaining plant and equipment the Regime ordered a large scale deception effort, involving cleaning existing plants to remove traces of BW activity, hiding relevant documents, destroying existing stocks of agent, and concocting a cover story for ongoing BW-related work at Al Hakam. Immediately Iraq scoured the principal facilities to remove evidence of an offensive BW program. The production plant was vigorously decontaminated, research papers altered, evidence hidden or destroyed and the BW cadre agreed to provide false accounts of past events and future intent. In the summer of 1991, on the orders of Husayn Kamil relayed through Ahmad Murtada, Dr. Rihab ordered that all documents associated with the BW program be destroyed and all production activities at Al Hakam be stopped. She claims to have collected all documents, kept a few, and destroyed or buried the rest. She ordered all BW scientists from Al Salman and Al Hakam to sign a legal document stipulating, under the threat of execution, a prohibition on speaking to UN inspectors about the production of, or progress on, any BW agent.

- After that order, the person in charge of physical security at Al Hakam witnessed Dr. Rihab remove about 20 to 25 electronic media disks (floppy disks) from her office.

- In late 1991, Saddam Husayn’s Secretary, ‘Abd Hamid Mahmud Al Khatab Al Tikriti, asked Husayn Kamil if Iraq would declare the BW program to the UN. Husayn Kamil indicated that it would not be necessary and he would order the scientists to hide all evidence of the program in their homes. Husayn Kamil arranged the collection of all documents relating to WMD and directed the Special Security Organization (SSO) to conceal them. This was to facilitate the reconstitution of WMD programs after the UN departed. There is some uncertainty whether these documents are the same as those handed to the UN in 1995 from Husayn Kamil’s chicken farm.

Saddam also authorized Husayn Kamil to destroy, unilaterally, Iraq’s stocks of BW agents. There were three distinct phases of destruction, including clean up and sterilization of facilities including Al Salman, Al Hakam, Al Manal and Al Safa’ah; destruction of munitions by TRC and Al Muthanna personnel; and neutralization and dumping of bulk BW agent. According to some accounts given by former Iraqi officials, the clean up of the Al Hakam site began in May 1991. Other accounts give the order as sometime in the summer of 1991. In any case, Dr. Rihab ordered MIC to sanitize Al Hakam to destroy any traces of botulinum toxin and anthrax. The Al Hakam site was sanitized, which entailed the sanitization of all surfaces, drains, equipment and sewers using formalin, alcohol and potassium permanganate. 

ISG, however, continues to harbor doubts regarding Iraq’s destruction of bacterial reference strains and isolates. According to Dr. Rihab, she destroyed these materials in early 1992, but ISG can verify neither that the materials were destroyed nor the other details of Dr. Rihab’s account. She maintains that she gave a small box containing no more than 25 vials of lyophilized bacterial pathogens, including those obtained from the American Type Culture Collection to the IIS in mid-1991 for safekeeping. Allegedly, Husam Muhammad Amin Al Yasin, who would eventually become the director of the National Monitoring Directorate (NMD), returned the box to her in early 1992. She also claimed that she asked former TRC head Ahmad Murtada what to do with the vials. Murtada took the matter to Husayn Kamil,

who ordered the vials destroyed. Dr. Rihab claims she did this by injecting the vials with Dettol™ and then autoclaving the vials. According to UNSCOM data, all ATCC ampules were accounted for and there should have been no remaining unopened vials from ATCC after the first UNSCOM BW inspection.

ISG judges the Regime took these steps with the aim of restarting the BW program in the future. In 1993, Husayn Kamil reportedly announced in a speech to WMD scientists that Iraq's WMD programs would resume and expand when UN inspectors left. Al Hindawi recounted to ISG a conversation he had with 'Amir Al Sa'adi about the future of the BW program following the first Gulf war. Al Sa'adi referred to Husayn Kamil's intent as "His Highness had a broad vision of the future." Al Hindawi interpreted this to mean that Husayn Kamil intended to reactivate the program later.

Even as Baghdad took steps to hide its remaining BW infrastructure and cover the traces of its previous program, the Regime sought to continue a covert BW development effort under the cover of civilian research. In April 1991, Dr. Rihab personally briefed Saddam Husayn on the plan to convert Al Hakam for the production of biopesticide. In that same month, MIC and Saddam Husayn decided to develop programs for SCP and biopesticide, using Bt as the cover.

- Dr. Bilal told ISG, "Al Hakam was kept as potential for the BW program in the future." He described that they decided they must do everything to preserve it and stated that the entire bio-insecticide and SCP effort at Al Hakam was a "100% cover story" created by 'Amir Rashid. Dr. Rihab also stated that the intent to produce the SCP and bioinsecticide Bt at Al Hakam was "to cover the equipment."

ISG judges that in the wake of Desert Storm and destruction of much of the BW effort, Iraq's strategic objective was to give the appearance of cooperating with UNSCOM while preserving the intellectual capital amassed in prior years on BW. The Bt and SCP programs offered an effective justification that allowed Iraq to keep the Al Hakam site with its extensive equipment and skilled scientists in one place. Dr. Bilal related that after they created the cover story for

Al Hakam, an economic study of Single Cell Protein (SCP) was conducted highlighting that Al Hakam's production capacity was only kilograms while Iraq's calculated "legitimate" SCP need was 70 tonnes per year.

- Nasr Al Hindawi advocated the development of SCP at Al Hakam. The idea was endorsed because of his reputation in SCP production that was expected to provide credibility for the program to outside observers. Using SCP as an alternative feedstock, however, required very large rates of annual production (hundreds of tonnes) as well as large quantities of scarce methanol and ethanol for growth media.
- Dr. Rihab was not interested in SCP. The production of Bt pesticides was a convenient cover. The assertion that Al Hakam had been involved in biopesticide production before 1991 provided what they hoped to be a plausible explanation that enabled Iraq to avoid declaring production of anthrax. She enlisted the support of Dr. Jabbar Farhan 'Abd-al-Razzaq Al Ma'dhihi from the TABRC who had conducted research on Bt to assist in the development of biopesticide production.

Ostensible biopesticide production at Al Hakam required both an expansion of the facilities and collaboration with the IAEC's TABRC. The cover story did not fit the limited capabilities that resided at Al Hakam: the production capacity of the plant was far too little to be convincing that it really was for commercial SCP purposes. Realizing this, Baghdad began to expand production capacity in 1993. Simultaneously, collaboration on biopesticide production with experts from TABRC generated processes and capabilities that would be directly relevant to any future Iraqi BW effort.

- Iraq expanded Al Hakam's water and electricity utilities; a move ISG assesses would have significantly expanded the site's potential to support planned biopesticide and SCP production, and also sought to transfer to Al Hakam any and all usable equipment to support the proposed biopesticide and SCP activity. For example, after UNSCOM's first visit to Al Hakam in September 1991, Al Hakam acquired a 1,500-liter fermentor and a dryer from

Al Muthanna in order to strengthen the cover story. Additionally, Baghdad sought to acquire necessary equipment to pursue BW-related work at Al Hakam. In 1995, for example, Iraq attempted to purchase two turnkey 50 cubic meter fermentor plants from a Russian Company that purportedly had expertise in botulinum toxin production. Iraq negotiated a deal with that Russian Company for equipment and assistance. A team of Iraqi scientists and technicians traveled to Russia. The deal fell through because the company did not receive an export license.

Collaboration with TABRC brought together groups of experts and organizations whose work had direct bearing on future BW work.

Jabbar Al Ma'dhihi, Head of TABRC, for example was instrumental in designing the process that resulted in reconfiguring Al Hakam to produce Bt bioinsecticide. Dr. Al Ma'dhihi also developed a novel solution to Iraq's need for BW growth media. Unlike traditional bacterial growth media, Al Ma'dhihi's creation was cheap and of domestic origin—made from waste products from food and agricultural processes. He noted that his media induced near 100% sporulation rates in Bt with little or no additional additives or intensive monitoring of the fermentation process. In ISG's view, this media would probably be a suitable media for anthrax spore production. Rihab, herself, has conceded that this media may support growth and sporulation of anthrax and admitted that the use of this media would make monitoring difficult.

- Separately, Dr. Rihab described the purpose of her group's research into alternative media, which was to circumvent the effects of sanctions imposed on Iraq after the 1990 invasion of Kuwait. Nasir Al Hindawi worked on alternative media for *Brucella*. Mosul University, worked on plants as a source of peptone media for anaerobic organisms. Some of the plant media was purportedly suitable for growing pathogens such as *Clostridium botulinum*. Rihab was angry that Mosul's research might attract UNSCOM attention.

A strategic objective from the earliest days of the BW program was to produce dry agent. Dr. Rihab was aware that liquid agent had a relatively short

shelf life and this was demonstrated to her when in 1991, she found that liquid BW agent recovered from bombs and bulk storage containers "was ruined." She therefore found the work at TABRC on drying Bt by Dr. Al Ma'dhihi of great interest. Al Ma'dhihi was able to dry Bt at bench-scale and was working toward pilot-scale levels. This technology was directly applicable to drying anthrax although safety precautions would have been necessary.

- Dr. Al Ma'dhihi used bentonite provided by Al Hakam. The particle size was of 1 to 10 micrometers and Al Ma'dhihi realized that this was too fine for agricultural work. However, such technology is applicable to BW.

Dr. Rihab was pleased with the biopesticide formulation Al Hakam produced. Al Hakam produced approximately 40 tons of dry formulated product each year from 1992 to 1996. In about 1994, Al Hakam slowed down the production of Al Nasr in order to improve the formulation for the farmers. However, there was disagreement among the developer, producers, and end-users on the utility and use of the Al Hakam's dry Bt product called Al Nasr (or "Victory"). Farmers found it cumbersome to use, having to apply it by hand one plant at a time; spraying the product as a liquid slurry by mixing it with water was not successful. Al Hindawi stated, "The Bt produced there was not very popular with the farmers and was not a profitable endeavor." The former minister of agriculture corroborated this view.

- Dr. Al Ma'dhihi, the developer of this product, explained that it was intended to be used by sprinkling the dry material directly on to plants. He commented that farmers did not like the product because the powder was too fine; it aerosolized into a cloud when applied and did not form an adequate residue on the plants.
- Those who produced Al Nasr, Dr. Rihab and Mr. Thamir 'Abd-al-Rahman thought otherwise on the use and value of the product. They both described mixing the dry powder with water to form a slurry and spraying the product using hand sprayers. They thought the product was well received.

ISG's assessment is that whatever the intention of Iraq's Bt drying technology it was more applicable

to BW than biopesticides. ISG has learned more about the potential use of Iraq's biopesticide program for prohibited purposes from other sources.

- It was reported, but not confirmed, that researchers from the BW program at Al Hakam used other organisms to model work with anthrax after 1991.
- The former chief anthrax technician stated to ISG that the Al Hakam Bt fermentation line would fully support anthrax production. If virulent anthrax isolates were available, it would take by his estimate, one week to redirect the line to begin production of anthrax. He noted however that attempting to dry anthrax using the Al Hakam equipment was highly hazardous without respiratory protection or containment around the spray dryer.

In early 1995, UN inspectors confronted Iraq with evidence of imports of bacterial growth media in quantities that had no civilian utility within Iraq's limited biotechnology industry, a step that ultimately led to the unraveling of Iraq's cover story regarding continuing BW-related activity. On 1 July 1995, Iraq acknowledged that it used this growth media to produce two BW agents in bulk, botulinum toxin, and *Bacillus anthracis* spores, between 1988 and 1991. This precipitated Iraq into preparing a *Full Final and Complete Disclosure* (FFCD). Iraq presented the draft version in July 1995. *A final version followed on 4 August 1995, only to be declared void less than two weeks later after Husayn Kamil fled to Jordan.*

Most of what ISG knows about Iraq's BW endeavors dates from the period August 1995 to early 1996. After his departure officials denounced "the traitor" Husayn Kamil and blamed him for Iraq's failure to disclose the BW program earlier. Tariq 'Aziz claims he persuaded Saddam Husayn to make a full disclosure of Iraq's BW efforts to the UN. For a short while information flowed freely and Iraq released a considerable quantity of documents on its WMD programs in anticipation that this would lead to the lifting of sanctions. (However, in the biological field there were only around 200 items, including notebooks, papers, receipts, photographs, videotapes and journal reprints. For a program that had already lasted more than 20 years this was a modest collection.) As a consequence of the disclosures, the UN supervised the destruction of Al Hakam and disablement of FMDV in June 1996.

Iraq's disclosures on its covert BW program almost certainly were tied to the disintegration of the economy, which had hit rock-bottom by late 1995 as a result of UN-mandated economic sanctions. ISG judges that Saddam was willing to risk an element of Iraq's WMD program in a bid to gain economic and sanctions relief. Getting out from under sanctions, by this time, was an overarching Regime objective. BW research at the time offered no real capability but nevertheless posed the risk of a potential embarrassment that could only get in the way of sanctions relief.

- After a series of drafts, Iraq submitted a new "Full, Final and Complete Declaration" (FFCD) on 22 June 1996. This initiated a series of UN inspections to verify the details and resulted in another FFCD, submitted in September 1996, and a further FFCD in September 1997. Despite these revisions, the new FFCDs did not supply any substantially new information and therefore did not meet UN requirements. The UN was unable to verify the contents of the documents in spite of two Technical Evaluation Meetings between Iraq and the UN in March and April 1998, and July 1998.

Recovery and Transition 1996-2003

With the bulk of Iraq's BW program in ruins, Iraq after 1996 continued small-scale BW-related efforts with the only remaining asset at Baghdad's disposal—the know-how of the small band of BW scientists and technicians who carried out further work under the auspices of the Iraqi Intelligence Service. By 1996, the combination of the destruction wrought during Desert Storm and the deliberate destruction of key BW facilities and equipment under UNSCOM supervision left Iraq with few physical remnants of its BW program. Numerous other dual-use biological facilities were subject to routine UN monitoring.

- Many of the key scientists went to work for the NMD. Others pursued advanced degrees in Iraq's universities or went into the private sector; or work at other government agencies, e.g., TABRC; while at least some continued to conduct small-scale biological research and development in disperse locations under the control of the IIS.

- ISG is uncertain what the function of the multiple IIS laboratories was, and who the scientists were (see also CW section, Annex I). Some of the work conducted there was probably a continuation of the work at the Al Salman laboratories after their destruction in the Gulf war in 1991 and that would include forensic related work. Other objectives were probably to develop poisons for assassination or debilitation. Whether any of the research was directly related to military development of BW agents is uncertain; the nature of some of the reported work would have had direct application to dissemination of ricin.
- Information collected at the time of OIF led to the discovery of assorted laboratory equipment purportedly used by a suspect BW scientist at a Mosque in Baghdad.
- A clandestine laboratory was identified by an ISG team at the Baghdad Central Public Health Laboratory in the summer of 2003. According to an employee of the laboratory, the IIS operated a laboratory at that location for several years. In advance of a 1998 UNSCOM inspection, secret documents were removed and stored at the Director's house. In December of 2002, the laboratory was emptied of all equipment and documents.

Dr. Rihab hypothesized to ISG that if a BW program had existed in Iraq prior to OIF, it would probably have been conducted in secret within the intelligence community. However, ISG's inspection of assorted equipment and sites has not uncovered evidence of either the true nature of IIS laboratories or conclusive links between these laboratories and Iraq's BW effort. ISG notes, in any case, that the tactic of using IIS and covert laboratories has historical precedence dating back to the program's origins in the 1970s, when the IIS provided the BW program with security and participated in BW-related research. Reverting to this practice would minimize the evidence available to inspectors. It would also leave the known and acknowledged BW workers free to deal with the UN inspection regime. However, it would require another cadre of scientists other than ones known to the UN to conduct this kind of research. The discovery of multiple IIS clandestine laboratories after OIF lends some credence to this assessment.

- There is information that suggests that up to 5 IIS laboratories operated in the greater Baghdad area at various times up until OIF.
- ISG found a possible DGS laboratory in Baghdad that contained a variety of chemicals but no laboratory equipment. Residents in the building alleged that the laboratory was a biological one. The investigating team found several DGS administrative documents, some of which were from employees requesting approval for danger pay for their hazardous work with biological and radioactive materials.
- A former IIS chemist indicates this five-story building and adjacent warehouse complex comprises the M16 training center at Djerf-al-Nadaf, SE of Baghdad. A former member of the NMD reported this site as one of the three IIS locations with equipment and activities intentionally not declared to the UN. Neither UNSCOM nor UNMOVIC were aware of their existence and had not visited these facilities. He believes the building contained a biological laboratory for unspecified work. Site exploitation revealed a modern building that probably housed both offices and at least one laboratory on the first floor. The building was completely looted, with very few remnants of equipment, materials, or documents. Neighbors indicated that the IIS removed everything from the site just before the war.
- According to a former mid-level BW scientist, Iraq conducted tests on prisoners using aflatoxin in 1994 at an undeclared clandestine facility. A former member of the NMD indicated he visited the facility in 1997 or 1998 to survey the equipment for possible declaration to the UN; he was told on-site that none of the equipment or activities there would be declared.
- ISG also has evidence that, possibly as recently as 1994, an IIS chemist who immigrated to Iraq from Egypt, Dr. Muhammad 'Abd-al-Mun'im Al Azmirli (now deceased), experimented on prisoners with ricin resulting in their deaths.

- In the chemical field, ISG learned that, in the 1970s, the former IIS Directorate of Science and Technology, M9 (which later transformed into M16) used this approach for research into lethal agents. The IIS used a succession of four clandestine laboratories in At Taji and Baghdad between 1996 and 2003 to research and develop chemicals. It also included testing of chemicals on small animals like mice, rabbits and rats.
- Additional reporting, though unconfirmed, indicates that M16 also conducted BW related research at two covert laboratories. In the early 1990s, Saddam tasked the IIS to do small-scale BW work in covert laboratories concealed within legitimate facilities. Further unconfirmed reports indicated the IIS conducted BW and CW experiments and stored WMD precursor materials in residences and warehouses around Baghdad until at least April 2003.

Research and Development

ISG judges that Iraq maintained the expertise and equipment necessary for R&D of bacteria, fungi, viruses, and toxins that could be used as BW agents up until Operation Iraqi Freedom (OIF) in March 2003

- ISG assesses that Iraq's bacterial and toxin BW agents were adequately researched and developed at the advent of the first Gulf war in 1991, and that Iraq had an extensive BW R&D program in the years prior to that. By the time of Desert Storm, Iraq had weaponized *Clostridium botulinum* ('Agent A'), *Bacillus anthracis* ('Agent B') and Aflatoxin ('Agent C') by filling liquid forms of these agents into munitions, although these munitions were not the most effective or efficient for BW dispersal.

Despite evidence of Iraq's intent to develop more dangerous biological agents after Desert Storm, ISG uncovered no indications that biological agents were researched for BW purposes post-1991, even though Iraq maintained—and in some cases improved—research capabilities that could have easily been applied to BW agents. ISG's investigations found no direct evidence that the expertise or equipment were being used specifically for BW work. That said, ISG judges that further R&D on the agents weaponized pre-1991 was probably not required. Additional agents would have required extensive R&D, in ISG's judgement, but despite concerns that surrounded the possible addition of other, more pathogenic, agents into the viral BW program, no evidence has been found by ISG.

- ISG conducted site visits and multiple interviews investigating Iraq's possible possession of smallpox and collected fragmentary and circumstantial information. A definitive conclusion is impossible, but, based on the available evidence, ISG concludes that Iraq intended to develop smallpox and possibly other viral pathogens like CCHF as potential BW weapons. In December 1990, Dr. Rihab informed Dr. Hazim 'Ali that Husayn Kamil wanted him to work on "more dangerous" viruses. According to a source, Dr. Hazim 'Ali was willing to work on other viral agents if Dr. Rihab provided him with

the materials. No additional materials were provided. Iraq had the basic capability to work with variola major (smallpox) and may have conducted some preliminary basic research. However, ISG has found no conclusive evidence that Iraq retained or acquired any stocks of smallpox or conducted advance R&D of pathogenic viruses.

ISG uncovered troubling information about post-1991 BW-related endeavours that raise concerns about the legitimacy of Iraq's activities and that suggest to ISG Baghdad aimed at some future time to resume its BW program.

- In the 1990s Iraq decided indigenously to research and produce nutrient growth media that could be used to produce multiple strains of bacteria to include *B. anthracis*, but no direct evidence has yet been uncovered that this media was used to produce *B. anthracis* post-1991. Dr. Rihab described to ISG her BW group's research in developing indigenously produced media to circumvent the effects sanctions imposed on Iraq after the 1990 invasion. Research into alternative media for the growth of *Brucella* was conducted following the introduction of the 1990 UN sanctions.
- Multiple sources have told ISG that the *B. thuringiensis* research and production at Al Hakam from 1991 to 1996 was done to provide cover for the equipment and capability at this facility. ISG has not been provided with a good explanation as to why an advanced capability to dry agent in a particle size too small for efficient biopesticide use was established as well. ISG judges that this work advanced Iraq's expertise and knowledge in large-scale drying of *B. anthracis* even if the agent itself was not produced and dried.
- ISG has found that up to five IIS laboratories operated in the greater Baghdad area up until OIF. Additional reporting, though unconfirmed, indicates that the M16 Division also conducted BW related research in two covert laboratories. In the early 1990s, Saddam tasked the IIS to do small-scale BW work in covert laboratories concealed within legitimate facilities. Further unconfirmed reports indicated the IIS conducted BW and CW

experiments and stored WMD precursor materials in residences and warehouse around Baghdad through April 2003. Information collected at the time of OIF led to the discovery of assorted laboratory equipment purportedly used by a suspect BW scientist on the Black List at a Mosque in Baghdad. A clandestine laboratory was identified by an ISG team at the Baghdad Central Public Health laboratory in the summer of 2003. According to an employee of the laboratory, the IIS operated a laboratory at that location for several years. In advance of a 1998 UNSCOM inspection, secret documents were removed and stored at the Director's house. In December 2002, the laboratory was emptied of all equipment and documents.

Building Human Capital

Over the course of many years Iraq undertook concerted efforts to create the cornerstone of a national BW program: a body of trained scientists with the professional skill and experience needed to develop and produce BW. Unlike nuclear and chemical weapons programs, which require vast physical infrastructure, expensive equipment and substantial financial resources, human capital is the essential element of a national BW effort, for scientific research underpins all aspects of a developing BW program. Iraq made the most of a limited pool of qualified personnel to identify and develop the requisite cadre of skilled scientists and technical personnel.

- Trying to develop such a cadre for the BW as well as CW programs was an integral part of the overall Al Hasan Ibn-al-Haytham Institute's goals. UN inspectors discovered that during the 1970s the Al Hasan Ibn-al-Haytham Institute recruited the best and the brightest graduating students—from the Universities of Baghdad, Colleges of Medicine, Science, and Veterinary Medicine, and the University of Mustansiriyah, College of Medicine. The Institute offered these students employment with incentives including opportunities for travel abroad and further education. Students selected for biology then attended a two-month training program at the University of Baghdad, College of Veterinary Medi-

cine, in "laboratory techniques and procedures." Some were selected for graduate studies abroad and some for graduate studies at the University of Baghdad or the University of Mustansiriyah, while others were given technician positions at the Ibn-Sina Center.

ISG assesses that at some point after the revitalization of Iraq's BW program in the mid-1980s, a shift in priorities occurred in which Iraqi BW personnel were selected for participation in the program more for their loyalty and dependability than for their technical skills, an approach that distorted the entire higher educational process and frequently ensured that the "best and the brightest" were replaced by the loyal and reliable.

- A senior Iraqi scientist described to ISG a practice that began in the early 1990s and continued until 2002 as a possible Husayn Kamil initiative. This initiative reportedly named *Al Mumtazin*, or "the distinguished," involved nominating candidates for post-graduate education based on their loyalty to the Regime, institution or superior rather than their technical competence. These "distinguished" candidates reportedly had lesser grades and were generally older than published requirements, according to an ISG interview with a senior Iraqi scientist.
- In a possible bid to counter the corrosive effect of selecting personnel for political and professional reasons, in the mid 1980s, Iraq established a mentoring process through which to conduct investigations into possible BW related bacteria and toxins. This system, used throughout the BW program, utilized compartmented small clusters headed by a senior scientist who had extensive research experience or a senior technician with extensive experience with either the agent or a class of bacteria of interest according to multiple sources who participated in the former program.

Research Facilities

Iraq's R&D to develop BW started in 1974 at the Al Hasan Ibn-al-Haytham Institute. Initially the BW effort was located in a house in the Al 'Amiriyah suburb of Baghdad, and then moved to Al Hasan site number 2, also known as the Ibn-Sina Center, at Al Salman. The biological part of the Al Hasan program was "research on microorganism for military purposes." It included antibiotic and environmental resistance, means of production, and agent preservation. Agents included *Staphylococcus aureus*, Bacillus species, *Vibrio cholerae*, botulinum toxin, influenza and polio viruses, and others. Although the militarily relevant piece of the Al Hasan biological program seems to have entered a hiatus with the closure of the Institute, biological activities, not specifically directed toward BW weapons continued unabated at the Al Salman site.

In the formative phases of the BW program, the Ibn-Sina Center was the primary center for BW R&D. Some BW R&D continued unabated at Ibn-Sina Center, which began to broaden in 1984. When Iraq revitalized the militarily relevant BW program in the mid-1980s, Al Muthanna was the primary site until 1987 when the program again moved to the Ibn-Sina Center. However, Al Muthanna continued with specific R&D participation such as that with ricin and aflatoxin on behalf of Al Salman. R&D continued at the Ibn-Sina Center until mid to late 1990 even after much of the BW program moved to the newly established Al Hakam facility in 1988.

In 1990, with the compulsory acquisition of the Al Dawrah FMDV Plant and the Agriculture Water Resource Center (AWRC) facility and R&D and production of aflatoxin moved to the AWRC. In addition, BW-applicable R&D was conducted during the 1980s at TABRC. Al Hakam continued to be a key BW-related R&D facility until 1996, when it was destroyed under UNSCOM supervision. Additionally, Al Hamath, TABRC, and the Tariq Facility (Fallujah III) were also key sites during this period (for more complete information on Iraq's R&D facilities and ISG's exploitations, see Annex B on BW Research and Development).

Iraqi BW Agent Research

Iraq's efforts to develop BW agents were extensive, and in the years leading up to the first Gulf war Baghdad investigated a wide range of biological agents with potential military applications. ISG investigated the extent of Iraq's research prior to the war, and assessed the degree to which Baghdad pursued development of these agents in the aftermath of Desert Storm.

***Bacillus anthracis* ('Agent B')**

Baghdad invested considerable time and effort prior to 1991 in the development of anthrax as a biological weapon. ISG assesses that the effort ended with Desert Storm. However, studies of simulants aided the quality of any future anthrax products.

R&D on growing the anthrax organism and inducing sporulation was initiated at Al Hasan site number 2, but the work was terminated at the end of 1978. The R&D was reinitiated in 1985 at Al Muthanna. Although denied by Dr. Rihab, the studies may have picked up where the Al Hasan studies left off, and work progressed rapidly and included laboratory production, characterization and storage.

- After the transfer of the BW effort from Al Muthanna to Al Salman, scale up production and aerosol studies (dry and liquid) were conducted. A continued interest in obtaining a suitable dry product and the efforts expended to acquire a suitable drying capability continued at Al Salman and later at Al Hakam.
- Iraq obtained two capable dryers that were air-freighted into Baghdad in 1989. One of these dryers was located at Al Hakam in 1991. Iraq also tried to obtain an "aseptic" spray dryer (identical to those air-freighted to Baghdad, but with additional biological containment capabilities) in 1990. This dryer was not delivered by the supplier.
- Static tests (using simulants for *B anthracis* spores) were conducted in March 1988 in LD250 aerial bombs. Dynamic and static trials using 122 mm rocket warheads filled with simulant were conducted in 1989 and 1990. Trials were then conducted in August 1990 using R-400 aerial bombs, again filled with anthrax simulant.

ISG continued to gain more insight into B. anthracis work done before 1991, which reinforced the findings of UNSCOM detailed below. However, no new information has been obtained on B. anthracis-specific R&D conducted after the 1996 destruction of Al Hakam.

- Thamer ‘Abd-al-Rahman, a key figure in Iraq’s anthrax work pre-1991, told ISG that he attempted to obtain the Ames strain of *B. anthracis* which he considered “very virulent” while attending a scientific workshop in 1989, but he was unsuccessful in that endeavor. Iraq declared researching different strains of *B. anthracis*, but settled on the American Type Culture Collection (ATCC) strain 14578 as the exclusive strain for use as a BW.
- Prior to work on the pathogenic strains of *B. anthracis*, Dr. Rihab directed the scientists to use surrogates in their early and more advanced stages of R&D and production. Accordingly, experiments were done with surrogates, *B. thuringiensis*, *Bacillus subtilis* and *Bacillus megaterium*, in order to determine appropriate growth conditions. Her logic was in part for safety. She wanted to permit the researcher to familiarize and learn procedures with a nonpathogenic organism before attempting to use pathogenic ones. These bacillus strains were used to simulate work on *B. anthracis* by researchers at Al Hakam after 1991. A similar practice apparently was followed 1985-1990. Laboratory-scale work was done with the *B. thuringiensis Israeliensis* strain at Al Hakam to determine optimized growth conditions. The main work, and ultimate production, of *B. thuringiensis* was conducted utilizing the *Kurstakii* strain. *B. megaterium* was researched at Al Salman in 1987-1988 as a model for *B. anthracis* using a 150l fermentor.
- One large field experiment was also planned and, according to the source, the experiment involved spreading of the bacteria by an airplane. ISG found no further information on this experiment. The information provided by the source confirms existing knowledge about Iraq’s use of *B. thuringiensis*, *B. subtilis* and *B. megaterium* as simulants for *B. anthracis*. However, as this is information that comes from a single source, ISG is unable to con-

firm the veracity of the claim of continued research into *B. anthracis* at Al Hakam following the 1991 Gulf war.

- ISG found information that indicated that research into anthrax vaccines was conducted at the Abu Ghurayb Veterinary College (Baghdad University, College of Veterinary Medicine). Unfortunately, ISG was not able to obtain further information as to what this research involved or what vaccine strain was utilized.

Clostridium botulinum (Botulinum toxin, ‘Agent A’)

ISG has uncovered no further information to suggest that Iraq actively continued to research and produce *C. botulinum* for use as a BW weapon following the 1991 Gulf war.

R&D on botulinum toxin was an integral part of the Al Hasan site number 2. Efforts appeared to be modest but were focused on growth conditions for maximizing toxin yield. This effort was terminated at the end of 1978 when Al Hasan was dissolved.

Tests then were re-established when the militarily relevant BW program was revitalized in 1985 at Al Muthanna. Seemingly, building on the knowledge gained by the Al Hasan effort, rapid progress was made. By early 1987, before the program was moved to Al Salman, inhalation studies on botulinum toxin were conducted in the 5m³ inhalation chamber at Al Muthanna.

At Al Salman, studies progressed to where field trials on the dispersal of liquid botulinum toxin using LD-250 aerial bombs were conducted in March 1988. After the move to Al Hakam in 1988, with its larger agent production capability, static (November 1989) and dynamic (May 1990) trials were conducted using 122 mm rocket warheads at the Al Muhammadiyat test range. R-400 aerial bombs were also tested in August 1990 as were the effects of metals (simulating the interior of munitions) on the agent.

Clostridium perfringens ('Agent G')

No information was discovered to suggest that BW-related research into C. perfringens continued after the 1991 Gulf war. Following the end of OIF, ISG obtained information relating to *C. perfringens* that essentially confirmed previous UNSCOM findings regarding Iraq's work on this bacterium as a BW agent.

- In late April 1988, Dr. Rihab initiated research on *C. perfringens*, known as 'Agent G', to facilitate its use as a BW agent. The development of 'Agent G' occurred at the Technical Research Center (TRC), Al Salman, and was directed by 'Ali Shihab during the late 1980s. Dr. Rihab instructed the researchers to investigate the various strains and identify the most effective for use as a large-scale BW agent. According to a source, the intent of the research was to disseminate *C. perfringens* as spores.
- The initial stage of the *C. perfringens* project focused on identifying a medium in which to optimize growth. Researchers procured Duncan and Strong growth media and modified the salt and nutrient levels. This initial research on media and isolates occurred in the beginning of 1990. The second phase of the research focused on bench scale production of 'Agent G spores', with the first successful production of *C. perfringens* spores in March 1990.
- As part of the second phase of research, the research protocol called for animal testing to be conducted quarterly and the results forwarded via an official report to Dr. Rihab. ISG has two accounts for the testing that occurred. One source describes research conducted in a small aerosol chamber on rabbits and mice attempting to inoculate abraded skin in these experimental animals. The results obtained through these experiments left the test animals with lesions typical of *C. perfringens* infection. The second account also involves the use of an inhalation chamber to aerosolize spores and infect the laboratory animals but after autopsies were performed, researchers concluded that aerosolized spores may not be effective as a BW agent. They then began injecting 'Agent G' via syringe and this resulted in successful tests using

guinea pigs and mice. The animals developed Gas Gangrene infections at the wound sites and eventually died. Results from the successful tests were reported to Dr. Rihab in April 1990, who instructed the researchers to move the production of 'Agent G' to a larger scale.

Aflatoxin ('Agent C')

R&D on aflatoxin began in May 1988 based on previous nonmilitary work on aflatoxin by Dr. Imad. Good progress was made which led to an initial weapons test in November 1989, consisting of static trials with 122 mm rocket warheads. Additional testing involved combining aflatoxin with CS and CN incapacitating agents as well as mustard CW agent. Studies included potency retention under conditions and temperature of deployment as well as effect of metals on the agent. This was followed by dynamic testing trials in May 1990. However, R-400 aerial bombs and Al Husayn missile warheads were munitions selected for BW weaponization in late 1990.

In 1992, an individual at the Central Public Health Laboratory—who worked for the SSO and was responsible for checking Saddam's food for contamination—denied having an aflatoxin standard, according to a source with direct access but of unknown reliability. According to the same source, the former director of CPHL had been involved in offensive aflatoxin research until at least 1991.

Debriefings since April 2003 of sources formerly involved with BW efforts indicate that Iraq at least continued research on aflatoxin throughout the 1990s. In 1994, a DGS forensics laboratory produced 150 ml of aflatoxin for testing on humans, according to a mid-level scientist who formerly worked in the BW program and visited the site.

Brucella

Dr. Rihab supported inclusion of brucella in Iraq's BW program and actively supported pre-Desert Storm research to that end. That initiative, however, appears to have ended in the wake of the first Gulf war.

According to a source, Dr. Rihab wanted to add *Brucella* to the list of BW agents. According to a former

mid-level scientist who worked at several Iraqi BW program locations, he conducted research on *Brucella* at Al Hakam prior to Desert Storm and later at Baghdad University until 1992 using imported strains and patient isolates, respectively, according to the scientist. The research included isolating bacterium, growing it in culture, extracting and purifying its toxins, and testing the toxin on mice. Although this research was not declared to UNSCOM, the scientist stated that his thesis was open.

- Rihab and Ahmad Murtada, the Director General of the former TRC, recommended that the scientist conduct the research as part of graduate degree on *Brucella* at Baghdad University under the direction of Alice Krikor Agap Melkonian. Before the war, the researcher conducted laboratory work at Al Hakam and course work at the university. Rihab provided the *Brucella abortus* isolate the researcher used at Hakam but it was not from the *B. abortus* isolates obtained by Rihab from American Type Culture Collection: none of these had been opened. The scientist stopped research on *Brucella* during the war but resumed his work after that at the university, working on isolates from a hospital patient. According to the mid-level scientist, the *Brucella* work was not secret and his thesis about the work was not classified.
- In 1991, after the war, work on *Brucella* restarted at the College of Science with an isolate from a patient at the Ibn-al-Khatib Hospital and was coordinated through the Ministry of Health. During the project, *Brucella* was isolated and grown. The researcher extracted and purified the endotoxin, tested it on mice and determined the toxin was not as effective as Shiga toxin, ricin or botulinum. Rihab received a copy of the researcher's report and work on *Brucella* was supposed to start on the person's return to Al Hakam but it was put on hold by Dr. Rihab in 1992 to focus on research and production of *B. thuringiensis*.
- Research on *Brucella* was also conducted at the Abu Ghurayb Veterinary College, but ISG has no information on the extent of this work.

- Research into alternative media for the growth of *Brucella* was conducted following the introduction of the 1990 UN sanctions. This research was carried out by 'Ali Shihab. ISG found no information to indicate the timescale of research, the results or whether the research was successful.
- After the establishment of the Al Razi Center in 1992, the Microbiology department, directed by Dr. Antoine Al Bana, carried out research into diagnostic kits for *Brucella*. The facility was visited by the ISG BW team who discovered *Brucella* bacterial isolates obtained from Al 'Amiriyah Serum and Vaccine Institute (ASVI) (see Figure 3). The strains found were *B. abortus* and *B. melitensis*. Although, pre-OIF, the facility had maintained the capability to conduct successful BW-related R&D on *Brucella*, there were no indications that this had occurred.

Ricin

The evidence surrounding Iraq's investigation of ricin for BW purposes is unclear, and thus ISG can offer no definitive conclusion. It is clear that Baghdad had weaponized ricin in at least a limited fashion prior to the first Gulf war. There is at least some evidence of post-war IIS involvement in ricin research and possible human testing, but ISG developed no definitive information with which to confirm reports of post-war production.

Iraq's R&D on ricin had its origin in the mid 1980s at the Scientific Research Center (SRC). In 1988/89 active collaboration was sought from personnel at Al Salman. The research proceeded apace with initial field trials using 155 mm shells in Nov 1990. The work at the SRC was initiated at the behest of an official with the Internal Security Service who followed the efforts through the field trial (see Figure 4).

ISG conducted a focused investigation into Iraqi work with ricin—a toxin derived from castor beans (*Ricinus communis*) of the indigenous Iraqi *R. communis* plants. The search to date has yielded conflicting information about the use of castor beans and continued ricin work after 1998.

ISG is aware from UNSCOM reporting that Iraq conducted limited weaponization of ricin prior to Desert Storm and that it conducted partially successful field trials with ricin. Based on this, ISG focused on two main themes: (1) part of the Al Tariq Facility—also known as Fallujah II—for castor oil production, and (2) the reported IIS work with the toxin. While ISG has not been able to find direct evidence of recent ricin production, several sources have provided information that suggest that work on ricin toxin continued well past 1992, possibly until the beginning of OIF.

The ISG team examined in detail the Al Tariq Facility and a site that supplied Al Tariq with castor beans—the Al ‘Aziziyah farms. The team debriefed a number of scientists and engineers employed at Al Tariq and a group of farmers from Al ‘Aziziyah, obtaining from each group a very different picture about work at Al Tariq and the intended use of the castor beans. Al Tariq staff employees maintained that castor beans were used exclusively for the processing of castor oil for the brake fluid and tire production industries. They also admitted contemplating the use of castor oil as an anti-foaming agent in the yeast industry. When prompted with a few more specifics, one Al Tariq employee explained away the activity as being pharmaceutical-related. Another shipment of castor beans, for a university, remains to be explained. For more information on this facility, see Annex 2.

ISG has investigated claims by former IIS officials—a former IIS chemist and his former supervisor, the late Dr. Al Azmirli—that the IIS produced ricin until at least 1995 and possibly until 2003, although ISG has not yet obtained direct evidence of ricin work.

- Interviews with Dr. Al Azmirli—a former IIS official and scientific advisor to Saddam—revealed that the IIS researched ricin as a BW agent until 2003. He himself was directly involved with ricin work until 1992, when Husayn Kamil demanded the program be turned over to Dr. Rihab and a doctor from the Ministry of Agriculture.
- Dr. Al Azmirli claimed that between 1992 and 1996, ricin was being produced at Al Shameir Hospital in Al Rashad until it was transferred to Al Hakam. A separate former IIS official confirmed that Al Azmirli produced approximately two kilo-

grams of ricin at the Ar Rashidiyah plant in 1991 and 1992. An exploitation of the Ar Rashidiyah plant corroborated the location and presence of a facility, but ISG could not confirm that ricin work had occurred there because of extensive looting.

- Mun’im Mustafa Fatahi, a close friend of Dr. Al Azmirli, reportedly told Al Azmirli that a group of people was actively pursuing ricin for weaponization. As of March 2003, ricin was being developed into stable liquid to deliver as an aerosol in small rockets, cluster bombs, and smoke generators, according to Al Azmirli.
- Documents obtained from Dr. Al Azmirli’s residence included an MSc thesis on the topic of ricin written by ‘Adnan Jasim from Baghdad University.

ISG has investigated claims from several sources that work on ricin toxin continued well past 1992, possibly until the beginning of OIF. The information that ISG obtained on the potential role of ricin in Iraq’s BW program post 1991 has primarily been based on single source reporting of unclear veracity.

- The IIS was involved in the research and limited production of ricin for the development of a BW weapon. A source stated that ‘Adnan Abd-al-Rasa’il Al ‘Ubaydi was responsible for all research related to ricin conducted by the IIS. In 1992, ‘Adnan produced a few milligrams of ricin. The IIS was then ordered not to continue with the ricin project because Husayn Kamil wanted the project. The source stated that all research and production processes were turned over to Dr. Rihab and a doctor from the Ministry of Agriculture. A group in Al Hakam was then involved in ricin production after 1992.
- According to a single source, the MIC maintained fields of castor plants in the Al ‘Aziziyah area for sale to the Al Tariq Company. According to a source, the castor beans harvested from these crops were allegedly used to make brake fluid and “chemical weapons.” When asked if the “chemical weapons” were possibly insecticides or pesticides, the source stated that the “chemical weapons” were used against humans. As the product of a single source, this information is hard to verify.

- During the approximate period of 1994 or 1995, Husayn Kamil, then Head of MIC, gave an order to confiscate farmland that belonged to the source in the area of Al ‘Aziziyah. By Husayn Kamil’s order, castor plants were to be planted on the acquired land and the MIC remained responsible for delivering the beans for each year’s planting. The source also reported that a castor crop was planted every year within different farming areas in the vicinity of the Al ‘Aziziyah. To hide the fact that MIC possessed dedicated castor fields, a cover story was developed between MIC and the Ministry of Agriculture or Ministry for Industrial Crops. Wheat, corn and cotton were subsequently planted in the vicinity of the castor crops, as a “cover crop.” The Ministry of Agriculture maintained a cover for the MIC in the area of Al ‘Aziziyah with offices for project managers. The same source indicated that the cover story was used to deceive UN inspectors.
- All the castor beans grown at this location were delivered to the Al Tariq facility. According to the source no payment was ever made for the castor beans. The only payment that occurred for the overall transaction was to the farmers who worked in the fields. There were various project managers who handled paying the farmers, who were on the payroll of the Tariq facility and ultimately MIC. The castor crops were planted in approximately February and March, and harvested annually in September. Each harvest yielded approximately 250 to 300kg of castor beans. The Al Tariq facility would normally send four or five trucks to the Al ‘Aziziyah warehouse to take delivery of the castor beans.
- During an exploitation of the TABRC facility, the team discovered a piece of equipment they determined was associated with de-hulling of castor beans (see Figure 5). The exploitation team also discovered a 100-ton press containing an oily residue and took a sample of this material. This material returned a positive test for ricin. Although a positive result was obtained this discovery does not indicate on its own any illicit activity on behalf of the facility, as any step in the production of castor oil will return a positive test for ricin. The scale of the equipment was small and no reason was provided as to the purpose of the machinery.

ISG investigated a laboratory at the Al ‘Abud Trading Complex, Baghdad. Evidence of ricin was found in samples collected, both by field analysis and at ISG laboratory assays.

- Based on the materials, equipment, and manual found at the site, ISG judged the complex did not appear to be related to the Regime’s chemical, or biological weapons programs. Rather, it appears to be an extremist-run laboratory with equipment and reagents that at a minimum could be used to produce ricin. Biological growth mediums and chemical precursors (triethanolamine) were also found in the laboratory.

Wheat Cover Smut (‘Agent D’)

R&D on wheat cover smut (bunt of wheat) was initiated in 1984 at the Al Salman site. After the BW militarily relevant program was moved from Al Muthanna to Al Salman, the wheat cover smut project was merged into a fungi and fungal toxin group within Dr. Rihab’s group. Smut spores were tested in static field trials in late 1989. Tests to evaluate smut spores as a carrier for aflatoxin were also part of the program. No additional information has been found by ISG related to Iraq’s interest in and work on smut spores.

Viruses

Prior to the first Gulf war Iraq pursued a range of viral agents as part of its BW program. ISG has uncovered no direct evidence to indicate a renewed interest or organized program to re-establish an Iraqi viral BW program and judges that Baghdad’s viral BW effort ended in 1991.

Researchers involved in Iraq’s 1970s BW research at the Al Hasan Institute reportedly attempted to develop influenza virus as a BW agent and were also conducting R&D on polioviruses. There were two virologists in the original group; one was a US trained veterinarian Dr. Muzhir Al Falluji, who had training and experience in animal orthopox (smallpox like) viruses; the other was Dr. Muslih Al Muslih (the 3rd Director of Ibn-Sina Center) who worked on poliovirus. Dr. Al Falluji taught several classes at the College of Veterinary Medicine. The Al Hasan Institute was closed in 1979 and along with it, the viral programs.



Figure 3. Entrance to al-Razi facility.



Figure 4. Castor Beans, found at the al-Abud laboratory by the ISG.



Figure 5. Thresher used to mash castor beans found at TABRC.

Iraq's viral BW program began its research and development (R&D) phases in July 1990 under the direction of Dr. Hazim 'Ali. This was the second known attempt by Iraq to conduct BW viral research. From 1973 until 1978, The Ibn-Sina Center of the Al Hasan Ibn-al-Haytham Research Foundation conducted research at its Al Salman site.

Iraq subsequently revived its BW programme in the mid 1980s. The revival of the Iraqi viral BW program began in early to mid 1990 when Dr. Hazim 'Ali was chosen to lead the effort. Iraq's pursuit of viral BW began over 4 years after the initiation of its research for bacterial and fungal agent development.

According to Hazim 'Ali, the viral BW program ended on 17 January 1991. This information is consistent with an English-language document titled "Viral Agents Program" obtained through the investigations of ISG, which states that work on the viral program began on 1 December 1990 and was cancelled on 17 January 1991, when all specimens were destroyed. This is in contrast to information provided to UNSCOM that included laboratory notebooks and ISG information stating that Dr. Hazim 'Ali isolated and began growing camelpox in October 1990.

Because of pre-OIF intelligence assessments about Iraq's possible possession of smallpox, ISG conducted extensive investigations that included site visits and multiple interviews to determine the validity of this assessment. ISG has collected fragmentary and circumstantial information that provides no definitive conclusions, either way on this issue.

- ISG has collected information from credible sources from the pre-1991 program demonstrating Iraq's interest and intent in developing pathogenic viruses specifically smallpox.
- Further, ISG assesses that Iraq maintained the capability in its personnel and basic equipment to conduct R&D into viral agents including smallpox.
- Finally coinciding with the 1991 Gulf war, Iraq intended to develop a production base to support pathogenic viral production.

Camel Pox

Iraq's interest in camel pox and its inclusion in the viral BW program have led ISG to assess that camel pox R&D was a surrogate for smallpox research, analogous to the use of nonpathogenic Bacillus species and Bacillus anthracis.

According to Hazim 'Ali, researchers in Iraq's BW program followed the practice of working with particularly pathogenic micro-organisms surrogates to facilitate transition to the actual pathogens. This approach permitted the researcher to familiarize and learn techniques, procedures and processes to increase the safety margin for the researcher and technicians.

- In Dr. Rihab's own words, Hazim's decision to work with camel pox was because "it was near to smallpox." When directly questioned about the possibility of smallpox in Iraq, she misspoke on 3 occasions saying "there is no camel pox in Iraq."
- Camel pox was one of the three viruses chosen for the viral BW program by Hazim 'Ali. According to Hazim, no experiments were conducted to determine the effectiveness of camel pox on humans. His decision to develop camel pox was based on his research of citations from standard microbiology and microbial infection textbooks. His recollection was that camel pox causes rare cases of human infection but these were not severe. Dr. Hazim's rationale for the utility of camel pox as a possible BW pathogen remains inconsistent with current and historical published scientific and medical knowledge.

ISG has no information to contradict his statements that his research only succeeded in initial isolation of camel pox from a clinical specimen obtained from the Veterinary Diagnostic Research Center in Abu Ghurayb.

The camel pox sample (scab) was not available immediately but by the end of October 1990, Hazim 'Ali obtained a sample and successfully isolated the virus in chicken eggs. Chicken eggs were inoculated with the camel pox and the results were promising with some characteristic lesions (white pox marks) appearing on the chorioallantoic membrane of the chicken egg. These lesions on the chorioallantoic membrane of a ten-day old chicken embryo were characteristic of infections described in textbooks.

Hazim claims he cannot remember if animal testing occurred. The source stated that a pilot experiment should have been conducted with the isolate to assess for activity in an animal; rabbits are particularly susceptible to camel pox. However, he could not remember an actual test of the viral isolate on rabbits due to the critical time in which the test would have occurred; the 1991 Gulf war. Hazim does not believe that anyone else could have carried out this experiment in his absence or without his knowledge.

Hazim investigated existing facilities in Iraq for scaling-up the production of camel pox if and when that was possible or necessary. He decided on using the chorioallantoic membrane method of viral egg production. Although denying a plan for large-scale production, he inspected the Veterinary Service Center in Erbil. It was used in the production of animal vaccines for Newcastle disease and fowlpox. The Erbil facility had a moderate scale egg production capability but according to Hazim an untrained staff. The large size of the facility required was explained due to the fact that the amount of virus obtained through this method would only average 5 mg of tissue.

This facility was autonomous to the Iraqi Government and an order to commandeer the plant for Hazim's activity was signed by the Minister of Agriculture. However, the order was never implemented.

Dr. Hazim 'Ali's performance in leading and conducting Iraq's fledgling viral BW research, based on comments by his colleagues, was underwhelming. Rihab described him as "not a man to work by himself." Dr. Nasir Al Hindawi commented that Hazim 'Ali did not produce a single virus.

Smallpox

ISG concludes that Iraq had a pre-1991 intent to develop smallpox as a strategic viral BW agent and had the basic capability to work with variola major (smallpox). However, ISG has collected no direct evidence that Iraq either retained or acquired smallpox virus isolates or proceeded with any follow up smallpox related research. ISG assesses, however, that Iraq did have the capability to conduct research into smallpox, if not in a manner up to Western BL-4 containment standards. Iraq possessed facili-

ties such as the Al Dawrah Foot and Mouth Disease Vaccine Plant and Al Razi Center had equipment that could potentially be used to work on high-risk agents such as smallpox.

Prior to OIF, the US intelligence community assessed that Iraq probably retained samples of the smallpox virus and may have been researching it for BW purposes. It was also stated that it had no information indicating whether such work was ongoing. Despite the limited information gained by the UN and a claim by a senior player in the CBW program that the intent of the viral BW program was to weaponize smallpox, the additional information uncovered by ISG has not provided evidence of an R&D effort to weaponize smallpox.

- According to Dr. Mahmud Farraj Bilal Al Sammarai, a senior official involved in the weaponization and testing of CBW agents, the aim of the viral BW program was intended for the weaponization of smallpox. He states that Dr. Hazim 'Ali started with Camel pox since it was easier to work with for development, but ultimately the program was intended to progress to smallpox. Dr. Bilal did not know for a fact that samples of smallpox existed within Iraq but stated that 'Ali might obtain them from the Baghdad Central Public Health Laboratory or collections at the Al 'Amiriyah Serum and Vaccine Institute (ASVI). Dr. 'Ali Mukhlif, Dr. Hazim 'Ali's sponsor to work with the TRC, told Bilal the intention of the program and Hazim's activities during a meeting at Al Muthanna in 1990.
- During investigations conducted by ISG and earlier by UNSCOM, Dr. Hazim 'Ali occasionally referred to "smallpox" when questioned about their research and quickly retracted the statement to say "camel pox." The source was unable to provide an explanation as to why he repeatedly made this mistake. This type of mistake added to the confusion surrounding Iraq's possible R&D efforts on smallpox. Hazim stated that he would not be surprised if smallpox isolates were found in Iraq and identified two culture repositories where viral cultures could be maintained over extended periods of time: Al Dawrah FMDV Plant and the Baghdad CPHL. None were found by ISG. However, the CPHL seed stock repository was reported to have been systemi-

cally looted post-OIF (see below, under “Feasibility of Maintaining Smallpox Cultures from 1972) and the Al Dawrah FMDV Plant was effectively shut down and electricity turned off after it was rendered unusable in 1996.

Contrary to comments made by Dr. Al Hindawi that there were no virologists in Iraq, ISG identified and interviewed close to a dozen, mostly US and UK trained, highly capable PhD virologists. Several had experience with orthopox (smallpox like) viral research experience mostly with animal related pox viruses. One actually performed genetic engineering research on animal pox viruses attempting to develop a recombinant animal vaccine. A couple had experience working with the smallpox vaccine strain (vaccinia). However, none of Iraq’s “best and brightest” virologists were assessed directly involved in Iraq’s BW efforts. After extensive interviews, none could provide direct information concerning the existence of historical or recent smallpox isolates or research. (See the accompanying textbox on reported Iraqi retention of smallpox isolates.)

Iraqi Retention of Smallpox Cultures

ISG cannot be certain whether or not Iraq had smallpox seed stock to OIF. ISG investigated Iraq's technical and practical capabilities to maintain viral or clinical smallpox isolates from the early 1970s in Iraq. Interviewing a number of senior Iraqi scientists and virologists ISG could make no definitive conclusions. ISG notes the stated intent of Husayn Kamil in 1990 to develop more virulent viruses as part of the BW program. While Hazim did not accomplish this objective, ISG cannot rule out the possibility that other, yet unidentified, researchers were given the responsibility to attempt to do so.

In 1978, Ministry of Health (MoH) reported to the World Health Organization that no smallpox cases had occurred in Iraq since an outbreak in 1972, and attested in writing that all remaining smallpox cultures and clinical specimens were destroyed in 1978. There was, however, no independent verification of the destruction of smallpox isolates or clinical specimens that may have been retained by either clinical or research institutes, and subsequent reporting on the subject is contradictory:

- One source ISG interviewed was an advisor to the Iraqi Minister of Health between 1980 and 1982. He stated that he was “90% certain” that Saddam did not destroy the last smallpox samples.
- Contrarily, Rihab stated categorically that no isolates of any kind were inherited by her from the original 1970s BW effort.
- According to a senior Iraq scientist at Al ‘Amiriyah Serum and Vaccine Institute, he was ordered by MoH urgently to produce 3.5 million doses of smallpox vaccine in 1980. This source was the principal responsible scientist involved in this effort. By his accounts, the Iraqi MoH attempted to procure smallpox vaccine seed stocks from the World Health Organization (WHO) in 1980 for this effort. The WHO refused Iraq’s request citing the recent success in the eradication program.
- Intelligence reports dating back to 1994 suggest that Iraq may have obtained smallpox cultures from

the former Soviet Union (FSU) in 1992. A biologist who had indirect access to this information stated that Iraq acquired isolates of smallpox from Russia in 1992. He went on to describe an effort to develop smallpox for the BW program from 1992 to 1994. He described efforts to grow the virus in both eggs and tissue culture. This effort reportedly failed and the viral cultures were maintained at the CPHL. The subject biologist is no longer in Iraq.

ISG has collected no information with which to conclusively refute or confirm the existence of smallpox isolates retained by Iraq from the period when the disease was still endemic, but if they were retained they would have been a potentially serious threat in the context of a renewed BW program.

- ISG assesses such viral cultures could remain viable for extended periods of time depending on the nature of the isolate, facility conditions and the overseeing scientist. Clinical smallpox specimens would be less likely to survive long-term storage unless they were held in liquid nitrogen. Frozen lyophilized smallpox isolates could, on the other hand, have an extended shelf life and probably remain viable for decades. Several institutes in Iraq had nitrogen freezer storage capabilities.
- ISG did learn that as late as 1992, Iraq was assessing the viability of smallpox vaccine it produced in the 1980s. A scientist who was involved in the production of the smallpox vaccine in the 1980s was asked to test samples presumably from that stockpile. The vaccine was found nonviable. At that time, he recommended that all remaining vials of that vaccine be destroyed. He does not know if that recommendation was followed. Separately, ISG learned from Dr. Hazim ‘Ali that a researcher at the Baghdad University Medical College was actually producing smallpox vaccine in 1996, for whom and for what purpose are unknown.

Baghdad College of Science was identified as one possible location for smallpox work prior to OIF. An ISG subject matter expert team visited the University of Baghdad, College of Sciences on three separate

Iraqi Retention of Smallpox Cultures (continued)

occasions and toured the facilities in late May and early June 2003. The visit observed generally old, poor condition, and sparse laboratory equipment. The team inspected a room (room 179) marked “Graduate Studies” which had locks on both doors. The room contained a large autoclave. The room had two large overhead fume hoods of the type used in restaurants to filter the air within the room. There was one small plastic class I safety cabinet, several shaker incubators, a glove box, old bottles of culture media. No freezers or liquid nitrogen containers were identified. During the course of its investigations, ISG inspected the Al Kindi veterinary vaccine facility. This facility was similar in function to the one Hazim ‘Ali investigated in Irbil in autumn 1990 that produced Newcastle and animal pox vaccines.

- ISG inspected the production buildings and observed that the equipment appeared to be for the expressed purpose of producing Newcastle virus vaccine in chicken eggs; however, this dual-use equipment was assessed to be easily diverted to produce Variola (smallpox) or other pathogenic viruses (see Figure 6).



Figure 6. 1,480-liter double-jacketed steel vessel (left) and egg incubator (right).

- ISG also visited the building where animal pox vaccines are produced in tissue culture. Their assessment was that as with the Newcastle vaccine unit, the equipment in this building could also be used to produce large amounts of smallpox virus in tissue culture although all equipment present is consistent with the expressed purpose of making animal vaccines.

ISG learned of a television news report that was broadcasted on Western television in mid-April 2003 that reported the CPHL had been looted of highly infectious virus such as smallpox, polio and influenza. ISG visited the latter and interviewed senior researchers who described the incident. Several visits to the CPHL and interviews with scientists and researchers have not shed further light into the existence of smallpox cultures being stored there. ISG did identify a “secret lab” that was operated there, which had been vacated in December 2002. The nature of the research in that laboratory was not determined.



Crimean Congo Hemorrhagic Fever

While Iraqi explanations for why CCHF was not considered for the BW program remains unsatisfactory, there is little substantial information to contradict the explanation.

Hazim 'Ali argued against CCHF being considered endemic to Iraq but did not deny that a sample could be obtained during the cyclical infection season. According to Antoine Sabri Al Bana, Iraq's leading CCHF expert, the virus circulated widely in herd animals such as donkeys, sheep and goats.

- Some cases of CCHF occurred in Iraq during the time Hazim 'Ali was studying overseas and described an incident involving physicians, who unaware of the virus and its symptoms, were unprotected whilst treating infected patients. As a result, some of the physicians acquired CCHF and died. Hazim 'Ali used this example to illustrate the introduction of the virus into Iraq and that it was not actually endemic to the country.
- According to Hazim 'Ali, two researchers from the Veterinary Medical College worked together on diagnosing and isolating CCHF in the 1970/1980s. The duration of the experiment and the extent to which testing was conducted using animals, remains unknown. Hazim 'Ali claims not to know where exactly the practical isolation of the virus occurred because of a lack of sufficient containment to work with the virus and no vaccine was available at the time. The work of the two researchers was published. Isolation of the first case of CCHF in Iraq occurred in 1979.
- In 1996, a CCHF outbreak occurred that resulted in over a 100 cases. Most cases were seen at the Al Khatib hospital, near Tuwaitha, south of Baghdad. The mortality rate even in treated cases approaches 50 percent.

Acute Hemorrhagic Conjunctivitis (Enterovirus 70)

ISG has investigated, but has found no information to suggest that BW-related research into the contagious agent acute hemorrhagic conjunctivitis (AHCV) occurred after the alleged cessation of the

Iraqi viral BW program in early 1991. The Enterovirus 70 strain that causes AHCV was introduced to Iraq in the 1970s.

- The documented work conducted on isolating AHCV was unsuccessful according to Dr. Hazim 'Ali. A senior virologist involved in the Iraqi BW program attempted to isolate Rotavirus and AHCV from clinical isolates. When the source isolated AHCV and had evidently obtained cytopathic results, the isolate was infected into Hep2 viro cells. The results of the test were unsuccessful.

Rotavirus

According to the senior level viral researcher, Rotavirus, which causes an acute gastroenteritis, was chosen because of a theory at the time that as Americans were "more hygienic", they might be more susceptible to infection with rotavirus. Little new information has been uncovered by ISG surrounding Rotavirus, the third virus chosen for the Iraqi viral BW program.

- Work was done to isolate the virus from clinical samples but ISG has no additional information to indicate the success of these attempts.

Other R&D Related to BW Development

Biopesticides

ISG judges that, following Desert Storm, in mid-1991, Al Hakam shifted its focus from Bacillus anthracis production to Bacillus thuringiensis, a biopesticide and a simulant for B. anthracis, as a mechanism to preserve a key segment of Iraq's BW production base. This shift in focus allowed Iraq the opportunity to continue the pursuit of relevant technologies and processes—such as the development of an entirely indigenous growth media and the drying of biopesticide—that could further achieve its desire for self-sufficiency in BW.

- Multiple sources told ISG that in order for Rihab's former anthrax group to produce Bt, they required the assistance of scientists at TABRC who had

Bacillus thuringiensis (Bt)

Bt is a biopesticide that is widely available on the international market and therefore, trade restrictions aside, it is not immediately apparent why Iraq should choose to develop its own production process from scratch. ISG assesses that there are many companies that would be willing to supply Iraq with Bt and/or sell it a license to produce the material. ISG is unable to find any indication that preproject planning work—market considerations, least cost / most effective method for Iraq to enter the bio-insecticides business—was ever conducted in relation to Bt.

been researching alternatives to chemical pesticides like *B. thuringiensis* since the early 1980s. ISG learned from several sources with direct access that Al Hakam developed *B. thuringiensis* production to cover past anthrax production and to preserve production infrastructure for the future.

- An Iraqi scientist and former head of the anthrax program told ISG that from 1992-1995 TABRC provided the seed inoculums to Al Hakam for industrial-scale production of Bt. However, ISG has no information to suggest that TABRC was involved in production of *B. thuringiensis* in quantities larger than the bench-scale amounts required for experimental purposes.

ISG judges that the TABRC became the primary facility continuing B. thuringiensis research after Al Hakam's destruction in 1996, but ISG lacks evidence that this research was intended as a simulation for B. anthracis research. However, undeclared pieces of equipment including fermentors were found at TABRC by ISG and an important former *B. anthracis* production expert was reported to have worked routinely at the facility from 2000 to 2003, which makes ISG suspicious of the true nature of the work done there.

- An ISG exploitation team found undeclared fermentation vessels and an underground storage area with other dual-use biological production and processing equipment at TABRC in October 2003 (see Figure 7).

- Thamir 'Abd-al-Rahman, who was declared to the UN as involved in Iraq's *B. anthracis* BW project, worked at the TABRC one day a week beginning in 2000 on a SCP project, according to an Iraqi microbiologist with direct access, but unknown reliability. Thamir also was reported to have possibly helped a *B. thuringiensis* researcher at the TABRC, Jabbar Al Ma'dhihi, with some viability tests on *B. thuringiensis*.

Multiple sources told us the primary mission of the TABRC was agricultural science R&D. The majority of TABRC's activities involved crop improvement and integrated pest management. As part of the Iraqi Atomic Energy Commission (IAEC) within the Tuwaitha Nuclear Research Complex, the facility had a mature scientific staff with expertise in recombinant DNA technology, microbiology, entomology, and access to agricultural pathogens, according to an Iraqi microbiologist of unknown reliability.

- Dr. Al Ma'dhihi—former TABRC Director— oversaw research into the biopesticide *B. thuringiensis* and considered it as a replacement for chemical pesticides in Iraq, according to an Iraqi scientist and former head of the anthrax program. Under Al Ma'dhihi's direction, TABRC reportedly conducted successful research into efficient small-scale production and drying of *B. thuringiensis* that could potentially be applied to the BW agent, *B. anthracis*. ISG is uncertain whether informal or formal collaboration between TABRC and the Al Hakam factory occurred before 1991.
- Some of the research into the genetic modification of *B. thuringiensis* done at TABRC in conjunction with the Department of Biotechnology at Saddam University (now known as Al Nahrayn University) from 1999-2003 used polyethylene glycol protoplast fusion methods, followed by screening, to produce a new strain of *B. thuringiensis* that would display high levels of biomass production as well as infectivity, according to an Iraqi microbiologist. ISG judges—based on this research—that the TABRC had genetic engineering capabilities that could be applied to BW agents like anthrax, but have found no evidence to date that such work was done.

Simulants

Generally, 'simulants' are closely related to the BW agent that they are substituting for, but lack the pathogenicity of the BW agent in humans. The rationale for the use of a simulant is that it can be safely used for a variety of purposes such as to accurately assess production methods, storage conditions, weaponization parameters, and dispersal techniques. Many simulants can also be used for a variety of legitimate civilian activities and therefore provide cover stories for BW programs.

Single Cell Protein R&D

ISG has found no direct evidence that the post-1995 work carried out by TABRC into SCP was used to cover continuing research into the production of BW agents, like what was done at Al Hakam. Testing of samples taken during site exploitations at TABRC and its SCP production subordinate, Al Hamath, by a US coalition BW exploitation team were negative for *B. anthracis* and *C. botulinum* (see Figure 8). ISG assessed that a thorough decontamination procedure or, more likely, that no large-scale R&D or production of known BW agents occurred at these facilities.

- An Iraqi microbiologist told ISG that the TABRC's SCP academic research began in the early 1990s and involved research, experimental testing, and pilot plant production. The work also involved the development of a process for upgrading the nutritional quality of the agricultural residues and wastes.
- The Al Hamath facility worked on a project for the pilot plant scale production of citric acid using *Aspergillus niger*. The process was abandoned when it was discovered that the strain of *A. niger* used was unsuitable for use in submerged culture as the mycelium suffered damage under the continual agitation required for submerged culture. Two 750l bioreactors from the abandoned citric acid production project were set aside for SCP work at Al Hamath but only one of the bioreactors was functional.

Single Cell Protein

SCP is cell or protein extracts from micro-organisms, grown in large quantities for use as protein supplements, for example in animal feeds. SCP production is used to alleviate problems of protein scarcity and can be used to replace costly conventional sources such as soy meal and fishmeal. The use of agricultural and industrial wastes for bioconversion to protein rich food and fodder stocks has the additional advantage of making the final product cheaper.

Growth Media R&D

ISG judges that beginning in the 1990s Iraq decided indigenously to research and produce nutrient growth media that could be used to produce multiple strains of bacteria to include **B. anthracis**, but no direct evidence has yet been uncovered that this media was used to produce **B. anthracis post-1991**. Dr. Rihab described to ISG her BW group's research in developing indigenously produced media to circumvent the effects sanctions imposed on Iraq after the 1990 invasion.

- Dr. Al Ma'dhihi was responsible for the development of an indigenously produced media with ingredients that did not come under UN scrutiny as a result of the sanctions against Iraq. Importantly, laboratory notebooks suggest the media was very effective in inducing nearly one hundred percent sporulation of the *B. thuringiensis*, a known simulant for the BW agent *B. anthracis*, with few or no additives or intensive monitoring of the fermentation process.
- During January 2004, ISG obtained a laboratory notebook dating back to 1989 detailing experiments conducted using Dr. Al Ma'dhihi's locally produced milk byproduct/corn byproduct media and the *B. thuringiensis* variant *Kenyae* with impressive sporulation results. The notebook outlined experiments concerning the effect of different concentrations of the media and additives on sporulation of *B. thuringiensis*. These results were consistent with the claims made for the effectiveness of the media. One experiment detailed in the notebook showed that per 24-48 hours growth of *B. thuringiensis* in this locally produced media, there was 100 per cent spore growth with a resulting viable count of 1.2×10^8 to 5.6×10^8 per milliliter.



Figure 7. Example of dual-use biological processing equipment found at TABRC (spray dryer).



Figure 8. Al Hamath facility.

- Dr. Al Ma'dhihi's media was essential to a possible Iraqi BW program as the media was made up of the simple local ingredients, which are both by-products of other food production processes. The milk byproduct, in particular, is a waste product. At Al Hakam, the corn byproduct was made from corn-starch produced at the Al Hashimiyah State Factory in Al Hillah near Babylon. The milk byproduct was obtained from an unnamed dairy at Abu Ghurayb. Besides being indigenous and cheap it was impossible to monitor or account as part of a UN verification process.
 - This locally produced media were utilized in the *B. thuringiensis* production process at Al Hakam and with growth requirements of *B. thuringiensis* being very close to *B. anthracis*, the whey/CSL media could potentially have been used at Al Hakam to produce *B. anthracis*. Dr. Rihab and Thamir 'Abd-al-Rahman, the director of the *B. anthracis* project at Al Hakam, have both stated in interviews to ISG that they are unaware of any tests on growing *B. anthracis* in the milk and corn byproduct media. This is an odd statement because both individuals co-authored a document that evaluated various growth media for growing Bacillus species including *B. anthracis* on such a commercially available media.
 - Thamir goes further to state that there was no reason to replace the modified G medium declared as used in the anthrax programs as it was reliable, produced high sporulation rates and was made from simple salts commercially available within Iraq, and therefore there was no need to hide procurement signatures. However, Modified G medium (MGM) cannot be used alone to grow *B. anthracis* spores. MGM requires that the anthrax organism be grown in a very enriched medium first and that relative large inoculums be used in the last step of fermentation that uses modified G medium. Thus using an alternative to the enriched medium and MGM would have a material advantage to minimize sanctions scrutiny. Furthermore, at the time of production of *B. thuringiensis* at Al Hakam, Iraq was under increasing scrutiny on the material balance of growth media from UNSCOM.
- Dr. Rihab admitted to ISG that use of such a locally developed milk and corn byproduct *B. thuringiensis* media would permit evading monitoring of media to track fermentation activity.
- An anthrax expert's assessment was that it was highly probable that this media would achieve similar rates of sporulation in anthrax production.
- Dr. Rihab described to ISG her BW group's research in developing indigenously produced media to circumvent the effects sanctions imposed on Iraq after the 1990 invasion of Kuwait.
- Dr. 'Ali Shihab did media work for an unspecified microbe. Shihab was the lead scientist for *Clostridium perfringens* development. ISG assesses that he was probably working on an alternative growth media for that organism.
 - Nasr Al Hindawi worked on alternative media for *Brucella* that was a candidate BW agent undergoing basic research in the period coinciding with Desert Storm.
 - After 1992, Baghdad University worked on plants as a source of bacteria growth media; the plant media was apparently suitable for pathogen growth, and Dr. Rihab had expressed her concern that it might attract the attention of UNSCOM.
 - Around June 2002, Dr. Al Ma'dhihi produced about five vials of *B. thuringiensis* formulated with bentonite and asked Thamir, who was working with Dr. Al Ma'dhihi twice a week at TABRC, for an assessment of their viability by re-growing them in a small volume shake flask culture. One of Dr. Al Ma'dhihi's MSc students was working on this organism, although no other specific reason for this work was given. Thamir cultured approximately two of the samples, with one of the resulting cultures exhibiting good activity of 80 to 90 percent mortality of test organism, the other performed poorly.

Drying Process/Carrier/Particle Size

Multiple sources have told ISG that the *B. thuringiensis* research and production at Al Hakam from 1991 to 1996 was done to provide cover for the equipment and capability at this facility, yet ISG has not been provided with a good explanation as to why an advanced capability to dry agents in a particle size too small for efficient biopesticide use was established. An UNMOVIC document from March 2003 on Iraq's Unresolved Disarmament Issues says that the particle size would have had little use in agriculture and that UNSCOM determined the *B. thuringiensis* strain used did not produce biopesticidal proteins, so it would not have had any utility as a biopesticide. ISG judges that this work advanced Iraq's expertise and knowledge in large-scale drying of *B. anthracis* even if the agent itself was not produced and dried.

- Iraq successfully dried *B. thuringiensis* utilizing bentonite as a carrier and drying agent. According to a source, only one grade of bentonite was available in Iraq and particle size was dictated by this. The bentonite was supplied through the Ministry of Industry and Minerals (MIM) mining company. Talc was also successfully tested as a carrying agent but was determined to be too expensive for production. Acetone was experimented with at Al Hakam as a drying agent, but was found to be too expensive for large-scale production.
- According to a source, at Al Hakam the dried *B. thuringiensis* was crushed into 1-10 μ m sized particles but ISG has found no information on who decided on this particle size. The same source claimed that the farmers using the *B. thuringiensis* from Al Hakam did not like the size of the particles since it made direct dusting onto plants difficult. Al Hakam had plans to enlarge the particles to granular size but they had not completed this work when the facility was destroyed in 1996.

Information surrounding the intended application of *B. thuringiensis* remains contradictory with no consensus on whether it was to be applied wet or dry. A senior researcher involved in the BW program has indicated that the *B. thuringiensis* was intended for use against corn borers as a wet or dry application by farmers. Sources are generally consistent in their assertion that the *B. thuringiensis* was never intended or tested for aerial application. Although the information available suggests Iraq successfully dried *B. thuringiensis* and produced the 1-10 μ m particle size applicable for efficient BW agent dissemination, ISG has found no information that Iraq actually used the same process to produce weaponizable dried *B. anthracis*.

Production Capability

ISG judges that between 1991 and 1996 Iraq possessed an expanding BW agent production capability. From 1996 to OIF, Iraq still possessed small but significant dual-use facilities capable of conversion to small-scale BW agent production. ISG has found no evidence that Iraq used this capability for BW production.

- Iraq maintained—and tried to improve where possible—a smaller, but capable, “legitimate” fermentation capability at agricultural and educational sites that could have been used to produce small but significant quantities of BW agent. ISG, however, uncovered no information that Baghdad did so.
- Samarra Drug Industries, for example, had the fixed assets that could be converted for BW agent production within 4 to 5 weeks after the decision to do so, including utilities and personnel with know-how and equipment, not all of which had been declared to the UN. Site buildings contain numerous jacketed process tanks ranging in capacity from 100-10,000 liters together with ancillary equipment such as filter presses, autoclaves and bio-safety cabinets.
- ISG cannot disprove the existence of Iraqi transportable fermentations systems that could have been used for BW. That said, no evidence has been found to date that there were such systems. ISG judges that the two mobile trailers found near Mosul and Irbil were not for BW production (see the accompanying annexes on mobile production facilities for further information).

Iraq relied heavily on imported equipment and supplies to conduct its BW program, was dependent upon dual-use civilian facilities to produce BW agent, and took steps to mitigate the impact of sanctions on its ability to pursue potential BW agent production.

Iraq relied on equipment that had been imported for civilian purposes for the production of BW agent prior to the first Gulf war, and demonstrated the ability to quickly adapt civilian facilities to BW agent production. This equipment was relocated to a purpose-built BW facility, Al Hakam, where the

production of botulinum toxin was started in 1988. The production of anthrax spores and *C. perfringens* (the causative agent of gas gangrene) followed later. Civilian facilities were requisitioned in 1990 for the production of aflatoxin (the Agriculture and Water Resources Center, Al Fudaliyah) and for the production of additional quantities of botulinum toxin and possibly anthrax (the Foot and Mouth Disease Vaccine Plant, Al Dawrah). After the war these facilities reverted back to their former use, and Al Hakam was disguised as a SCP (yeast) and a *Bacillus thuringiensis* (biopesticide) production plant.

- Prior to the construction of Al Hakam, alternative locations and options were considered by the Iraqi authorities. This included the possibility of having mobile production facilities. Pre-OIF intelligence reports indicated that Iraq had such facilities.

Baghdad’s BW production centered on a number of important fixed facilities. The facility at Al Hakam was perhaps the most important, but Iraq pursued BW in a range of locations.

Iraq initiated production of BW agents (for field tests) at Al Salman in 1987 using seven laboratory fermentors (7- and 14-liter vessels) and two small production fermentors. Regarding the two small production fermentors, one was acquired in 1987 from the At Taji single cell protein (SCP) project (300 liter) and the other was a 150-liter fermentor purchased while the program was at Al Muthanna. A medium capacity spray dryer also was transferred from the At Taji SCP Plant to the BW program in 1987.

After the Al Hakam facility (northern production area) became functional in 1988, the 300 liter and 150 liter fermentors were transferred to the new facility. Additionally, a larger scale production capability was acquired by moving the Clostridial vaccine production line from Al Kindi Veterinary Research Facility (later named the Veterinary Vaccine and Drug Production Facility [VVDP]) to Al Hakam. This collection of fermentors and tanks—reported by the supplier to be fermentors—consisted of two 1,850-liter fermentors, one 1850-liter tank, and six 1480-liter “tanks” and eight 800-liter mobile “tanks.” The 1,850-liter fermentors and six 1,480-liter “tanks” were all used in production of BW agents. Iraq asserted the mobile

tank was used only for storage and transport of bulk agent. A second spray dryer that could produce small particles—one of two air-freighted from a supplier to Baghdad in 1989—was located at Al Hakam at the time of its first UN inspection in September 1991.

In 1990, additional production capability was acquired for the BW program with the addition of Al Safa'ah (Agriculture and Water Resources Center at Fudaliyah) and Al Manal (Al Dawrah Foot and Mouth Disease Virus (FMDV)) facilities to the BW program. Al Safa'ah possessed a sizeable fermentation line consisting of several 400-liter fermentors and associated other tanks. Additionally, the facility had several incubators including one walk-in incubator, which allowed for some creative stacking of glass flasks said to be used for aflatoxin production. Al Manal had valuable high containment capacity for R&D and contained: one 125-liter mobile tank; one 141-liter and one 236-liter seed fermentors one 1,425-liter and two 2,100-liter fermentors; two 2,550-liter mobile tanks; two 2,600-liter, two 2950-liter, and two 3,500-liter fermentors. Of these, assortments of 2,600-liter and 3,500-liter fermentors were used to provide a capacity for 1,200 liters (10X concentrated) of agent per batch (not all of the available capacities were said by Iraq to be used in this production process) (see Figure 9).

Additionally, other sites had production capability of a more limited scale, e.g. Al Kindi Veterinary Research Laboratories (Al Kindi VVDP facility) and Al 'Amiriyah Serum Vaccine Institute (ASVI), or capability that would require modification on a limited scale, e.g. Samarra Drug Industries. The Al Kindi VVDP facility retained one 1,850-liter tank—damaged during Desert Storm, when the other tanks and fermentors were transferred to Al Hakam. Production for viruses and bacteria employing glass flasks and embryonated eggs were less efficient but ample.

- Iraq declared work on larger-scale fermentation systems for SCP, and on a capability to produce large-scale quantities of a commercial biopesticide in the first UNSCOM inspections in the years immediately following the 1991 Gulf war. Many former officials told ISG that Iraq aggressively worked from 1992 to 1995 at Al Hakam to improve the production and processing of SCP and the biopesticide *B. thuringiensis* in an attempt to save the facility from being destroyed by UNSCOM.

From 1991 to 1996, Iraq continued to expand its dual-use production capability at Al Hakam—until the facility and equipment were destroyed under UNSCOM supervision in May-June 1996. Fermentors and associated equipment were transferred from Al Safa'ah to Al Hakam. Indigenously produced fermentors, 2.5 cubic meters and 5 cubic meters, were installed in the southern production area. These were assessed by international experts as “not fancy but functional” although Iraq has stated to ISG that the 5 cubic meter fermentors were not functional due to propeller shaft problems. Large physical plants were constructed in anticipation of acquiring two 50 cubic meter turnkey fermentation systems. These were not delivered.

To avoid sanctions imposed after Iraq's invasion of Kuwait, Iraq initiated a program to develop the in-house manufacture of media and media components suitable for the growth of bacterial BW agents, see Section on R&D. ISG site exploitations have revealed sites with the potential to undertake growth media production.

- The large-scale production of bacterial BW agents is a multi-stage process that requires a growth medium suitable for the selected organism together with a ‘train’ of specialty, and fermentation equipment. Because of sanctions and UNSCOM inspections, beginning in 1990 Iraq had difficulty obtaining an external supply of growth media for large-scale production of BW agent. By 1992, UN inspections, mandatory declarations and UN monitoring of growth media importation and use created further impediments for any Iraqi biological production effort. Rihab apparently began an effort in 1990 first with some of her BW researchers, and then later with at least one scientist at the IAEC TABRC, to develop bacterial growth media from indigenous sources. Rihab stated that when the effort was initiated in 1990, the intent was to circumvent sanctions placed on Iraq. ISG does not have evidence that this effort was originally intended to enable clandestine production of BW agents, but nevertheless provided some capability in this regard.

The production capabilities at Tuwaitha continued to expand during this period. The FMDV Plant at Al Dawrah remained functional until it was partially disabled under UN supervision in 1996; selected fermentors and tanks—identified as used in botulinum toxin production in 1990—were removed from the facility and destroyed at Al Hakam in 1996.

Other facilities at Al Kindi VVDP Facility and ASVI recovered and made modest improvement in production capability as did Samarra Drug Industries (SDI). During this time frame two new organizations—Al Razi Institute and Ibn-al-Baytar—were established in converted facilities. These organizations obtained highly qualified expertise, some of which were associated with the Iraqi BW program including Dr. Hazim ‘Ali, who headed Iraq’s viral BW effort and was named Director of Al Razi Institute.

Beyond its important fixed facilities, Iraq also possessed important relocatable assets associated with its BW production efforts. The destruction in May-June 1996 of the facilities and equipment involved in Iraq’s BW program, including the equipment that had been moved or installed at Al Hakam post 1991, significantly altered Iraq’s dual-use capability, but did not eliminate all such capability.

At the Al Dawrah FMDV Plant, one 2,600-liter, two 3,500-liter, and one 236-liter fermentor as well as one 2,550-liter mobile tank were not destroyed under UN supervision in June 1996. These fermentors and tanks were not identified in 1995/96 by UNSCOM as involved in Iraq’s BW program. However, DNA evidence of *B. anthracis* was found in both 2,550-liter tanks and a 141-liter fermentor in 1996. All of these fermentors and tanks could be transferred from the FMDV facility to another site or sites within a few weeks after the decision to do so. ISG assesses these as relocatable production assets.

In 1990, Iraq produced at least 39—possibly as many as 70—1,000-liter mobile tanks that could be readily converted into fermentors. Additionally, 8 mobile 800-liter tanks/fermentors were transferred from Al Kindi Vet Vaccine Facility to Al Hakam in 1987/88. Of the combined 1,000-liter and 800-liter mobile tanks, only 24 were cited as destroyed by Iraq. Evidence of such destruction of 24 units was provided

to UNSCOM and stored at the UN Headquarters in the Canal Hotel. Thus, 23 remained after the alleged unilateral destruction of BW weapons and agents by Iraq in 1991. ISG has determined that two more tanks were destroyed at Al ‘Aziziyah. Of those remaining, four are 800-liter imported tanks/fermentors.

- Rihab stated that Iraq was able to produce one cubic meter model fermentors “with bad wheels”. Documentary evidence dated September 2000 recovered by ISG indicates that Iraq converted one cubic meter storage tanks into fermentors that are assessed to have been indigenously fabricated for Al Hakam under Rihab’s supervision. These storage tanks have been an unresolved issue for the UN. Rihab denied receiving mobile tanks/fermentors while at Al Hakam in 1994.
- ISG obtained a document that indicated 10 one cubic meter tanks were connected prior to 2000 to form a 10 cubic meter fermentation plant (location unknown). Another document indicates the delivery of an additional 13-14 such tanks in 1993.

A spray dryer—the second of two air freighted into Baghdad in 1989, model number 0142 was located in 1997 by UNSCOM in a warehouse in northern Iraq, the first model 0141 was at Al Hakam in 1991 and was destroyed in 1996. Before the two weeks it took to assemble a sampling team, Iraq again relocated the dryer, completely disassembled it to cleanse and sterilize it and then reassembled it. This dryer was under monitoring until 15 December 1998 by UNSCOM. Its present whereabouts is unknown.

ISG judges that after 1996, Iraq maintained—and tried to improve where possible—a smaller, but capable, “legitimate” fermentation capability at agricultural and educational sites that could have been used to produce smaller, yet significant quantities of BW agent, but ISG has found no direct evidence to substantiate this possibility.

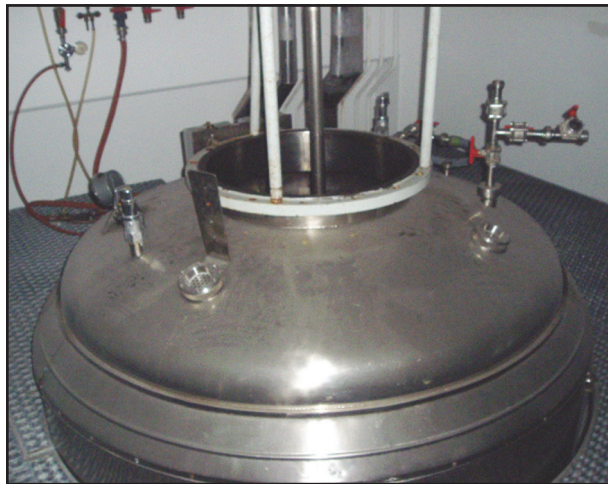


Figure 9. Sign at the entrance to FMDV “Almanai” (top left), vial of vaccine dating from 19 October 1983 (top center), and a main production fermentor (top right). Top plate of 3,500-liter bio-reactor (bottom left), and 236-liter bio-reactor (bottom right).

Break-Out Production Capability Pre-OIF

ISG judges that a break-out production capability existed at one site, the State Company for Drug Industries and Medical Appliances, SDI, at Samarra. Since Iraq could relocate production assets such as fermentors, other sites with basic utilities could also be converted for break-out. A full program to include R&D and production or even just large scale production would require months rather than weeks to re-initiate in a break-out context.

A break-out of large-scale proportion would require all three key production elements; fermentor capacity, media capacity, and technical expertise. A break-out capability must also take into consideration the scale and scope of the program being considered. Modest or small-scale break-outs would be easier and require less time after a decision to do so was made. For a larger scale and scope such as Iraq possessed in 1990 would require more equipment, larger supply source, more personnel and a longer time period for effective start-up. Iraq, having had achieved a maturing program, had a core group of experienced personnel; a better start than existed in 1985. Personnel are movable assets as is growth media. While sanctions and inspections may be a hindrance to an ample supply of media, it would not have been a show stopper. Iraq developed a milk and corn byproduct media that is judged to be adequate for the production of anthrax spores, albeit of a reduced production efficiency. Thus, the equipment for the scale and scope of a program becomes the critical factor to evaluate a break-out capability.

ISG assesses the SDI to have the fixed assets that could be converted for BW agent production within four to five weeks after the decision to do so, including utilities, personnel with know-how, and the equipment (with slight modifications) required. Media and additional less-skilled personnel could be obtained (see Figure 10).

ISG judges the movable assets at the Al Dawrah FMDV Plant could provide the core of an alternative break-out capability at any other suitable site in Iraq, perhaps within 2 to 3 weeks after the decision to do so. The 1 cubic meter tanks or fermentors presently unaccounted for are other important assets that, if indeed still exist, could, when combined with the Al

Dawrah FMDV assets, exceed the capacity Iraq possessed in 1990. In this case media and personnel are also movable assets.

- Iraq had shown the ability to move fermentor assets pre-1990 era. Iraq had also shown its ability to utilize small cadres of skilled personnel to lead clusters of less skilled personnel in the production process.
- Iraq gained additional production and development know-how during the post-1991 era.
- Iraq has developed the capacity to produce indigenously, substitute media for the production of some agents, such as corn and milk byproduct media for anthrax spores.

*ISG judges that *Bacillus anthracis* (anthrax) would likely be the agent of choice for breakout production.*

- It represented the single strategic BW agent that Iraq had in its historical arsenal.
- Iraq has a previous track record in large-scale growth, processing, testing and weaponization of anthrax spores.
- Corn byproduct medium, indigenously manufactured for Bt production, would also be suitable for the growth of *B. anthracis*.

Mobile Assets

Prior to OIF, a key source reported that Iraq had developed a mobile BW capability designed to evade UN inspectors and to provide Baghdad the ability to produce BW agents for offensive purposes (see Figure 11). According to the US Intelligence Community, this reporting was augmented by reports from at least three additional sources who indicated a mobile BW or fermentation capability existed in Iraq. The reported development of a mobile BW agent production capability was a central element in the pre-war assessment of Iraq's WMD programs and, as a result, has been one of the key issues addressed by ISG.



Two 1,000-liter, stirred, jacketed vessels suitable for use as fermentors for the growth of bacterial BW agents.



Autoclave with control panel.



Plate filter press.



Production hall with tiered vessels of Soviet origin not declared to the UN.



High grade water production plant.

Figure 10. *Examples of equipment found at SDI that could be diverted to BW purposes.*



Figure 11. Truck-mounted BW production unit-based on source reporting.

Regarding the mobile capability, ISG's BW team has focused primarily on following leads from the key source and the others with indirect or direct access to Iraq's BW activities to bring us closer to an assessment as to whether Iraq did indeed pursue an undeclared mobile BW agent production capability. The ISG effort consisted of debriefing over sixty individuals and exploiting numerous sites identified as related to a transportable BW production effort. However, ISG acknowledges that much of the site exploitation effort was hampered by Iraqi post-OIF activities such as turnover of employees and looting. Based on information collected by ISG, the key source was determined to be unreliable.

- Debriefings and site visits have uncovered information that differs with pre-OIF reporting, including denials of the existence of the program from personnel allegedly involved. ISG has exhausted many leads and exploited many sites reportedly pertaining to Iraq's alleged mobile BW agent production capability and have obtained no additional evidence to corroborate the claim of the existence of a mobile BW program. As for other individuals that alleged the existence of a mobile BW capability, ISG has not been able to corroborate this reporting and believe that these individuals are outside of Iraq.

ISG cannot disprove the existence of Iraqi transportable fermentation systems that could have been used

for BW, but ISG uncovered no evidence that there were such systems. A report covering the detailed investigations of ISG is attached as Annex 3.

As part of its investigation into a possible Iraqi mobile BW agent production program, two mobile trailers that were recovered near Irbil and Mosul in 2003 have been examined by ISG. These trailers had tanks or suspected fermentors on board and were initially suspected to be part of a mobile BW agent production program. ISG judges that its Iraqi makers almost certainly designed and built the equipment exclusively for the generation of hydrogen. ISG judges that it is impractical to use the equipment for the production and weaponization of BW agent, and cannot therefore be part of any BW program. A report covering the detailed investigation of the trailers by ISG, is attached as Annex 4.

- ISG has found no evidence to support the view that the trailers were used, or intended to be used, for the production of BW agents, or the filling of BW weapons.
- The design of the equipment makes it unsuitable for the production of BW agent and impractical as part of a BW weapons production system.
- The information gathered, and the assessment of the equipment on the trailers, are consistent with the theory that Iraq developed the trailers for hydrogen gas production.

These findings reflect the assessment solely of the two specific mobile units that were located, and do not necessarily mean that such a capability or intent did not exist.

Weaponization

Between the late 1980s and the start of Desert Storm in 1991, Iraq attempted to develop a range of systems for the dispersion of BW agent. In the dash to field viable BW weapons the workers in the program adapted robust bombs capable of mounting on many types of aircraft and warheads, including the Al Husayn missile. They also worked furiously to ready an aircraft spray system.

- The scientists and engineers conducted weapons trials over some three years with both simulants and BW agents, on occasion using living animals as targets. Delivery systems tested included a helicopter-borne spray system, aerial bombs, artillery shells, multi-barrel rocket launchers, long-range missile warheads and an aircraft mounting of an adapted auxiliary fuel tank.
- In the haste to prepare for the 1991 conflict, systems tried and tested with CW agents were preferred; the R-400 aerial bomb and the Al Husayn warhead, charged with anthrax, botulinum toxin and aflatoxin. Additionally, engineers at Al Muthanna rushed the auxiliary fuel tank, modified into a spray system, of the Mirage F1 aircraft into service (see Figure 12).
- Prior to Desert Storm, Iraq had dedicated complimentary programs to develop spray technology that could effectively disseminate either CW or BW agents. These spray dispersal systems were intended for use in conjunction with various developmental unmanned aerial vehicles (UAV) programs. Initial testing was quickly beginning to show progress by the time of Desert Storm. Since that time however, while their desire for these systems remained, their developmental work shifted focus. Due to the attention of the UNSCOM inspectors, the developmental effort shifted away from the more controversial spray technologies toward completing the longer range UAV goals.

ISG judges—with important reservations—that the former Regime clandestinely destroyed almost all of Iraq's biological WMD and long-range missiles in 1991. Numerous interviews with high-ranking Iraqi political figures, WMD scientists, and military and security officers indicate that after a brief period of concealment in 1991, Iraqi leaders decided to destroy Iraq's undeclared weapons stockpile in secret.

- Shortly after the passage of Security Council Resolution 687 in early April 1991, Iraqi leaders also decided to erase all traces of the offensive BW program.
- By the autumn of 1991, Iraq probably accomplished both the destruction of the weapons stockpile and surviving evidence of the BW program.
- Interviews conducted by ISG have produced a reasonably coherent picture of this unilateral destruction, with few conflicting details, although important questions about the disposition of bulk BW agent and bacterial reference strains remain.
- ISG judges that the former Regime destroyed most of its hidden stockpile of BW weapons. A few pre-1991 weapons probably either escaped destruction in 1991 or suffered only partial damage. It is thus possible that a few more will be found in the months and years ahead.

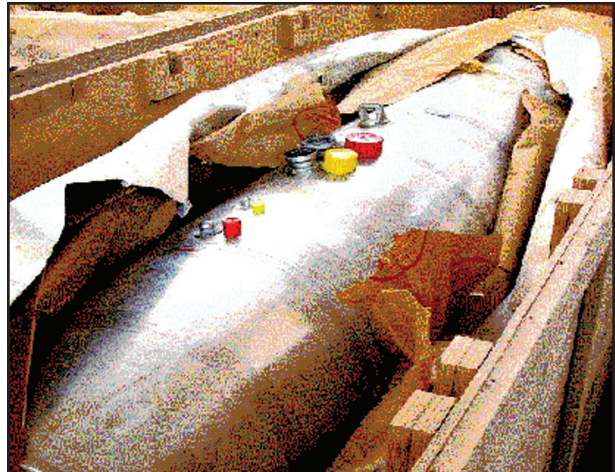
ISG bases its reservations on the following factors:

- The security situation in Iraq has limited the physical verification of Iraq's unilateral destruction claims—by excavating and counting weapon fragments, for example.
- Many of the officials interviewed by ISG had previously lied—or told half-truths—to UNSCOM, and they may have lied to ISG as well, though ISG assesses that most were being open and truthful.
- The continuing exploitation of Iraqi documents may produce evidence that contradicts the assertions of the Iraqi officials.
- The efforts of the Iraqi Interim Government and Coalition forces may yet result in the discovery of unacknowledged WMD stockpiles left by the former Regime, though ISG judges this to be very unlikely.

ISG has not discovered any evidence that Iraq has conducted research or trials dedicated to the dispersion of BW agents since declaring its offensive program in 1995. Iraq pursued some delivery systems projects until OIF that could have provided some BW utility and whose origins lay in the development of BW and CW dispersion systems.



Al-Aziziyah: R-400 bomb fragments.



Al-Asad: new Mirage FI drop tank (France).



Al-Asad: drop tanks (Russian).

Figure 12. *Examples of possible BW delivery systems.*

- Iraq continued to develop delivery platforms for small payload weapons up to OIF. ISG has not identified any specific payloads for these systems. By their nature, these platforms were expensive and limited in number. They would have far greater utility for special weapons, such as BW or CW agent or radiological material, rather than conventional warheads. The Delivery Systems Team has reported on UAV that operate autonomously and remotely piloted vehicles (RPV) that were operated from a ground station. The L-29 RPV was the latest development of a concept that commenced in the Technical Research Center

(TRC), the home of Iraq's BW program in the late 1980s. After the L-29, Iraq continued to work on the development of UAVs and RPVs, the Al Quds being one example.

- Although the Iraqis made significant initial progress in their spray dissemination programs, disregarding the definite adverse impact in their research from Desert Storm, they were still significantly short of the target goal. Perfecting just the sprayer technology—such as optimizing tank pressures, nozzle designs for droplet size and concentrations, together with determining operational flight envelopes—for

use with either a chemical or a BW mission in mind was still years from fruition. The aircraft or UAV carrier platforms also were far from being completed. However, the “know-how” and the same “experts” still existed and the technology necessary is largely duplicative with agricultural uses. Therefore, it was potentially just a matter of iterative analysis and experimentation to achieve a capable CBW spray dissemination system.

Attempts at BW Weaponization

In common with much else in Iraq’s BW program, progress was steady and planned, except when the exigencies of impending war forced a convulsive change of pace and direction. Thus, having toxicological and production aspects in hand, some scientists and engineers turned their attention to weaponization. Starting with small-scale animal tests using small quantities of agent dispersed using a detonator in a confined space they progressed, step by step, toward full-scale weapons trials using viable BW agent. Dr. Rihab and her team, assisted by MIC consultants, evaluated many types of weapon. The initial trials were modest and used a BW agent simulant. Next, individual weapons charged with viable BW agent were fired statically. Eventually, trials used salvos of rockets at their operating range. The rationale for the choice of weapon types and agents is a matter that, even now, Iraqis are reluctant to talk about. Al Muthanna organized the trials and advised on the weapons technology. As a result, the thinking appears to have followed CW lines. Until the imposed requirement to weaponize at pull speed in 1990, the latter field trials aimed at amassing data for the delivery of anthrax. This may have been an attempt to provide a means of denying ground in front of an invading enemy, and would parallel the use of CW agents such as mustard. Following the instruction from Husayn Kamil these trials stopped and efforts switched to longer range delivery systems such as aircraft bombs and sprays and ballistic missiles.

Aerial Bombs. Dr. Al Hindawi and Dr. Rihab state that their first weapons-related field trial consisted of the explosive detonation of two cylinders representing munitions containing a simulant. A trial using an Iraqi manufactured LD-250 aerial bomb charged

with botulinum toxin followed in March 1988, using animals on a grid as a target. They reported repeating this trial later the same month. ‘Zubaydi’ Helicopter Spray Device. As early as 1987 under the auspices of the residual Al Hasan BW program at Al Salman, Iraq started efforts to develop BW aerosol dissemination systems. Dr. Tariq Zubaydi, a university professor interested in “detecting bacterial organisms in the air,” coordinated these tests. He had proposed reverse engineering a nebulizer system. In time, his work led to developing better spray systems in support of his research. TRC was keen to exploit his research for BW purposes. The first known field test occurred in July 1988 at Khan Bani Sa’ad. These early tests involved rotary sprayers mounted on a helicopter.

Artillery Shells. According to one of the scientists involved in TRC’s Ricin program, Dr. Lu’ay Qasim, Al Muthanna technicians detonated four 155 mm artillery shells filled with the agent in a ground test at Jurf as Sakhr.

122 mm Multi-barrel Rockets. In the following year, 1989, the TRC team, assisted by Al Muthanna, was investigating the dispersion achieved by individual rounds and salvos from 122 mm multi-barrel rocket launcher systems. Weapons were filled with Botulinum toxin, aflatoxin, wheat cover smut spores, and simulants.

Fixed-Wing Aircraft Spray Systems. The “Thul-Fiqar” project started in November 1990, soon after the publication of an Israeli newspaper article described how an aircraft with a biological weapon could kill the majority of a target population under favorable conditions. Husayn Kamil ordered Al Muthanna to develop a capability to disseminate a BW agent from an aircraft. As a result, two independent working groups were established; one group consisted of experts from Al Muthanna, the Technical Research Center (TRC) and the Iraqi Air Force, while the other group was restricted to the Military Research and Development Center (MRDC) at Baghdad’s Al Rashid Airfield. These projects may have their origins in CW rather than BW. In a letter dated 10 December 1990, Gen. Fa’iz Shahin, DG of Al Muthanna, writing to Husayn Kamil, referred to “successful tests of spraying mustard gas by planes which proved to be very effective.” This may account for the speed with which Al Muthanna was able to advance with this task.

- ***Mirage F1 Auxiliary Fuel Tank Spray System.*** The Al Muthanna group worked on modifying Mirage F1 auxiliary fuel tanks to disperse the BW agent. The first tank modified contained an electric fuel valve adapted to feed agent through a crude venturi outlet. This tank was installed on a Mirage F1 and one field test was performed at Abu 'Ubaydi Airfield near Al Kut. This unsuccessful test led to more tanks being modified for testing by adding two more valves and outlets and strengthening the structure of the tank. Various combinations of water with other additives were tested with differing degrees of success. It eventually was determined that under proper circumstances (correct combinations of additives and flight conditions), acceptable results were achieved (i.e., the liquid dispensed was deposited on the ground in the testing areas as planned). However, when simulated BW agents were then tested, the results were unsatisfactory.
- ***MiG-21 RPV.*** A senior NMD official recently reported on his pre-OIF research of the 1990-91 MiG-21 RPV development project and the associated Mirage F-1 CBW spray tank project, as well as the later L-29 RPV project. The purpose of the research was to prepare the NMD to respond to urgent requirements from UNMOVIC. The NMD official said his investigation confirmed that the MiG-21 RPV had been intended for a mission to deliver CBW agents and that the Mirage F-1 project was a related effort to develop an aircraft-mounted CBW spray tank. While the MiG-21 RPV effort failed, the Mirage F-1 spray tank development, on the other hand, was considered successful. While varying in some minor details concerning the timing of some test events, this NMD official essentially corroborates the UNSCOM report.

The Gulf War

By the start of the 1991 Gulf war, Iraq had produced significant quantities of BW agents. The weaponization of these agents demonstrated a rudimentary understanding of BW weapons and agent dissemination. Dr. Mahmud Farraj Bilal Al Samarra'i, the Al Muthanna official who headed the effort to weaponize CBW agents, described this aspect of the BW program as 'immature'. Iraq had no operational experience with these agents or BW weapons, had limited delivery systems to employ them, and had no practiced employment doctrine. Dr. Bilal's philosophy was to adapt chemical weapons for BW agent use. Though Iraq had made initial efforts toward the development of more advanced aerosolization technologies, senior BW managers dismissed this approach in favor of tried and tested CW systems.

Based on an apparent press article, Husayn Kamil and his Deputy 'Amir Hamudi Hasan Al Sa'adi directed a compartmented program to develop aircraft spray tanks and modify a MiG-21 jet aircraft into a remotely piloted vehicle (RPV). Iraq conducted several successful field trials using a modified 1,100-liter fuel tank mounted on aircraft. The UAV effort failed to reach an operational developmental prototype prior to 1991.

ISG recovered documents that provided insight into Iraq's perceived success in BW weaponization. According to 'Amir Al Sa'adi, who coincidentally evaluated Dr. Rihab's professional work, he annotated her award nomination package in 2000 and cited the conventional explosive dissemination munitions, aerial bomb, artillery, and rockets as inactive. He judged efforts for spray system as not reaching weaponization with the research as incomplete.

Concealment And Destruction of Biological Weapons

Iraq's Initial WMD Concealment Effort

UNSCR 687, approved on 3 April 1991, required Iraq to disclose fully its weapons' programs and stockpiles, yet the former Regime decided later that month only to declare partially their programs and weapons.

- In the week following the passage of UNSCR 687, MIC Senior Deputy Dr. 'Amir Al Sa'adi convened a meeting of all the senior managers from the missile, chemical, nuclear, and biological weapons programs. These program heads brought with them inventories of weapons, missiles, launchers, accessory equipment, bulk agents, raw materials, and production machinery, along with recommendations of what to declare and what to hide.

Al Sa'adi and the program heads wrote a paper detailing a series of options for Iraq's response to the resolution. These options, according to Al Sa'adi, included:

- Declaring everything and actively cooperating with inspectors.
- Declaring all sites and weapons but saying nothing about activities under development such as the nuclear program, and not volunteering information responding to questions when asked.
- Hiding everything. They based this option on the Coalition's claim that it destroyed everything during the war.
- A fourth option may have called for Iraq to make a simple declaration of a few lines and to let the UN respond with clarification of what was required.
- One or two of the options contained a provision that Iraq should unilaterally destroy the biological program. Another option called for Iraq to declare only BW research and development work.

Al Sa'adi submitted the options to Husayn Kamil, not directly to Saddam. Husayn Kamil later gathered Al Sa'adi and several of the program heads and gave them instructions regarding the declarations. He did not base his instructions on a single recommended option but contained elements from several options. After the initial declaration in April, Iraq also submitted a more detailed declaration in May 1991.

- Whether Saddam was involved in the decision is not clear, though ISG judges that he was probably involved. Once Husayn Kamil made the overall policy for the declarations, Al Sa'adi, in consultation with the program heads, decided which weapons and programs to declare.

Senior Iraqi officials have stated several reasons for Iraq's retention of weapons and its failure fully to declare its programs.

- Husayn Kamil decided that a full declaration—to include the nuclear and BW programs— would be embarrassing to Iraq and would bring undesired international scrutiny, according to one participant in the April 1991 meeting.
- Former Deputy Prime Minister Tariq 'Aziz stated that Husayn Kamil originally wanted to keep the concealed, undeclared weapons for use in the future, and he speculated that Kamil probably wanted to use them against the United States, Israel, or Kuwait.
- Former Oil Minister and MIC Deputy, 'Amir Muhammad Rashid Al 'Ubaydi, speculated to ISG that Iraq did not declare all of its weapons in order to maintain a deterrent against the United States, which continued to menace Iraq from Kuwait and southern Iraq at the time of the initial declaration.
- Another official believed that Iraq's decision not to declare all of Iraq's weapons came from Saddam who was afraid of Iran, Israel, and perhaps other neighbors. Post-war Iraq was unstable, and Iraq found itself in a helpless and defenseless position.
- Another official believed Iraq retained missiles and launchers because Iraq was experiencing serious Iranian-instigated security problems—the 1991 Shia uprising— and Iraq wanted to keep the missiles in case war developed with Iran.

- In the period shortly after the passage of UNSCR 687, most Iraqi officials did not think that the resolution would be vigorously applied, and they expected that inspectors would only operate in Iraq for a couple of months.

Because of Husayn Kamil's decision in April 1991, Iraq only partially declared its holdings of chemical weapons and missiles, while it did not declare its biological and nuclear weapons program at all. Iraq concealed the undeclared weapons to varying degrees.

- Iraq concealed between 128-157 R-400 bombs containing BW agent at Airfield 37 in western Iraq and at Al 'Aziziyah to the southeast of Baghdad.
- Iraq also concealed 25 biological agent-filled Al Husayn missile warheads; 15 in the embankment of the Tigris Canal northwest of Baghdad, and 10 warheads in the Al Mansuriyah former railway tunnel to the northeast of Baghdad. These warheads contained botulinum toxin, *Bacillus anthracis* spores, and aflatoxin, though the number filled with each agent is still uncertain.
- Iraq also concealed an undetermined amount of bulk BW agent at a succession of locations around the periphery of Baghdad.

The Destruction of Iraq's BW

An IAEA inspection in late June 1991 triggered Iraq's decision unilaterally to destroy the undeclared weapons that had been concealed from the UN, according to multiple senior Iraqi officials.

The IAEA's inspection team was blocked from sites in Abu Ghurayb and Fallujah. The Iraqis fired warning shots over the inspectors' heads, but the inspectors brought back photos indicating Iraq was hiding undeclared uranium enrichment equipment from the inspectors.

- The IAEA inspection and the international uproar surrounding it caused consternation and a measure of panic in the Regime's leadership, particularly Husayn Kamil, and Saddam appointed a high-level

committee headed by Deputy Prime Minister Tariq 'Aziz to deal with inspection matters, according to multiple sources.

- A senior Iraqi scientist who directed the destruction of chemical and biological munitions contends that the decision to destroy the hidden materials was made at the end of June 1991. The IAEA inspection and the ensuing controversy prompted Iraqi concerns about renewed war with the US, according to Dr. Bilal. 'Amir Rashid telephoned Dr. Bilal and ordered that all hidden chemical and biological munitions be destroyed within 48 hours. When Bilal responded that this was impossible, 'Amir Rashid directed that Bilal use the resources of the Iraqi Air Force and the surface-to-surface missile force to accomplish the task. Dr. Bilal gathered his colleagues from Al Muthanna, went to the locations of the stored munitions, and began the destruction.

Interviews with high-ranking political figures, managers of military industries, WMD scientists, and disarmament officials indicate that Iraq decided in the spring of 1991 to eliminate evidence of the BW program. All the interview subjects agree that Iraq accomplished this elimination by the autumn of 1991, though there are still important questions about the timing of the effort, the amounts and origins of material destroyed, and whether Iraq initially planned to retain a stock of BW.

The Iraqi leadership regarded the BW program as politically dangerous for Iraq and made the decision to destroy the BW program, according to Tariq 'Aziz.

- Husayn Kamil actually made the decision to destroy weapons and evidence of the BW program in April at the same time that he decided not to declare the program, according to NMD head, Husam Amin.
- In early May 1991, Husayn Kamil verbally ordered Technical Research Center (TRC) head Ahmad Murtada to destroy all biological agents, along with all documentation for their research, development, and production, according to Dr. Rihab.

- Former MIC director ‘Amir Rashid also indicated that the destruction decision came from Husayn Kamil, who then relayed the decision through Al Sa’adi and himself, to TRC head Murtada for execution.

The BW program’s destruction occurred in three distinct phases:

- The cleanup and sterilization of research and production facilities, including Al Salman, Al Hakam, Al Manal (Al Dawrah, FMDV Plant), and Al Safa’ah (Al Fudaliyah)
- The destruction of munitions by the TRC Biological Group and Al Muthanna personnel
- The deactivation and dumping of bulk BW agent.

Concealment of the production aspects of the BW program required the thorough cleanup of Iraq’s BW research and production facilities, which reportedly began shortly after the destruction decision. Cleanup was completed prior to the arrival of the first UNSCOM BW inspection in August 1991, according to TRC head Dr. Ahmad Murtada.

- The TRC T-3 BW research and development facility at Al Salman, located three kilometers south of Salman Pak, which Coalition bombing had badly damaged during the 1991 war, was further destroyed with explosives, and the site graded and landscaped. A review of reporting from the summer of 1991 indicates this activity began in early July 1991 and was complete by the end of that month.
- The Al Manal production facility was cleaned up, equipment not originally part of the facility was taken to Al Hakam, and the site returned to its original owner—before the first UNSCOM inspection in May 1991, according to Dr. Rihab, although MIC did not formally relinquish control until July 1991.
- Al Hakam, one of Iraq’s major BW agent production plant, was not damaged during the 1991 war, and Husayn Kamil sought to maintain the facility—with its specialized equipment and work force—by creating a civilian cover story to explain the presence of the large-scale production equipment. The plant was converted for production of biopesticide and single cell protein.

Iraq destroyed its BW weapons in the summer of 1991, according to multiple sources.

- Dr. Bilal of Al Muthanna was responsible for destroying the BW–R-400 aerial bombs and Al Husayn missile warheads—because no one within the TRC T-3 Directorate had any experience with weapons, while Al Muthanna personnel were very familiar with them. Bilal was assisted by Sinan ‘Abd-al-Hasan Muhi Mustafa Al ‘Ubaydi and Isma’il Ahmad Salih Bashir Al Bashir of TRC.
- There were two sites within the ‘Aziziyah bombing range for the destruction of the R-400 BW bombs—possibly 133 or 134 of them, according to Dr. Bilal. Deactivation of the agent within the bombs with formalin and potassium permanganate (for botulinum toxin and anthrax bombs) or bleach (for bombs containing aflatoxin) was followed by destruction of the bomb casings with explosives.
- The Al Husayn BW warheads were chemically deactivated by Al Hakam personnel at their storage sites (the Tigris Canal embankment and the Al Mansuriyah former railway tunnel), then taken to An Nibai and destroyed with explosives, according to Bilal and Rihab.
- Iraq’s BW declaration indicated Iraq had 157 R-400 BW bombs (100 botulinum toxin, 50 anthrax, and 7 aflatoxin) and 25 Al Husayn BW warheads (5 anthrax, 16 botulinum toxin, and 4 aflatoxin). UNSCOM, UNMOVIC, and the Iraqis themselves regarded these numbers as soft estimates because of the lack of documentation.
- UNMOVIC-monitored excavations at the Al ‘Aziziyah destruction site in February and March 2003 unearthed evidence of 104 R-400s, in addition to the 24 R-400s excavated under UNSCOM supervision. As a result, UNMOVIC considered the 128 R-400s accounted for at Al ‘Aziziyah.

It also appears that Iraq destroyed its stocks of bulk agent in the summer or autumn of 1991, but Iraqi accounts of this destruction vary in timing, amounts, and location. As a result, ISG still does not have a clear picture of bulk agent destruction. There remain a number of inconsistencies in the accounts of the officials involved.

- A 2,200-liter storage tank of anthrax in underground storage at Al Hakam remained there during the 1991 war, along with two one cubic meter tanks on trailers. The trailers had flat tires and the large tank was not transportable. The disposition of this material is unknown, according to a former BW program official.
- In the summer of 1991, Al Hakam personnel deactivated anthrax stored in an unknown number of one-cubic meter stainless steel tanks using formalin and potassium permanganate. They dumped the anthrax into a septic tank for an unspecified period, then trucked the deactivated anthrax to an area near the production bunkers at Al Hakam and dumped it on the ground.
- In April 1991, Al Hakam personnel removed some of the *Clostridium botulinum* and *Bacillus anthracis* produced at Al Hakam and stored it in a bungalow in Ar Radwanayah until May 1991, according to Dr. Rihab. This agent was supposed to return to Al Hakam for disposal but was not. Later, Rihab's staff destroyed and disposed of the BW agent in ar-Radwanayah. This concealment and destruction was never declared to the UN.
- An Iraqi BW program official inadvertently told UN inspectors about the dumping of an unknown number of one-cubic meter stainless steel tanks of anthrax in the desert northwest of Baghdad near An Nibai in July 1991, according to a former BW official.
- Al Hakam personnel reportedly transported several one cubic meter tanks of botulinum toxin and 340 liters of *Clostridium perfringens* to Airfield 37 in western Iraq in January 1991 as the war was about to begin. At some point, unidentified personnel loaded these tanks onto a truck and drove them around Baghdad until September or October 1991. Iraq had told the UN it destroyed the material in July 1991. This was not so. The tanks probably returned to Al Hakam where, following deactivation, disposal occurred, though the Iraqi NMD could not confirm this, according to a BW program official.
- One source indicated that the 340 liters of *Clostridium perfringens* at Al Hakam remained there until the destruction of Al Hakam (in 1996), but this contention is not supported by other sources. Another source maintains that researchers tested this agent in May 1991, found severe fungal contamination, and assessed that the agent was no longer pathogenic.

The Iraqis also apparently destroyed tanks of anthrax at the 'Aziziyah firing range, the site of the R-400 bomb destruction. The number of containers and the amount of agent destroyed is unclear.

- Three one cubic meter tanks of anthrax stored at the 'Aziziyah firing range were ordered destroyed in June 1991, according to a participant in the destruction. After gathering debris from the destruction, he reported to his supervisor, Dr. Bilal, that the tanks had been destroyed. However, an entry in the log book of the officer in charge of the 'Aziziyah range only lists the destruction of two of the tanks, and therefore the source believed that one of the containers still exists at Al 'Aziziyah.
- Two destroyed one cubic meter bulk storage and transport containers –along with parts of a third container–were found at Al 'Aziziyah during Iraqi excavations of the site just prior to OIF, according Dr. Bilal. If true, it would account for the missing third anthrax tank. Other participants in the 2003 excavations have not confirmed the finding of this third container.

Iraq declared that all bulk agent, including anthrax that remained after the filling of weapons, had been stored at Al Hakam and was unilaterally destroyed there in July and August 1991, according to UNMOVIC. UNMOVIC also noted that UNSCOM found evidence of anthrax disposal at Al Hakam but considered the evidence insufficient to support Iraq's statements about the quantity of anthrax destroyed and the circumstances surrounding that destruction.

The problem of accounting for the destruction of bulk agent is part of the larger issue of Iraqi BW agent material balance. ISG cannot arrive at an agent material balance because it still does not know with confidence:

- The amount of each agent produced at each production facility
- The amount of each agent used in weapons filling
- The number of weapons filled with each agent
- The amount of bulk agent of each type destroyed.

It is not clear whether the original decision to eliminate the BW program called for the destruction of bulk agent and BW munitions, or if Iraq initially planned to conceal and retain the bulk agent and filled munitions. Kamil's original plan may have only encompassed the cleanup and conversion of the research and production facilities.

- The BW munitions were all destroyed in the summer of 1991, according to multiple sources, but Iraq was also engaged in a much wider campaign of unilateral destruction during this period that also encompassed the chemical and missile programs.
- Iraq apparently destroyed much of the bulk BW agent in July 1991, but some reportedly remained hidden until September or October 1991, according to one BW program insider.

A letter written by Husam Amin to Qusay Saddam Husayn, as head of the Iraqi SSO, supports the judgment that Iraq unilaterally destroyed most of its pre-1991 CW and BW weapons and long-range missiles. The letter, written in August 1995 shortly after Husayn Kamil fled to Jordan, listed undeclared capabilities that Kamil might reveal to the UN.

- The letter points out that “the destruction of the biological weapons occurred in the summer of 1991 (after the ceasefire) and not in the fall of 1990 as in the Iraqi declaration” to the UN.
- The letter mentions a number of undeclared capabilities e.g. weaponization of BW agents, BW production at the Al Dawrah FMDV Plant, the Badr-2000 program, and other matters, but contains no mention of any existing undeclared CBW weapons or missiles.

Husam Amin acknowledged writing the letter, and ISG judges that the letter is authentic.

What Remained Hidden and Undeclared 1995-1998?

ISG's investigation found no evidence that Iraq continued to hide BW weapons after the unilateral destruction of 1991 was complete, and ISG judges that most of the documents and materials hidden by the Special Republican Guard from 1991 until 1995 were indeed surrendered to the UN. However, Iraq continued to conceal documents from 1998 until 2003.

- For several years, Special Republican Guard officers concealed the “know-how” documents, which Husayn Kamil ordered collected in 1991. These officers used safehouses in the Ghaziliyah and Hay at Tashri neighborhoods of Baghdad and a farm in Abu Ghurayb to hide the documents.
- In late 2002, weeks before the arrival of the UNMOVIC inspectors in Iraq, NMD employees reportedly were ordered to collect all documents indicating discrepancies between the number of chemical and biological munitions destroyed or used and the total number produced. These documents, which filled 16 boxes, were being turned in to the IIS to be hidden or disposed of.

ISG investigations also determined that Iraq failed to declare to the UN a number of significant capabilities and activities. Examples of such omissions include:

- Storage and disposal of bulk BW agent, including anthrax, at Ar Radwanayah in 1991.

Weaponization Related Activities in the Years Following Desert Storm

Various reporting indicates an interest in acquiring systems for the dissemination of CBW. Acquisition related efforts were usually couched in generic terms, such as “aerosol systems” or “aerosol generators,” and typically associated by the Iraqis with agricultural use. It would also appear that there may have been plans to keep the spray technology remnants of the CBW programs hidden from UN inspectors.

**Detailed Accounting of Iraq's Al Husayn Missile
"Special" Warheads**

According to Iraqi declarations and Dr. Mahmud Farraj Bilal, Iraq had produced 75 "special" Al Husayn warheads, including 50 chemical warheads, and 25 biological warheads.

In April 1991, Iraq initially declared to the UN only 30 warheads—all of them chemical. Iraq destroyed these under UNSCOM supervision. Of the 30 CW warheads:

- 16 contained unitary Sarin (GB) nerve agent
- 14 contained the cyclohexanol/isopropanol mixture that was the basis for Iraq's "binary" GB/GF nerve agent. The methylphosphonic difluoride (DF) component for these warheads was also destroyed.

In addition to these 30 declared chemical warheads, Iraq initially concealed 20 undeclared chemical warheads from UNSCOM, which it destroyed in the summer of 1991. All were "binary" warheads filled with a mixture of cyclohexanol and isopropanol.

After Husayn Kamil fled Iraq in August 1995, Iraq clarified that the 75 Al Husayn warheads actually consisted of 50 chemical and 25 biological warheads. Of the 25 biological warheads, Iraq declared and Dr. Bilal believes that:

- 5 contained "Agent B"—anthrax spores
- 16 contained "Agent A"—botulinum toxin
- 4 contained "Agent C"—aflatoxin

To verify Iraq's claims, UNSCOM sampled remnants of warheads destroyed at An Nibai and found traces of anthrax in containers of seven distinct missile warheads. In response, Iraq changed its account of BW warheads. Dr. Bilal clarified that no one knew for certain the number of warheads filled with a given agent because the Iraqis kept no records of the filling operation.

Of the 45 "special" warheads that were unilaterally destroyed by Iraq, UNSCOM recovered and accounted for remnants of 43-45.

The Al Husayn warhead "material balance" is thus:

75	Total "special" warheads produced by Iraq
30	Destroyed under UNSCOM supervision
20	"Binary" CW warheads unilaterally destroyed at An Nibai
25	Deactivated BW warheads unilaterally destroyed at An Nibai
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45	Total warheads unilaterally destroyed
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75	Total "special" warheads destroyed

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- In 1994, a Hughes 500 helicopter was equipped with two L-29 drop tanks at At Taji Airfield by Dr. Imad 'Abd-al-Latif 'Abd-al-Rida' Ali Shihab. He reportedly did this to satisfy a requirement from the Minister of Agriculture to replace its aging agricultural helicopters. No other helicopters were converted. UNSCOM tagged the helicopter and while inspectors agreed it was only for agricultural use, it was kept under close scrutiny. ISG recovered these tanks in February 2004 and have conducted extensive sampling and forensic analysis to determine what materials were disseminated from these tanks,

but have not discovered any materials relating either directly or indirectly to BW.

- The L-39 RPV, UAVs and ballistic missile developments are addressed in the Delivery Systems Section of this Report.

Detailed Accounting of Iraq's R-400 BW Aerial Bombs

Iraq declared and Dr. Mahmud Farraj Bilal contends that Iraq originally manufactured 200 R-400 bomb casings for use as BW. Some of these were coated internally with epoxy for filling with "Agent A" (botulinum toxin) and "Agent B" (Bacillus anthracis spores). Dr. Bilal maintains that Iraq unilaterally destroyed 133 or 134 R-400 BW aerial bombs in 1991. In the two months prior to the outbreak of war in 2003, Iraq excavated two R-400 destruction sites in 'Aziziyah and recovered the remnants of 133 or 134 R-400 bombs, including eight or nine intact bombs. UNMOVIC, however, accepted that 128 R-400 were accounted for at 'Aziziyah.

Six more bombs were found to be defective prior to filling. Al Hakam personnel discarded these six bombs in the Euphrates River. Later, UNSCOM retrieved these from the river.

Dr. Bilal claims that the Iraqis reviewed a videotape of the UNSCOM-supervised destruction of 60 or 61 empty R-400 bombs at Al Muthanna in 1991. They noted that 30 of the bombs destroyed had black-stripe markings, indicating they were epoxy-coated and intended for BW use. Bilal believes that the remainder of the 60-61 bombs destroyed on the tape showed those manufactured for BW use.

The R-400 BW aerial bomb "material balance" is thus:

200	<i>casing manufactured for BW use</i>
128-134	<i>Filled R-400s unilaterally destroyed at 'Aziziyah (with 8-9 intact bombs), with UNMOVIC accounting for 128 and Dr. Bilal stating 134.</i>
60 or 61	<i>Empty R-400 casings deestroyed at Al Muthanna under UNSCOM supervision</i>
6	<i>Defetive casings discarded inteh Tigris River by Al Hakam personnel</i>
194-201	<i>Total R-400 casings manufactured for biological use accounted for.</i>

Dr. Bilal's recent thinking on the R-400 destruction at 'Aziziyah and Al Muthanna is at variance with what Iraq told UNSCOM during the late 1990s. At that time, Iraq asserted that 157 R-400s were destroyed at 'Aziziyah and that 37 were destroyed at Al Muthanna. When these are added to the six disposed of in the Tigris, the number equals the 200 R-400 cases originally manufactured for BW use. Dr. Bilal now contends that Iraq's prior claim of 157 destroyed at 'Aziziyah was based on the diary of an officer at the range and was inaccurate. Bilal's assertion that 60 or 61 empty cases were destroyed at Al Muthanna is at variance with UNSCOM data that indicates that 58 R-400s were destroyed under UNSCOM supervision at Al Muthanna.

Unresolved Issues

In March 2003, when UN inspectors departed Iraq, many contentious issues remained unresolved. Additional issues have emerged from ISG investigations. ISG investigated these matters with interviews, site visits, documents searches and material sampling. ISG made progress understanding most of the unresolved issues, but a few vital areas remain outstanding. With the degradation of the Iraqi infrastructure and dispersal of personnel, it is increasingly unlikely that these questions will be resolved. Of those that remain, the following are of particular concern, as they relate to the possibility of a retained BW capability or the ability to initiate a new one.

- ISG cannot determine the fate of Iraq's stocks of bulk BW agents remaining after Desert Storm and subsequent unilateral destruction. There is a very limited chance that continuing investigation may provide evidence to resolve this issue.
- The fate of the missing bulk agent storage tanks.
- The fate of a portion of Iraq's BW agent seed-stocks.
- The nature, purpose and who was involved in the secret biological work in the small IIS laboratories discovered by ISG.

Through an investigation of the history of Iraq's bulk BW agent stocks, it has become evident to ISG that officials were involved in concealment and deception activities.

- ISG judges that Iraq failed to comply with UNSCRs up to OIF by failing to disclose accurate production totals for *B. anthracis* and probably other BW agents and for not providing the true details of its alleged 1991 disposal of stocks of bulk BW agent.
- Officials within the BW program knowingly continued this deception right up to OIF and beyond, only revealing some details well after the conflict.
- Those concerned put two motives for the continued denial and deception in relation to undeclared dumping of BW agent at a site in Ar Radwanayah:

—The members of the program were too scared to tell the Regime that they had dumped deactivated anthrax within sight of one of the principal presidential palaces.

—Changing the account would only complicate matters with the UN and would have no effect on the material balance.

More detail on these subjects, where it exists, is included in the appropriate section of the report.

Program Direction

Decision Making, Command and Control and rationale of Iraq's BW Program. Despite access to many of Iraq's senior political and military figures, including Saddam, many aspects of the BW program remain opaque to ISG. Specifically ISG learned very few new details of the following:

- The role of the military and intelligence services in defining the requirements for the BW program.
- The rationale behind key decisions such as the reasons for starting the program, the selection of agents and weapons.
- The military response to meet the requirements of a BW program.
- The doctrine for the use of BW weapons.
- The procedures for the release of BW weapons and who was to make the decisions.

Research and Development

Genetic Engineering and Viral Research. From 1998-2003, Iraq devoted increased resources and effort to its biotechnology and genetic engineering activities, a concern that the UN continued to investigate until its departure. ISG has talked to scientists and workers in the biotechnology and genetic engineering fields, and viral researchers specifically. Despite an extensive interview program and numer-

ous site visits that have included sampling, ISG found no evidence of activity likely to contribute directly to BW.

BW Agent Simulants. The UN deemed Iraq's accounting of its production and use of BW agent simulants—specifically *Bacillus subtilis*, *Bacillus licheniformis*, *Bacillus megaterium* and *Bacillus thuringiensis* to be inadequate. ISG remains interested in simulant work because these items may be used not only to simulate the dispersion of BW agents, develop production techniques, and optimize storage conditions, but also the equipment used for their manufacture can also be quickly converted to make BW agent. It permits maintenance of techniques and provides continuing familiarity with the process to preserve skill levels. Iraq continued its work on *Bacillus thuringiensis* as a bio-pesticide carried on bentonite, at Tuwaitha after the destruction of Al Hakam. As a result of interviews with the former staff of Al Hakam and principal researchers at IAEC, ISG has discovered that this research also included investigations of bentonite not only as a carrier but also as means of enabling the speedy production of slurry from the stored dried biopesticide.

IIS Laboratories

ISG has found a number of small IIS laboratories, some containing biological equipment. There are reports that aflatoxin and ricin work has been conducted by the IIS into the 1990s and that human experimentation occurred. Given the historical connections of the IIS with Iraq's BW program, it is a concern that the nature, purpose and those involved at these small IIS laboratories have not been identified by ISG. This is an unresolved issue that will be further investigated.

Seedstocks

Disposition of Iraq's BW Program Culture Collection

Doubts persist regarding Iraq's destruction of bacterial reference strains and isolates. According to Dr. Rihab, she destroyed these materials in early 1992. Dr. Rihab gave a small box containing no more than 25 vials of lyophilized bacterial pathogens, including those obtained from the American Type Culture Collection to the IIS in mid-1991 for safekeeping.

Husam Amin returned the box to Dr. Rihab in early 1992. Dr. Rihab ostensibly asked former TRC head Ahmad Murtada what to do with the vials. Murtada took the matter to Husayn Kamil, who ordered the vials destroyed. This was accomplished by injecting the vials with Dettol™ and then autoclaving the vials. ISG cannot verify that these materials were destroyed or the other details of Dr. Rihab's account. Given correct storage conditions, ISG assesses that these seed stocks would still be viable.

Agent Production

Anthrax. The UN could not confirm, and in fact its evidence contradicted, the quantities of anthrax declared by Iraq as having been produced, used for trials, filled into weapons, and destroyed. The UN assessed that Iraq probably had greater stocks of the agent on hand in 1991 than it declared, probably for use in the Mirage F1 drop-tanks, and questioned Iraq's account of destruction of the agent. ISG has interviewed most of the key Iraqis who admitted working with the agent, and has obtained contradictory explanations of the events. The details are in Annex A.

Botulinum Toxin. Iraq's declaration of the amount of botulinum toxin it produced, used in experiments and trials, filled in weapons, wasted during handling, and unilaterally destroyed is derived from calculations, or contrived from the numbers of weapons stated to have been filled—none of these figures is verifiable. ISG teams have interviewed principal engineers and scientists involved with botulinum toxin; there has been no new information.

Mycotoxins: Aflatoxin. The resources that Iraq devoted to the manufacture, testing and filling of weapons with aflatoxin has puzzled investigators since Iraq first declared the agent. There is little doubt that Iraq conducted such a program, but the UN assesses it almost certainly overstated the production, raising the possibility that some of the weapons declared to have contained aflatoxin may have contained other BW agents. There is no evidence to support Iraq's claim about the numbers of weapons filled with the agent, and most of the limited number of staff involved in aspect of the effort have not been located. ISG has not determined the rationale behind Iraq's choice of aflatoxin for its offensive BW program.

Wheat Cover Smut. The UN was not able to verify the amount of wheat cover smut produced, used or consumed owing to a lack of sufficient documentation from Iraq. Iraq had stated it produced smut coated with aflatoxin, but neither this statement, nor the destruction of the wheat cover smut could be verified. ISG has not discovered any new information on this agent.

Clostridium perfringens. (*C. perfringens*)—the causative agent of gas gangrene—was one of the first agents Iraq examined. Despite its interest and various fragments of research—including interest in cluster munitions and an awareness of the use of *C. perfringens* in anti-personnel weapons—the UN found no evidence to indicate that such a course was pursued. An ISG team obtained two vials of *C. perfringens* as well as one vial of *C. botulinum* type B, from a mid-level scientist who formerly worked in the BW program. This matter is addressed in Section D—R&D.

Ricin. Unlike other BW agent programs, work on ricin emanated from the IIS, and almost certainly was based on its limited developed use as an assassination weapon. Iraq conducted a limited weapons development program until Desert Storm that included a test using artillery shells charged with ricin. Later Iraq expanded into the manufacture of castor oil, which yields the material from which ricin is extracted. Although this manufacture was later abandoned, Iraq retained the ability to restart such production in volume. ISG has pursued the Tariq castor oil facility and its possible role in ricin production as well as the security services' interest in and use of ricin.

Undeclared BW agents—In addition to the BW agents listed above, Iraq may have investigated variola major (smallpox). Additionally the amount of peptone or tryptone soya broth (TSB) growth media imported by Iraq and not accounted for give rise to concern about the possible production of *Yersinia pestis* (plague), *Francisella tularensis* (tularemia) and *Brucella* species (brucellosis). ISG has examined smallpox and *Brucella*, but has not uncovered any information on plague or tularemia.

Drying of BW Agents

Iraq actively pursued the goal of drying its BW agent for improved storage and optimal dispersion and inhalation. The UN was unable to determine whether Iraq dried any of the bulk agents it produced, although it possessed the expertise and equipment to do so. ISG has found a successful program for drying the anthrax simulant, Bt; safety of the drying process would affect its application to anthrax. ISG found no evidence of dried agent.

Bacterial BW Agent Production and Storage

Production Equipment. There are a number of critical items of equipment and materials normally required for the production of bacterial BW agents. Iraq was able to manufacture fermentors, separators, settling tanks and growth media, often of a lower quality than those it formerly imported, and all of which have commercial purposes. This manufacturing aspect is a vital prerequisite for resuming a BW program and could lead to the possibility of making mobile BW facilities. ISG investigated the industrial infrastructure needed for such activity and the particular possibility of a mobile BW program. ISG discovered no evidence to indicate a renewed interest in manufacturing equipment for BW purposes.

1m³ Stainless Steel Mobile Tanks. In 1990, Iraq produced 39 1m³ stainless steel mobile tanks. The tanks are significant because they were used to store and transport bulk agent, and with modification the imported tanks could be used for fermentation purposes to produce BW agent. Al Hakam already possessed eight 800-liter stainless steel mobile fermentors. Iraq claims to have unilaterally destroyed 19 of the 1m³ and 4 of the 800-liter fermentors in 1991. UNSCOM verified these figures from remnants presented to inspectors in the mid-1990s. ISG has identified the remains of 2 additional 1m³ tanks. Thus out of an original 47 items, 18 1m³ and four 800-liter fermentors are still to be found. There are 22 items unaccounted for. Additionally, ISG has learned of additional production after 1990 (see Figure 13).



Figure 13. 1m³ Stainless steel mobile tanks.

Weaponization

Al Husayn Biological Warheads. Iraq declared that it manufactured a total of 25 Al Husayn warheads for BW, claiming to have filled 16 with botulinum toxin, 5 with *Bacillus anthracis* spores, and 4 with aflatoxin. There is evidence only to confirm that sufficient stainless-steel agent containers were unilaterally destroyed to account for the declared quantities of BW warheads. It is not possible to conclude that all of the BW warheads were destroyed or that only three agents were used.

R-400 and R-400A Bombs—Iraq declared that it ordered the manufacture of 200 R-400A bombs for BW, but reportedly did not fulfil that quota and instead used some R-400 bombs. Iraq claimed that 157 bombs were filled with BW; 100 with botulinum toxin, 50 with *Bacillus anthracis* spores, and 7 with aflatoxin. Investigations by ISG at the Al ‘Aziziyah site confirmed that by the beginning of OIF approximately 132 out of 157 bombs had been accounted for, indicating that at least 25 bombs remain unaccounted for. Because all the known physical evidence has now been investigated, it is unlikely that this matter can be resolved without the discovery of documents or new testimony from those involved.

Spray devices and RPVs. Iraq showed a continuing interest in the use of spray devices as a means of dispersing BW agent. The program started with the adaptation of helicopter-borne agricultural spray equipment and progressed through experiments with MiG-21 and Mirage F1 aircraft. In the 1990s L-29 aircraft were adapted for remote operation, but there is no evidence of spray tanks being fitted to them. The Mirage F1 used an auxiliary fuel tank as a trial spray system. Iraq claims that only 4 of these tanks were modified and that the original tank and aircraft were destroyed in opening bombardment of the Gulf war in 1991. No evidence exists to support the destruction of the aircraft and tank, although the remains of the other tanks have been verified in the past. Recent ISG investigations have discovered very large numbers of drop tanks, but none that had been modified for trials or use as a BW weapon. The L-29 development program continued up to OIF and Iraq possessed approximately 30 L-29 aircraft that could be adapted for remote operation. Drop tanks existed for this aircraft, some in use at the same site that had been used for helicopter spray trials.

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