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(UNMOVIC)

Compendium

The Biological Weapons Programme

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OVER VIEW OF IRAQ'S BIOLOGICAL WEAPONS ACTIVITIES

The biological weapons programme of Iraq was much smaller than its chemical weapons programme and various missile projects in its size and scale (the biological programme probably cost Iraq tens of millions of dollars as against hundreds of millions of dollars for both the chemical and missile programmes). The biological warfare programme, which was the last started among Iraq's efforts in the field of weapons of mass destruction, materialized after Iraq had already developed and deployed its chemical weapons and progressed in the modification of foreign missile systems. However, the programme was the most covert undertaken of all the non-conventional weapons programmes in Iraq.

1964 – 1970: Prerequisites for the biological weapons programme

According to Iraq, the Chemical Corps was formed in January 1964, within Iraq's Armed Forces. As is common practice in other armies, its primary task was the protection of troops from nuclear, biological and chemical (NBC) attacks. A number of Iraqi Chemical Corps officers were educated or trained in foreign military institutions specializing on NBC defence. These educational and training programmes included the properties of chemical and biological warfare agents, their medical effects, identification and detection methods, usage of individual and collective protective and decontamination equipment, and appropriate prophylactic measures.

With minor adjustments, Iraq's Chemical Corps adopted foreign field manuals on NBC defence and acquired relevant equipment and materials, including individual protective equipment, portable field laboratories and decontamination stations. The Chemical Corps further introduced NBC training procedures using CW agent simulants in field exercises for other units within Iraq's Armed Forces.

NBC defence is a legitimate area of military activity aimed at protecting troops and civilian population from potential NBC threats. Defensive activities would require specific knowledge of NBC agents and weapons characteristics and properties. By the end of the 1960s, the Iraqi Chemical Corps had gained such general knowledge. This was an important pre-requisite for future attempts to develop chemical and biological weapons.

Iraq ratified the 1925 Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare in 1931. In 1972, Iraq signed the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction (BWC). However, Iraq ratified this treaty in June 1991, following the 1991 Gulf War and Security Council resolution 687 (April 1991).

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In its 1997 Biological Full Final and Complete Disclosure (FFCD), Iraq stated that “The underlying motives behind Iraq’s efforts to initiate BW studies and to possess BW weapons were always the fear that Iraq’s enemies in the region were actually developing such weapons or in fact possessing weapons of mass destruction”.¹

After 1995, Iraq provided a considerable amount of information regarding its former BW programme in the form of declarations such as the FFCDs (1995, 1996, 1997) and later the Currently Accurate, Full and Complete Declaration of Biological Programme Background and Activities up to 2002 (CAFCD) issued in December 2002, as well as letters, submissions and interview testimony. Iraq’s statements and declarations regarding its former BW programme are presented below, followed by UNMOVIC comment and discussion which includes evidence obtained through inspections.

1974 – 1978: Initiation of the BW programme (Al Hazen Ibn Al Haitham Institute)

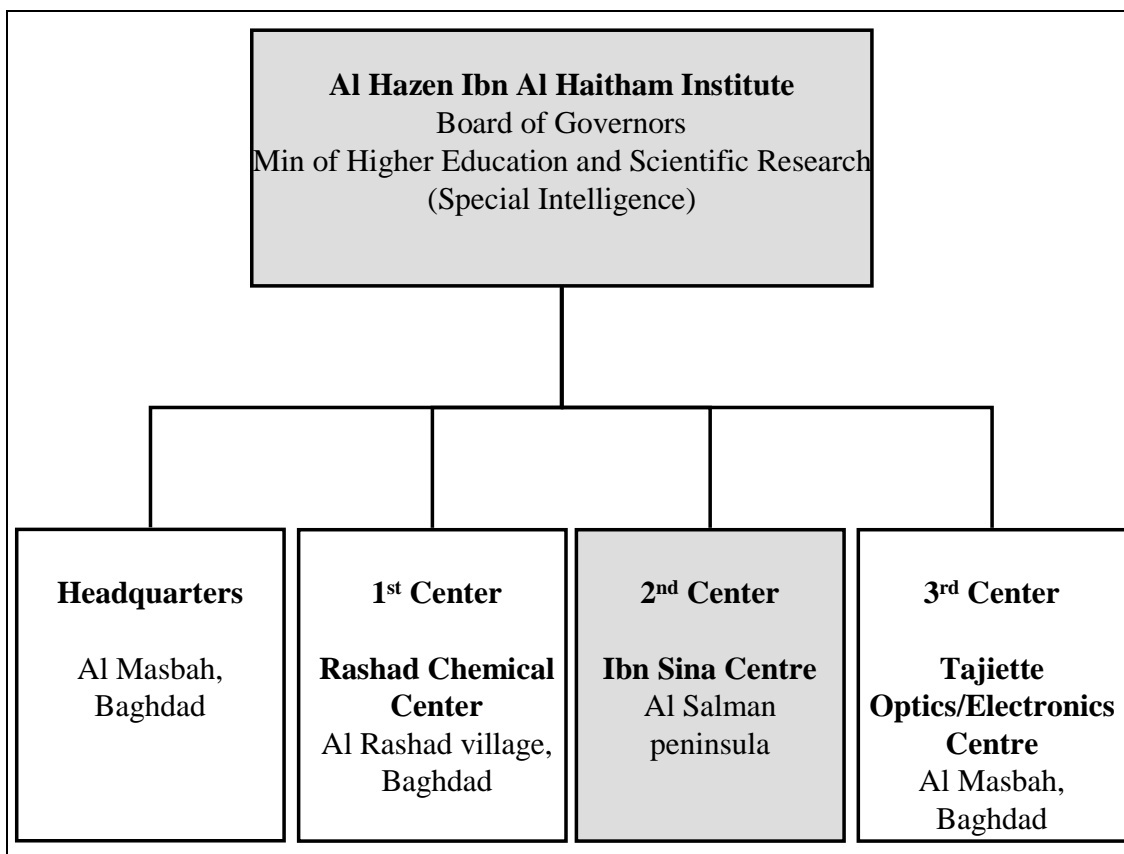
According to Iraq’s declarations, its first interest in developing biological warfare capability was in 1974, when the Al Hazen Ibn Al Haitham Institute was created by Governmental decree to conduct scientific, academic and applied research in the fields of chemistry, physics and microorganisms (Figure V.I.I). The institute was attached to the Ministry of Higher Education and Scientific Research, but in practice was affiliated to the State Security Apparatus through supervision by individuals affiliated to a State Security Organ.² The institute received sufficient funding from the government. Its board of directors consisted of representatives from various governmental ministries and agencies, including the Chemical Corps. A Chemical Corps Major as chairman performed the administrative oversight.

¹ Biological FFCD September 1997 Chapter 1.8.1

² Biological CAFCD, December 2002 Chapter 1.1

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Figure V.I.I. Organization of the Al Hazen Ibn Al Haitham Institute³



The Ibn Sina Centre, or “Second Centre”, was dedicated to biological work and, after a brief period at a residential house in Ameriyah, it was established in buildings on the Al Salman peninsula (Figure V.I.II). The new location was designed to accommodate around 50 scientists.

³ UNSCOM193/BW53, August 1997

Figure V.I.II. Location of Ibn Sina Centre on the Salman peninsula



Biological activities at Al Hazen Ibn Al Haitham Institute

The biological work of the institute was focused on research into the identification of micro-organisms, but not those traditionally associated with biological warfare with the exception of an attempt to produce botulinum toxin.

The Centre comprised several laboratory buildings and a small animal house. The laboratory buildings were equipped with evaporative cooling systems which had limited effectiveness during the intense summer periods. The equipment for the biological laboratories was initially acquired from the Ministry of Health. The equipment were autoclaves, ovens, bench incubators, media glassware, centrifuges and microscopes. Additional equipment and materials were procured from abroad and included freeze dryers, laminar flow hoods, an amino acid analyzer, very small (200 ml) laboratory fermenters and bacterial growth media.

Iraq declared that the Centre performed the following studies on bacteria, viruses and toxins: cultivation of *Bacillus subtilis*, *Bacillus cereus*, and *E. coli* bacteria; identification of Shigella and Cholera bacteria in water; identification of food contaminants; isolation and preservation of Influenza virus. The bacteria *Clostridium botulinum* was also cultivated, however botulinum toxin was not separated from the biomass. Limited numbers of laboratory tests were conducted on small animals. Iraq also maintained that the Centre had no bacterial isolates from international culture collections in the 1970's apart from one isolate, *C. botulinum* - presumably a Type A strain since work with this bacteria has been

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described⁴, had been imported from ATCC by the director of the institute⁵, the rest of the isolates were local isolates from hospitals or the environment (soil).⁶

Iraq has stated that the biological work of the Centre was poorly directed, and that the personnel did not have a clear idea of their objectives. According to Iraq, the Institute achieved little of any real value in part due to a lack of appropriate facilities and equipment. Iraq also claimed that a part of the research was related to the academic pursuits of the scientists involved.

In January 1979, Al Hazen Ibn Al Haitham Institute was dissolved and a number of the staff was imprisoned for scientific fraud (overstating achievements).

Iraq stated that there were no direct links or continuity between this organization and following developments in the field of biological and chemical weapons. However, interviews with its former employees claimed that all assets and most personnel of Al Rashad laboratory and Ibn Sina Centre were taken over by other organizations and continued to operate. The site belonging to the Ibn Sina Centre passed back into the hands of the intelligence services. A former biologist at the Centre stated⁷ in an interview that at the end of 1978, when Al Hazen was dissolved, most of the personnel working in biology were transferred to the Ministry of Agriculture, the Ministry of Higher Education and Scientific Research, and the Ministry of Health. However, at least five of the researchers at the Ibn Sina Centre went on to make contributions later in the BW programme.

Although its assets were transferred to the State Organisation for Technical Industries (SOTI), Iraq has stated that the name of the Institute was still used after its dissolution for the purchase of equipment for some SOTI and Scientific and Technical Research Centre (STRC) projects.

Comment

Iraq's decision to commence a WMD programme did not occur in isolation nor was it a spontaneous decision. There were no doubt many motivating reasons for such a decision, some relating to the personal experiences and ambitions of Iraq's leadership and some reasons which reflect the strategic perceptions at the time. It would appear reasonable to assume that following the defeat of the Arab forces in the 1967 six day war and the 1973 Yom Kippur war, Iraq's interest in the acquisition of chemical and biological weapons intensified. According to Iraqi declarations, they believed that their immediate enemies (Israel and Iran) either had WMD or were in the process of acquiring such a capability.

The 1974 Government decree creating the Al Hazen Ibn Al Haitham Institute and the Ibn Sina Centre was effectively the implementation of a policy decision for Iraq to acquire a

⁴ UNSCOM 193/BW 53, August 1997

⁵ Ghassan Ibrahim- Chairman of the institute and a Major in the Chemical Corps.

⁶ UNSCOM doc. no. 915003, 12 May 1998, "Further clarification and details requested by Biological TEM, Vienna 20-28 March 1998"

⁷ UNSCOM 125/BW 27, August 1995 Statement by Dr. Munem

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BW weapons programme. Although the Ibn Sina Centre was under the control of the intelligence and security apparatus, UNMOVIC has no evidence that the intelligence agencies provided any direct input into specific work programme of the Centre.

The management and control of the Al Hazen Institute also seems strange and may well have been a catalyst for its eventual failure. Being under the auspices of the Ministry of Higher Education and Scientific Research, which probably convened the Board of Governors, and being in fact controlled by the intelligence and security apparatus and having a chemical corps major as chairman it seems little wonder that guidance and control were lacking. It is likely that the over all work plans and the day to day management was delegated to the heads of the respective Centres and they themselves were left to grapple with prioritising what should be pursued. It appears that those directing the individual programmes had little idea on what to focus and how it should be achieved and were possibly more intent perhaps on academic pursuits than practical results. Iraq's first foray into the biological weapons field yielded slow progress: many mistakes are unsurprising with an organisation in an embryonic stage.

In the biological field, those recruited to the Ibn Sina Centre of the Al Hazen Institute were well qualified and senior academic staff; their reason for failure seems more likely due to lack of direction than lack of abilities or equipment. It also appears curious that Iraq should appoint a Major to be the chairman of such an organisation especially given the presumably higher ranking staff in the three individual centres. It is possible (although not stated) that the Major occupied an administrative position.

Even though there is no evidence that the intelligence services directed the work programme, studies on food and water contaminants and botulinum toxin at the Ibn Sina Centre are more indicative of regime protection or of a "dirty tricks" than of a military biological warfare programme. Strangely enough, there is no evidence that an enhanced literature search was conducted by the Centre to determine suitable candidate agents, which would be obvious for the start of a BW programme. Some reference is made by Iraq in its FFCDs that open source literature was used but no reference to a systematic study based on results from such a search.

Clearly, the statements concerning the progress in the biological area indicate an achievement far short of that attained in the chemical area. This can partly be explained by the fact that CW activities at the Al Rashad laboratory taken over by Al Hazen Institute were started in 1971, three years earlier than biological activities.

The demise of the Al Hazen Institute did not imply a termination of its substantive activities but in reality some of its functions may well have continued with the transfer of some personnel and assets into other organizational structures.

In general, even limited progress achieved by Ibn Sina Centre could possibly have provided a sound research basis for developments that were to come, and hence shorten the lead-time to the production of biological weapons. Experience of biological research conducted by the Centre helped to realize a need for further specialized education of the national cadre involved, especially in the areas of microbiology relevant to fermentation, such as sporulation and sedimentation. Subsequently, several personnel (at least five)

were sent to continue their education abroad.

The Centre was also instrumental for the understanding of requirements for the future biological weapons activities, including the design of biological facilities, the procurement of specific laboratory equipment and materials, and the adoption of safe microbiological practices and procedures.

1979-1985: Biological activity that may have an impact on BW developments

Biological activities

Iraq declared that following the dissolution of the Al Hazen, Ibn Al Haitham Institute in 1978, work ceased on the BW programme. The CW effort continued at the Al Rashad site which was returned to the control of the Chemical Corps⁸. With regard to the BW programme, according to Iraq's declarations, there was no connection between the Al Hazen Institute and the BW programme which followed in 1985.

During an interview with a former researcher at the Al Hazen Ibn Al Haitham Institute, it was stated that following the dissolution of Al Hazen, he was asked to establish another department at Salman Pak⁹. He suggested that the new department was to be augmented with personnel from the Al Rashad chemical centre and later from the Tajiette optics/electronics centre. This department, (later to become the Forensic Laboratory) was under another new organisation.

In another interview¹⁰ with an Al Hazen researcher¹¹ in 1997, it was stated that when Al Hazen closed, it was decided that a department was to be established within the Presidency to test foods and water quality for pathogens to protect the leadership. When he went abroad for his PhD he was unaware of the organization name, but when he returned in 1984 it was called the Technical Research Establishment, (possibly called the Scientific and Technical Research Centre - STRC) later to be called the Technical Research Centre (TRC). This organization included both chemical and biological testing for food analysis and was located about a kilometre from the Ibn Sina Centre at Salman Pak. Three other researchers who were at the Ibn Sina Centre from 1975 also worked at this new organization.

Iraq also provided details on the evolution of the new buildings established in the early 1980s on the Al Salman peninsula close to the Al Hazen Ibn Al Haitham Institute. According to Iraq, the peninsula was under the control of the Technical Affairs Directorate under the Office of the President. This Directorate, which was a technical arm of the intelligence and security apparatus from 1980 to 1984, became the STRC in 1984 and then the Technical Research Centre from 1985 to 1991. It remained under the control

⁸ UNSCOM doc. no. 70009907

⁹ UNSCOM 200/BW 56, September 1997

¹⁰ UNSCOM 200/BW 56, September 1997

¹¹ Dr. Munem

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of the intelligence and security apparatus. The responsibility of this Centre was to “satisfy the needs of the State in the field of securing government communications against intrusion (Electronic department) and the safety of food for consumption (Forensic department). The Forensic department contained chemical and biological laboratories”.¹²

According to Iraq’s declarations, in 1980–1981, work began on the design and construction of a new building and several affiliated structures of the forensic department of the Technical Affairs Directorate at Salman Pak. This work was finished by 1983. The newly constructed building comprised a number of laboratories, an animal house with rooms for animal breeding, an incinerator and exhaust ventilation system. Air handling units with filters and cooling towers were placed on the roof. The building for the inhalation chamber was already built in 1982, and the chamber itself was imported in 1983 from a Western supplier. The building was equipped with “*filters for sterilizing the exhausted air from inside the building*”.¹³

Iraq claimed that the forensic department of TRC (and its immediate predecessors) from the beginning was mainly engaged in forensic chemical studies involving food and water analysis and riot control chemical agents. However, the TRC reported to the Office of the President and in fact, according to the 1997 FFCD, was under the direct supervision of General Hussein Kamel personally.¹⁴

Comment

From Iraq’s declarations and interviews with Iraqi scientists, it is clear that some biological activities continued at Salman Pak under the auspices of the security apparatus. Some staff from the dissolved Al Hazen Ibn Al Haitham Institute were instrumental in the build-up of what would later become the Forensic Research Department of TRC. Individuals coming from the closed Ibn Sina Centre had been involved in basic research on botulinum toxin, cultivation of bacteria in small fermenters, freeze-drying and storage.

It is quite possible that the Technical Affairs Directorate, the STRC and later the TRC activities included research and development, if not small production of chemical and biological agents for use by the intelligence and security services. By the end of 1984, activities at Salman Pak included research on wheat smut with a view to finding suitable measures for crop protection, as well as investigating this agent as a possible weapon that would cause economic loss (This is discussed in more detail later in this chapter). This activity is well beyond the bounds of the declared interests of the Forensic section with regard to food testing and safety. Moreover, some of the facilities either constructed or acquired during the early 1980’s do not appear consistent with food testing – facilities such as the inhalation chamber and the incinerator.

¹² Biological FFCD 1997, Chapter 1.8.4

¹³ Biological FFCD 1997, Chapter 3.2.3

¹⁴ Biological FFCD 1997, Chapter 1.8.4

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Developments in the biotechnology sector of Iraq during this period presented an improved platform which was available as a base for the later Iraqi BW programme. In line with the Ba'ath Party's plan to expand and modernize Iraq's industrial base, between 1977 and 1983, a substantial effort was made to improve the biotechnology capability in the agriculture and health related sectors. Focus was placed on large-scale production. The Baby Milk Factory plant and the Foot and Mouth Disease Vaccine (FMDV) plant at Dora were constructed by foreign contractors starting in 1977. The single cell protein (SCP) pilot plant at Al Taji was approved in 1975 and became operational in 1978-1979, the Agricultural and Water Resources Centre imported fermentation and storage vessels in 1979 and 1980 for a pilot plant for date sugar processing, and in 1983 production equipment at the Veterinary Research Laboratory (Al Kindi) at Abu Ghraib was expanded through the acquisition of a large-scale fermentation line. Also, in early 1981 the possibilities for establishing an Iraqi "Type Culture Bank" were investigated. Moreover, a few of the researchers later involved in the BW programme obtained scientific training abroad during the 1970's and 1980s.

1983: Approval to re-start BW R&D

In the early days of the Iran/Iraq War, perhaps in 1982 or 1983, Professor Nasser Hindawi, a prominent microbiologist, was concerned about the developments in the war with Iran. He told UN inspectors that he wrote to the Ba'ath Party expressing his concerns and scientific opinions regarding the value of biological weapons use on the battlefield. It is uncertain whether this report was followed up.¹⁵ However, in 1983 Major General Nizar Attar, the Director General of Project 922¹⁶, sought and obtained the approval from the Minister of Defence to include biological R&D within the framework of CW activities.¹⁷

Iraq stated that its BW programme was a stopgap measure because of the long lead-time involved in the development of a nuclear programme and there was a need for a deterrent.¹⁸ There was no input from the MoD because most of the people involved were originally from MoD, and so were familiar with what the military wanted.¹⁹

¹⁵ UNSCOM 125/BW 27, August 1995

¹⁶ Project 922, later known as Al Muthanna State Establishment (MSE), had been formed in 1981 after the dissolution of Al Hazen Ibn Al Haitham Institute

¹⁷ Biological CAFCD, December 2002 Chapter 2.1

¹⁸ Biology Technical Experts Meeting, Vienna, March 1998

¹⁹ Biology Technical Experts Meeting, Vienna, March 1998

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Comment

Although General Nizar Attar was familiar with NBC defence issues he was nevertheless a chemist and never professed any level of expertise or real interest in the BW programme. In 1983, Muthanna was extremely busy developing and producing chemical agent for the war with Iran and this was no doubt the focus of the Director General's efforts. Although Iraq has suggested that the inclusion of a BW programme into the work programme for Muthanna was a personal initiative of General Attar, this seems less likely. Therefore it is more likely that the decision came through the Revolutionary Command Council (RCC) from the Office of the President following the suggestion of Professor Hindawi, since probably he briefed the RCC on this topic.

While a BW research and development programme may have fitted well into the cover of Muthanna (the State Establishment for Pesticide Production), Iraq had few people familiar with BW agents or in their production or weaponisation.

The inclusion of a BW programme into a CW programme at least in the early stages is not uncommon and has been the case in other countries which previously developed chemical and biological weapons. BW has generally lagged behind CW in terms of research, development, production of bulk agent and weaponisation.

1984: The Wheat Cover Smut project

As declared by Iraq, a Wheat Cover Smut project started at Salman Pak around the end of 1984. One of the objectives of this programme was to investigate the possible use of wheat cover smut as an economic weapon. According to Iraqi declarations, two small-scale trials were conducted in 1985 and 1986 and wheat was planted in the north of Iraq in 1987 and infected with smut as a pilot production trial.

1985-mid 1987: Re-Start of the BW R&D programme

BW Research and Development at Muthanna

Iraq declared "After the liquidation of Ibn Al-Haitham Institute the CW part of the old programme was considered for reactivation by the Chemical Corps of MOD. The new project was named project/922. Although the objective of project/922 was the creation of a CW facility the director of the project sought and obtained approval to add an R&D section in the BW area. However, no practical steps to implement the BW objective were undertaken until 1985"²⁰. Later in the same document Iraq declared that "In 1983...the BW activity was added to MSE (project/922) project objectives. Namely: The creation of an R&D section at MSE to reactivate the BW effort started at Al Hassan Ibn Al Haitham in the seventies with similar objectives".²¹ And finally Iraq summed up the reactivation of the BW programme as follows "The second beginning in 1985 was also embarked upon without proper planning and the effort followed a step by step approach depending

²⁰ Biological FFCD September 1997 Chapter 1.1.2

²¹ Biological FFCD September 1997 Chapter 1.8.3

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mainly on the personal initiative of the director of the CW project General Nizar Al-Attar at the time and a few young energetic specialists with keen interest but with inherent limitations”.²²

According to Iraq’s declarations, the BW R&D activities were inserted into Project 922 functions either at the creation of the Project in 1981 or soon thereafter (in 1983) but that no action was taken to implement this activity until 1985. The stated circumstances leading to General Attar's recommendation was somewhat informal. According to interview information, in 1985 a senior official in SOTI, the administrative body for Muthanna, phoned General Attar to ask whether he could use the services of a microbiologist, Dr. Rehab Taha, who had recently returned from completing her PhD in the UK. General Attar accepted the SOTI offer,²³ and agreed to include a BW research and development programme at Muthanna.

The task of the biological group was defined as carrying out the necessary R&D work which would lead to the production of BW agents on a laboratory scale and to evaluate their properties and characteristics as suitable BW agents. No plans were elaborated regarding large-scale production, weaponisation and storing of the BW agents”.²⁴ Within 3 months Dr Taha suggested that two agents could be researched, anthrax and botulinum toxin, and based on this General Attar wrote a one page report for the Minister of Defence and presented it to him personally in perhaps May or June 1985.

The report which suggested in general terms a biological research and development programme that could "succeed in five years to do something" received a favourable response from the Minister.²⁵ During an interview conducted by the ISG, Dr Taha stated that a 5-year plan was drawn up in 1986, maybe as a result of the report for the minister that would lead to BW weaponisation.²⁶

Iraq declared that at its initiation there was no well defined objective for the programme. Agents were acquired from abroad by SEPP/MSE in 1985 and 1986 (*B. anthracis*, *B. subtilis*, *B. megaterium*, and *C. perfringens* in December 1985 and April 1986/ *C. botulinum* and *F. tularensis* in April 1986). Also, local isolates of agents were obtained (*C. perfringens* in November 1986).

In the SEPP/MSE research plan for 1985, planned work on three biological agents (*C. perfringens*, *B. anthracis*, and *C. botulinum*) was described. Initial work centred on literature studies. Subsequently, research focused on the characterisation of *Bacillus anthracis* (anthrax) and *Clostridium botulinum* (botulinum toxin) to establish pathogenicity, growth and sporulation conditions, and storage parameters. But there was

²² Biological FFCD September 1997 Chapter 1.8.10.1

²³ UNSCOM 125/BW 27, August 1995

²⁴ Biological FFCD September 1997 Chapter 1.1.3

²⁵ UNSCOM 125/BW 27, August 1995

²⁶ ISG Report, Vol III, page 8

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no bulk production of agent and a 150 litre fermenter imported by the facility was not used.²⁷

In December 1986, on Dr Taha's recommendation Professor Nasser Hindawi was added to the staff as a senior consultant on a part time basis.

During the latter part of 1986, Iraq declared that “a report was submitted by MSE about the results achieved with a proposal to affiliate Al Taji fermenter to MSE for future requirement of scaling up production, also that any further development meant that extensive investments in production and test facilities were needed”.²⁸ Iraq declared that in early 1987, there was a change of Director-General at MSE with General Nizar Attar being replaced by General Faiz Al Shahine and that General Shahine was of the opinion that the BW activities were incompatible with the CW activities at Muthanna particularly in light of the large investments needed. Iraq also declared that the “MSE site was not suitable for advanced biological activities because of possible contamination and the presence of accommodation centres near the site. General Shahine pushed for the BW group transfer. Al Taji fermenter site was considered for possible utilisation”.²⁹

In early 1987, a scientist to the Science Committee of Bureau of Presidency submitted a proposal concerning inter alia dissemination of agents by aerosol. He was asked to carry out a study based on the ideas he had submitted. “After a meeting with the DG of MSE in April/May 1987 he was informed that MSE was no longer supporting the BW programme and the BW group will be transferred outside MSE. He started work at TRC T-3 department on 6 July 1987 at Al Salman and was released from TRC on Sept 26 1988”.³⁰ This coincided with the first botulinum toxin inhalation test, which was conducted at MSE in February/March 1987.

Take-over of Al Taji Single Cell Protein pilot plant in mid-1987

The establishment of a research plant for production of single cell protein (SCP), using petroleum derived products as feedstock, in Iraq was approved in 1975 and production started in 1978-1979 at Al Taji under the direction of Professor Nasser Hindawi. Iraq constructed a building specifically for the purpose of SCP production and equipped it with a 450 litre, several 7 and 14 litre fermenters and a spray dryer. According to Iraqi statements, in 1980 the equipment was functioning and staff consisted of 7 to 8 people, and 11-12 students. During 1980 a student, later having a major role as a researcher during the BW programme, joined the site for a few months. According to Iraq, research at the pilot-scale level was almost complete in the early 1980s and a decision was required as to whether this work should be expanded into full-scale production. Due to the financial costs of the on-going war with Iran, neither the Ministry of Oil nor the Ministry of Agriculture was willing to fund expansion into a large-scale plant. Lacking priority and funding, the production of SCP was stopped and the plant was formally

²⁷ UNSCOM 125/BW 27, August 1995

²⁸ Biological FFCD September 1997 Chapter 1.1.6

²⁹ Biological FFCD September 1997 Chapter 1.1.6

³⁰ Biological FFCD September 1997 Chapter 5.2.5.5

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closed in 1984. The staff was dispersed to different places, but the equipment remained at the site.

According to a document from the Presidential Bureau to the Ministry of Oil on 7 March 1987, the ownership of the Al Taji building and equipment was to be transferred to the General Establishment for the Production of Agriculture Pesticides (MSE or SEPP).³¹ Several meetings took place between representatives of the Ministry of Oil and MSE to find the best solution for taking over the Al Taji site.

The BW group did not move to the Taji facility but in mid-1987 they were transferred to the TRC site at Salman Pak and resumed work under new management. In 1987 MSE also changed affiliation from the Ministry of Defence to the Military Industrialization Commission (MIC): General Hussein Kamel was in charge of MIC as well as the intelligence and security apparatus and directly oversaw the activities of the TRC. Given that the TRC had taken responsibility for the BW programme in mid-1987, Iraq declared that on 1 August 1987, it had decided to transfer the Al Taji SCP plant to TRC instead.³²

Comment

It seems that the BW programme was reinstituted at MSE rather than at Salman Pak because MSE already had a BW research programme in its charter from the early 1980s. MSE may have been seen as a location for a military BW programme while the Salman site was under the control of the intelligence and security services. Some biological work continued at Salman Pak throughout the early 1980s until the time that the BW group from MSE. When the BW group moved, they did not establish a BW section but rather were accommodated in the already established biological section of the Forensic department. Iraq already declared that in 1984 this department had worked on wheat smut as a possible biological agent. It is also possible that work continued at the Salman site through out the early 1980s on food pathogens such as Clostridium botulinum, other bacterial toxins and plant toxins (such as ricin).

The possible role of Professor Hindawi is discussed through Chapter V and it is the UNMOVIC assessment that he played a key role in mentoring the BW programme, from agent selection, developing pilot and large-scale production techniques, the suggestion of the use of the Al Taji SCP facility, the transfer of Al Kindi fermenter and in the establishment of the Al Hakam site.

Mid-1987 to 1991: Expansion of the BW programme

The biological weapons group was transferred to the TRC, Forensic Research Department (T-3), at Salman Pak in May 1987, forming the key R & D facility of Iraq's

³¹ FFCD March 1996, Chapter 10, doc. no. 172

³² FFCD March 1996, Chapter 10, doc. no. 176

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former BW programme. The work was renewed at the new location in July 1987.³³ The TRC was headed by General Ahmed Murtada (PhD Engineer) who was also head of several defence related industries. The biological group from Muthanna was accommodated with the Forensic biological group already at the site but Iraq has declared that Dr Taha's group worked independently from the Forensic department.

The biological weapons programme was significantly expanded after its transfer to the TRC. According to Iraq's declarations, by the end of 1986, the biological work was already planned to be scaled up with the intention to produce botulinum toxin at pilot-scale and in 1987 construction was started on a new building at Salman Pak to house a pilot-scale fermenter.

Most major aspects of the BW programme were developed at Salman Pak, including the research into additional bacterial agents and fungal toxins, scaling up of the agent production, initial production of some agents, toxicity tests using a broad range of animals on site, and filling of munitions for some field tests.

In 1988, Iraq also began pilot-scale production of botulinum toxin at the SCP Pilot plant at Al Taji while a new dedicated BW agent production site known as Al Hakam was under construction in the desert some 60 km south west of Baghdad. According to Iraq, Al Hakam became the main biological warfare agent production site once it commenced operations in 1989 until the programme was terminated in 1991. Two other sites were also used for a surge capacity in BW agent production in 1990 and 1991.

Furthermore, among the accepted proposals in a document sent to the Senior Deputy (Minister) for Military Industrialization Affairs on 22 October 1988, was the suggestion to provide scientific staff specialized in genetic engineering, viruses, rickettsia, and insect and rodent vectors of biological agents (Table V.I.I).

³³ UNSCOM 253/BW 70, December 1998

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Table V.I.I. Proposals in a document on “Expressing an opinion” to Senior Deputy (Minister) for Military Industrialization Affairs³⁴ Dated 22 October 1988

Proposal	Handwritten note in the margin
Develop research staff working in the field of biological research, through attending conferences, seminars, and holding training courses for the personnel of the Technical Research Centre	Yes to the goal
Conclude joint agreements with some research centres belonging to some sisterly and friendly countries that are interested in this field for the exchange of information	Cannot be implemented
Create a biological agents corps in the armed forces, the task of which is to train and use biological agents	Requires an in-depth study, maybe premature
Provide the necessary research and production requirements (such as production biological reactors) and train personnel for operating them	Yes
Provide a scientific staff specialized in genetic engineering, viruses, rickettsia, and insect and rodent vectors of biological agents	Yes
Transfer to Iraq the technology of biological agents for research & production purposes	Yes

1988-1990: Pilot-scale production

Iraq declared the construction in 1988 of a new building to house the 150 litre fermenter that was transferred to Salman Pak from MSE. This pilot plant fermenter had been ordered in 1985, delivered in early 1986, but apparently not operated until after September 1988 when it was installed at Al Salman. Iraq has stated that it was used from late 1988 to train staff on fermenter operation and later for the production of bacterial simulants (*B. subtilis*, a simulant for anthrax, end of 1988 and from the beginning of 1989, *B. megaterium* and *B. thuringiensis*) as well as BW agents (*B. anthracis*, in about March 1989).

After the transfer of the 150 litre fermenter to Al Hakam in the beginning of 1990, it was used for the production of *C. perfringens* from August to October 1990.

After the takeover of the SCP pilot plant by TRC in 1987, the plant was refurbished and an operational test of the 450 litre fermenter and other equipment was carried out at the beginning of 1988. Shortly after this test, the production of botulinum toxin A (Agent A) began and continued until the equipment was transferred to Al-Hakam Factory in late 1988. The production took place during two periods, January/February to March and July to October 1988, and in an annual report for 1988 (submitted in December 1988) the

³⁴ UNSCOM doc. no. 902024 The document was signed by three scientists and handed to the Executive Chairman in 1997

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production of concentrated material equivalent to 8,000 litres un-concentrated agent was reported.

1989-1991: Large-scale production

Al Hakam Factory

According to Iraq's declarations "At the end of 1987 beginning of 1988 and after achieving good results in the research of A&B (botulinum toxin and anthrax) agents, HK gave the orders to TRC's D.G. [General Ahmed Murtada] to prepare the production requirement for those agents".³⁵ Iraq elaborated on this decision making process by declaring that "The decision to embark upon the production of these agents after the biological group was transferred to TRC was taken by the director of MIC (HK) himself without the usual due process of consideration and diligence associated with major investment decisions. This was due to the nature of the position of TRC within MIC, characterised by direct link with HK personally. TRC being a different and unique body entrusted with security measures unlike other MIC establishments. Other projects executed by MIC usually pass through the various departments like the Technical Dept. for studies and planning and financial allocations etc."³⁶

It has been stated by Iraq that the Al Salman site was not suitable to conduct large-scale production activities because it was too close to Baghdad and was valuable for other purposes. The Al Taji site was not an option either because it belonged to the Ministry of Oil.³⁷ Thus, an alternative site for production was sought-after and Iraq has stated that the formal decision to build Al Hakam Factory was taken 24 March 1988, and hence the project was given the name Project 324.³⁸

The construction of Al-Hakam Factory buildings started in the second half of 1988. The first buildings to be constructed were the production buildings in the Northern area, followed by the R&D Building, and Animal House³⁹ in Area C. Finally, the Southern area to house the 5m³ fermenter, building⁴⁰ was constructed in last quarter of 1989. This was at the same time as the equipment was expected to arrive according to the contract.

In 1989 a decision was taken by TRC to transfer all BW activities to the Al Hakam Factory.

³⁵ Biological FFCD September 1997 Chapter 1.1.15

³⁶ Biological FFCD September 1997 Chapter 6

³⁷ Biological FFCD September 1997 and Biological Technical Experts Meeting Vienna, March 1998

³⁸ Biological FFCD September 1997 Chapter 1.1.16

³⁹ The Animal House (Bldg 37/I-17) was completed in the second half of 1990. (Biological Technical Experts Meeting, Vienna, March 1998)

⁴⁰ Building 1 (I-22), Insecticide Production, was supposed to accommodate the Chemap equipment for production of anthrax. It was then used for storing the R-400 bombs instead. The bunker 2A (I-23) was built before building 22 because there was a need to store the accumulated BTX. (Biological Technical Experts Meeting, Vienna, March 1998)

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Working groups were formed for botulinum toxin, anthrax and evaluation. The majority of the personnel employed or working at Al Hakam Factory were transferred from the Al Salman site. At the start of production at Al Hakam Factory at least 16 people had been earlier trained on using fermenters, either at the Al Taji site or at the fermenters located at the Veterinary Research Laboratories (Al Kindi) in Abu Ghraib.

Comment

Although Iraq declared that General Hussein Kamel issued an order on 24 March 1988 for the construction of Project 324, several facts, however, suggest that the administrative planning of Al Hakam factory started at least in 1987, and perhaps even in 1986. This is covered in detail in a later section (Chapter V.VII).

Production of botulinum toxin type A (Agent A) has been declared to have begun in January and continued to August 1989, using a 450 litre fermenter transferred from the Al Taji site. A vaccine production line consisting of several fermenters and tanks transferred from Al Kindi was also used to produce botulinum toxin from February 1989 until August 1990. Between January 1989 and August 1990, Iraq has declared the production of about 14,000 litres of 20 times concentrated toxin, in total.

During the period from May 1990 to the end of June 1990 the 450 litre fermenter was used to produce *Bacillus anthracis* spores (Agent B). After August 1990 an order was issued to increase the production of BW agents including *Bacillus anthracis* spores (Agent B). Iraq declared that the production line transferred from Al Kindi was switched from producing botulinum toxin to dedicated agent B production from August 1990 until January 1991. In total about 8,500 litres of 10 times concentrated Agent B was produced at the Al Hakam Factory.

Also other *Bacillus* was produced between August 1989 and January 1991. Overall about 550 litres of about 10 times concentrated *B. subtilis* and 50 litres of more than 10 times concentrated *B. thuringiensis* were produced using the 450 litre and the VRL fermenters.

Production of *C. perfringens* (Agent G) was undertaken between August and November 1990, resulting in 340 litres of 10 times concentrated spores.

The Foot and Mouth Disease Vaccine (FMDV) plant

General Hussein Kamel gave orders in August 1990 “to increase the production capacity of biological agents”.⁴¹ As a consequence, according to information provided by Iraq, the Foot and Mouth Disease Vaccine (FMD) site at Dora was chosen for BW-related activities in August 1990.⁴² Furthermore, in 1990, Al Fudaliyah was affiliated to the TRC and subsequently used for the production of aflatoxin.

⁴¹ Biological CAFCD, December 2002 Chapter 6.1

⁴² UNSCOM notes from the high level meetings in Baghdad on 17 to 20 August 1995, shortly after General Hussein Kamel left Iraq. During this meeting, weaponization of BW agents and the involvement of the FMDV site was acknowledged for the first time by Iraq.

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The Foot and Mouth Disease Vaccine plant in Al Dora was planned and built 1977 – 1982 as a turnkey facility by a foreign contractor. The plant was designed to produce vaccine against three strains of FMD virus in Iraq, using a production method based on cell culture in large fermenters. An original Iraqi document indicates that the ownership of the FMD Division was formally transferred – free of charge – from the Ministry of Agriculture to MIC-TRC on 6 September 1990.⁴³ It appears that this transfer was based on the understanding that the TRC would continue to produce FMD vaccine in Al Dora.⁴⁴ However, due to the increased pressure to produce BW agent, FMD vaccine production ceased in late 1990, and most of the equipment were used for BW purposes. After transfer of ownership, a virologist recruited for the BW programme was in charge of the site.⁴⁵ The FMD vaccine plant at Al Dora was referred to as Al Manal by the TRC.

Staff from Al Hakam supervised production at Al Dora. In September 1990, Iraq stated that it modified the fermenters and the facility for the production of *Clostridium botulinum* toxin as well as for viral R & D in the framework of the BW programme. According to Iraq, a total of 5,000 litres of concentrated toxin was produced in Al Dora from November 1990 until January 1991. The BW work stopped at Al Dora in January 1991

Al Fudaliyah

Al Fudaliyah was established in 1980 as the Centre for Agriculture and Water Resources under the Science Research Council (SRC). According to Iraq, the site accommodated a Department of Water Resources and a Department of Palm and Dates. The latter produced sugar, citric acid, and yeast from date juice and molasses. This facility contained a pilot plant for date sugar processing and included fermentation and storage vessels imported in 1979 and 1980. According to testimony given by the former Director of the Centre, it was dissolved in November 1989 and he left the place at the end of December 1989. There are differing Iraqi accounts on the exact timing of when Al Fudaliyah was taken over by TRC. According to testimony given to UN inspectors in 1995,⁴⁶ the transfer happened in April 1990, while two different timelines from two former BW scientists, and the CAFCD from 2002 state that the transfer happened in September 1990, after General Hussein Kamel's order to increase production.⁴⁷ According to an internal secret Iraqi document from 27 September 1990, which was provided to the UN Commission by Iraq, the transfer of Al Fudaliyah from the Ministry of Agriculture to the TRC was requested by the presidential office on 13 September 1990.⁴⁸ Al Fudaliyah was re-named Al Safah by Iraq.

⁴³ Letter from Ahmad Hussein, Head of the Presidency Bureau, to the MIC, dated 6. September 1990. This document was handed over to the Executive Chairman of UNMOVIC on 30 September 1995.

⁴⁴ This was indicated in a letter from General Hussein Kamel to the Office of the President, 21 August 1990.

⁴⁵ UNSCOM 125/BW 27, August 1995

⁴⁶ UNSCOM 125/BW 27, August 1995

⁴⁷ Biological CAFCD December, 2002 7.1

⁴⁸ UNMOVIC doc. no. 700101_012

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According to Iraq, a total of 2,200 litres of aflatoxin-solution were produced in the course of the former BW programme. Of these, 1,800 litres were produced at Al Fudaliyah in late 1990 and the first two weeks of 1991, using a labour-intensive manual production process based on medium-sized glass flasks. Most of the agent was shipped to Al Muthanna in late 1990 for weaponisation, and a smaller quantity was transferred after the outbreak of war in January 1991 to Al Hakam, where it was later unilaterally destroyed by Iraq.

Comment

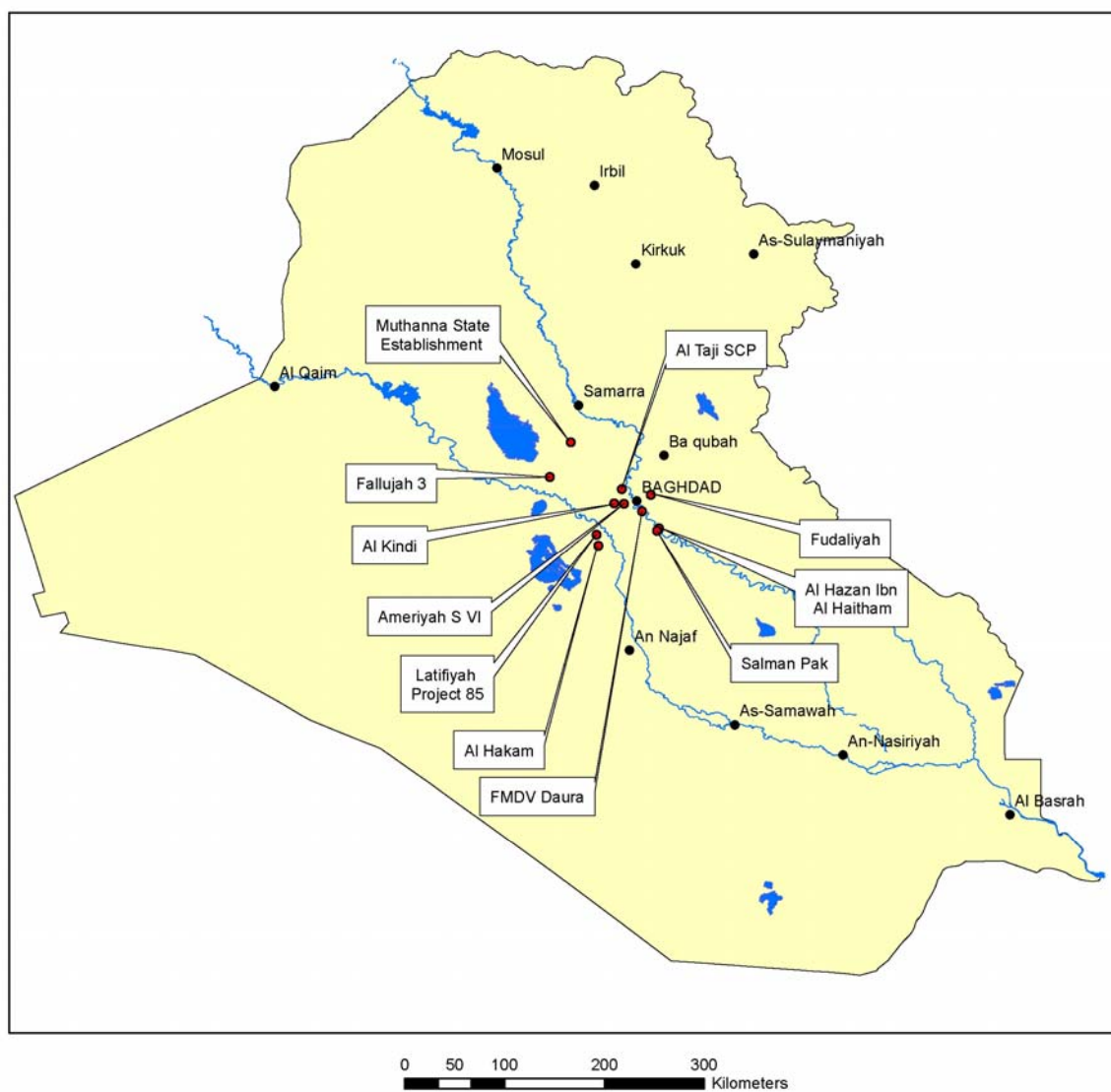
It is likely that the transfer of Al Fudaliyah was discussed in April 1990 but the actual action was taken in September 1990 as supported by the Iraqi document.

Unlike its chemical weapons programme, which ceased its production of agents in 1989 following the ceasefire in the Iran/Iraq war, the biological programme continued to produce agent in increasing quantities. The programme expanded and diversified perhaps to catch up with the perceived level of achievement in the CW area.

The relevant biological research and production sites are shown in Map V.I.I.

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Map V.I.I Iraq Biological Related Sites All sites, are addressed in the following sub-chapters except Fallujah 3 described in the chapter on Iraq's CW programme.



1988-1991: Field testing and weaponisation

1988: Zubaidy device for aerosol dissemination

Iraq declared that during 1987 and 1988 a researcher at Salman Pak was involved in the development of an aerosolisation device for biological weapons. This project was pursued from June 1987 to August 1988⁴⁹, and also involved field tests of an aerosol generator, in July/August 1988, that became known as the Zubaidy device. Iraq declared that “non-pathogenic *Bacillus subtilis* isolated from the soil and cultured in the lab was used in subsequent dissemination studies from a crop dusting helicopter...the results were again inconclusive due to poorly designed and executed work proceduresassistance was provided by technicians from T-3 and engineers from T-2 departments as needed....No attempts were ever made to create a weapon system on the basis of Dr Zubaidy’s sprayer”.⁵⁰ Time-wise the field tests occurred after the first field tests with *B. subtilis* in LD-250 bombs (March/April 1988). According to Iraq, Dr Zubaidy worked without the support or consultation from the biology group transferred from SEPP/MSE.

1988-1991: Field testing

The field testing of weapons filled with biological agents came at specific times and in batches. As shown in sub-chapter X “*Weaponisation of BW agents*”, the first period of activity started in early 1988. At this time, Iraq had not gone into bulk agent production and small quantities of agent were produced for the specific purpose of weapons testing. After a first period of testing in spring/summer 1988, biological weapons testing stopped for more than a year, according to Iraq. Field testing of weapons then continued up to mid-January 1991.

Iraq declared that “In anticipation of future requirements, the D.G. of TRC in 1988 gave instructions to conduct field experiments to specify delivery and dispersion means of biological agents. Owing to a shortage of experience within the bio group, MSE was consulted to support this activity. So field experiments were carried out using similar types of munitions used by MSE for CW. The field tests, static and dynamic, followed the same pattern of testing munitions in existence for filling CW agents”.⁵¹ Iraq also declared that after reviewing some types of empty munitions used for the CW programme, MSE and TRC initially selected only the LD-250 aerial bomb and the 122mm rocket warhead for trials for BW agents. The 155mm shells were selected for one test with ricin and by the end of 1990; a Mirage F-1 fuel drop tank was selected for modification for possible use.

The decision to start weaponisation came at the beginning of 1988, and it was made solely by General Hussein Kamel and passed to the relevant personnel.⁵² The DG of

⁴⁹ Dr Zubaidy left Salman Pak in August 1988, and submitted his final report in September the same year

⁵⁰ Biological FFCD September 1997 Chapter 5.2.5.5

⁵¹ Biological FFCD September 1997 Chapter 1.1.18

⁵² Biological FFCD September 1997 Chapter 1.2.2

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TRC⁵³ met with Al Muthanna's DG⁵⁴, and decided that Al Muthanna would coordinate the work of weaponisation since they possessed experience in field testing and weapons. It was also decided that the head of Al Muthanna's research and development⁵⁵ should coordinate the activity, to include advice on weapons and design for field trials. Photographic evidence shows Muthanna personnel along with members of the biological section, involved in the field testing of BW filled munitions.⁵⁶

1990: Weaponization

In May 1990, a 400 kg aerial bomb (R-400) was certified, by the Iraqi Air Force command to be suitable for delivery of chemical and biological weapons.⁵⁷ Iraq declared that "After August 2/1990, HK ordered the production of 200 pieces of R-400 bomb bodies as well as 25 Al Hussein warheads to be allocated for BW weaponisation...the filling of the bombs and warheads started in late December 1990 and completed on 11 January 1991".⁵⁸ In late 1990, Iraq filled and deployed R-400 aerial bombs and Al Hussein missile warheads with anthrax spores, botulinum toxin and aflatoxin.

The concept of putting BW agents into Al-Hussein warheads began after 2 August 1990. Project 144 was asked to manufacture an additional 25 special chemical warheads to the 50 already ordered for CW. No indication was given to most of the Project 922 staff that these were for other than CW agents. General Ra'ad (PhD Engineer) described to a UN inspection team that they switched from producing containers in aluminum to stainless steel for these warheads due to the lack of aluminium sheets.⁵⁹ Iraq stated that the order to manufacture the chemical container and to modify the conventional Al-Hussein warhead to be fitted with the container was given to Project 144 in late March or early April 1990 in co-operation with MSE. In total, 75 special warheads were produced.⁶⁰ For CW warheads, a number of sample containers were made from aluminium (capacity was about 150 liters), tested for leakage under pressure, filled with inert liquid, assembled with the modified warhead, and then tested statically. In parallel, samples were also prepared for flight tests. The first test was made on April 8 which was a failure, and then ten days later another test was made which was considered successful. An order to produce 50 pieces was received in April 1990 and work began immediately. The personnel remember that many of the aluminium containers (more than 20) were rejected as they faced problems with welding. Stainless steel sheets were used to complete the quantities ordered, and also for the subsequent order of 25 containers. The batches of warheads were collected by MSE as they were completed. Fifty warheads were filled with CW agents and 25 warheads were filled with BW agents.

⁵³ General Ahmed Murtada Ahmed

⁵⁴ General Faiz Abdullah Al-Shahine

⁵⁵ Brig Dr Mahmoud Faraj Bilal, headed from Feb 1987 to 1990

⁵⁶ Video tape handed in the summer of 1995 as part of the Haidar Farm documents

⁵⁷ Biological CAFCD December 2002, Chapter 8.7

⁵⁸ Biological FFCD September 1997 Chapter 1.2.2

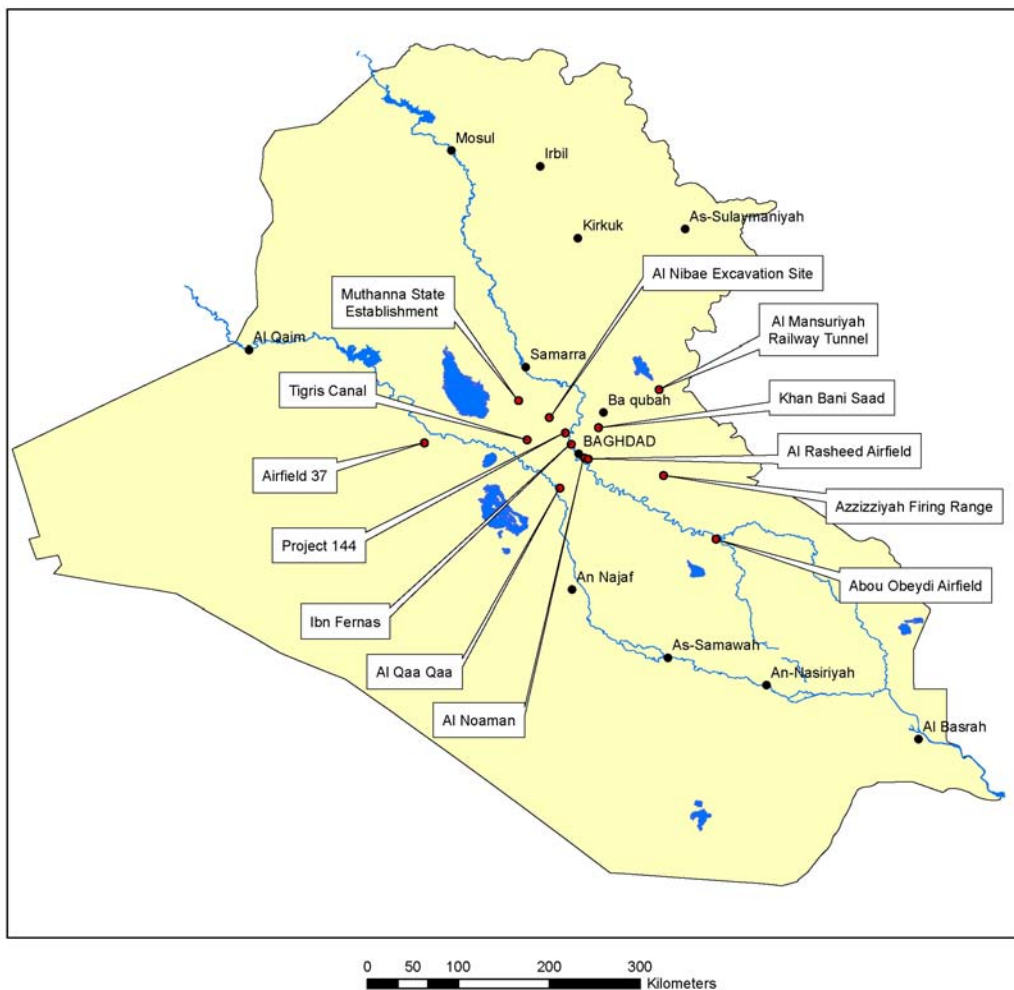
⁵⁹ UNSCOM 133/BW 30, January 1996

⁶⁰ Biological CAFCD December, 2002 Annex 8.11, Supporting: Documents BW Al-Hussain warheads doc. no. 4

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Biological weapons-related sites are shown in Map V.I.II. These facilities are mentioned later in Chapter V.

Map V.I.II Biological Weapon Related Sites



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Comment

Clearly, weaponisation must have been discussed in 1987 since attempts to learn means of dispersing biological agents, was mentioned in the plan submitted by the BW group for 1988.⁶¹

The decision making with regard to weaponization of chemical agents would have been derived by the senior military commanders based on their operational requirements.

Within MIC, the Naval and Air Weapons section was probably involved in the evaluation and the final weaponization decision relating to aerial bombs and missile warheads more than may have been suggested by Iraq. This section was responsible for the introduction of some new weapons systems into the Armed Forces. With regard to BW munitions, although less well defined, a similar rationale must have been applied.

The timing of the order to put chemical and biological agents into warheads suggests that the direction was from the Office of the President. The numbers of particular agent fill may have been the decision of the respective heads of the chemical and biological programmes. Daily biological weapons fill were reported to the senior MSE military officer.

Both the R-400 bombs and Al Hussein warheads are not very efficient for the dissemination of biological agents. It appears that the major criterion for selecting the R-400 bomb was not optimal dissemination, but rather their safe use by the operational Air Force commands. Both the R-400 bombs and the Al Hussein warheads were seen as strategic rather than tactical systems and presidential adviser, General Amer Al Sa'adi has stated that biological weapons could only have had a psychological effect.

Destruction

Iraq declared that it destroyed all bulk biological warfare agent and munitions as well as removed all traces of production and supporting records, in the summer of 1991. Iraq stated "Soon after Iraq's acceptance of SCR 687 in April 1991, it was decided at the political level to take measures to obliterate the entire BW programme and admit work on research and development only. The destruction decision also covered the munitions and the remaining bulk agents. Implementation of the order began in June 1991 and continued until the end of July 1991".⁶² Iraq stated that equipment was thoroughly decontaminated or burnt; facilities were scrubbed down with appropriate decontaminants, sewage pits were cleansed, filters burnt, seed stock destroyed, some equipment and materials were removed and chemical were used to inactivate biological material held in bulk storage or in weapons. By the time the first United Nations biological weapons inspection team arrived in Iraq in August 1991, the clean up had been completed and an appropriate cover story was rehearsed.

⁶¹ UNSCOM doc. no. 100103 (Plan for the year 1988, Technical Research Centre)

⁶² Biological FFCD September 1997 Chapter 6.5.1

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Comment

Through the period of UN inspections (1991-1996), Iraq changed its declarations several times. Although UN inspectors were able to verify much of what Iraq declared from a qualitative perspective, they were unable to do so from a quantitative perspective. Neither the UN nor the ISG have found any evidence of remaining bulk agent or filled BW munitions, however some personnel involved in the past BW programme did declare to the ISG a new location for destroyed and dumped agent.

In 1995, Iraq declared that its biological weapons programme ceased in 1991 and was not resumed thereafter. In the period from 1991 to 1998, Iraq received over 70 biology-related disarmament inspections and was placed under intensive monitoring in December 1994 until December 1998. No additional BW weapons or bulk agent were discovered by UN inspectors nor was any evidence found of a restart or continuation of a BW programme. In the short time of inspection activity by UNMOVIC, from November 2002 until March 2003, despite much speculation and information supplied from a wide range of sources, UN inspectors found no evidence of BW-related activity.

In the period post-March 2003, when the ISG searched for evidence of BW-related activity, no new evidence emerged. The intensive ISG searches and interviews unearthed no other facilities associated with the past biological weapons programme, no other agents that were produced, no other people that were involved and no new weapons systems. In fact one of the main conclusions of the ISG is that the Iraqi leadership lost interest in the biological programme after 1996 because of decaying infrastructure and continued sanctions.

Despite pre-war concerns about the production and use of smallpox as a BW agent, or the possibility of mobile or underground production facilities, there was no evidence forthcoming to substantiate these concerns. There was no information gathered by either the ISG or UNMOVIC which contradicted Iraq's claims of the destruction of bulk BW agent and weapons in 1991.

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**FINANCIAL ALLOCATIONS AND PROCUREMENT FOR THE BW
PREPROGRAMME**

Estimate of financial allocations to BW programme

According to Iraq, activities related to the BW programme started in the early 1970s with the development of the Ibn Sina centre of the Al Hazen Ibn Al Haitham Institute as mentioned in the previous chapter. Funding for the design and construction of the buildings began in 1974. Financing former BW related facilities was ongoing until 1995, and concluded with the planned expansion in the single cell protein, biofertilizer and biopesticide programmes for the Al Hakam Factory. Available data for entities and funding show that BW activities and the development of near industrial capabilities continuously progressed from 1985 until 1990. The BW programme probably cost the Iraqi government many tens of millions of dollars, that was well below the chemical and missile programmes on which Iraq spent on each at least several hundred millions of dollars (Chapter VII).

According to interviews with individuals involved in the past BW programme, after 1987 the command and control of the programme originated with General Hussein Kamel, son-in-law of the President, personally (not only as a result of his office) and came through the Director General of the Technical Research Center (TRC), General Ahmed Murtada, to the technical leader of the Al Hakam (T-5 section), Dr. Taha. It appears that funding requests were sent directly to General Hussein Kamel for his approval and that the BW programme was not funded strictly on an annual basis but rather allocated as required, out of the over all TRC budget.

Though information given by Iraq, as reflected in Table V.II.I does not give a complete picture of actual expenditures under the BW programme, basic financial figures make it possible to suggest that the BW programme was well funded. The appropriation of money for capital development and operating costs was very direct and based on proposals from facility managers.

According to Iraqi statements, through his ministerial position, General Hussein Kamel had the authority to appropriate funds directly without being subjected to review by committee. This expedited fund allocation and sped up the decision and procurement chain.

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Table V.II.I Expenditures for the BW programme of Iraq (as declared by Iraq in the CAFCD)

Years	Reported activity	Salary & Services in Iraqi Dinar	Capital construction	Procurement of equipment & materials in millions	Approx. Total \$US equivalent* in millions
1985	R&D; Production; Salman construction	24,000	ND	.63	.7
1986	R&D; Salman construction	24,000	ND	.33	.4
1987	R&D; Hakam construction	32,000	ND	.3	.4
1988	R&D; Hakam construction	1,000,000	20,000,000/IQD	NA	63
1989	R&D; Production	2,000,000	NA	2.5	8.5
1990	R&D; Production; Weaponisation	1,000,000	NA	.2	3.2

* This is only a very rough approximation based on average exchange rates and is intended only to provide some concept of the level of expenditure. Even if the above levels of expenditure are doubled, the amount is still small compared with expenditures on the chemical and missile programmes. Assumption that over the period 1985 to 1990, 1 Iraqi Dinar = US\$3. ND - not determined: NA - not applicable

The following areas of funding have been declared by Iraq:

- Design and capital construction of sites, buildings and technological systems,
- Procurement of technical resources (equipment, raw materials, biological materials- including agents and laboratory animals, technical systems and devices),
- Salaries to staff and contractors,
- Overhead expenses (maintenance services), and
- Possibly, water, gas and electricity, payment of taxes and rent also occurred and were an essential part of the expenses.

Since the funds were distributed directly by General Hussein Kamel, without the usual due process of consideration through the various departments for planning and financial allocation of funds, there were no discussions or planning of a special BW budget by the

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Cabinet of Ministers, or the Revolutionary Command Council. Financing was rather flexible and centralized by decisions made by one official, General Hussein Kamel.

Iraqi statements indicated that because of the peculiarities of funding, there was not an audit or accounting system which verified funds allocated. Apart from the President, no one had the authority to question General Hussein Kamel's decisions regarding appropriations of funds and he directly supervised the TRC and the BW programme embedded in it. Since the BW programme was relatively small even within the TRC activities and it was within the Muthanna complex, there does not appear to be a close scrutiny of funding or results. As believed by General Amer Al Sa'adi, the former deputy of General Hussein Kamel, even the Minister of Defence who signed a decision to reconstitute BW research projects in 1983 apparently lost track of the whole programme in late 1980s.

From Iraqi declarations, other agencies, such as the Ministries of Health, Agriculture and Irrigation, and Higher Education and Scientific Research were partially involved in the BW programme in that they provided services when requested by TRC, human and technical resources without payment. Facilities such as the Al Taji Single Cell Protein, the Foot and Mouth Disease Vaccines Plant at Al Dora and the Agricultural and Water Resources facility at Al Fudaliyah were taken over and used without cost. No evidence or support for financial transactions or reciprocal services between these agencies. There were also substantial contributions by MSE that provided funding from its research and development budget for the BW programme in 1985 and 1986 and contributed significantly in personnel to the weapons field-testing. Other costs such as the production of bombs and warheads are not reflected in Table V.II.I.

The Director-General of Muthanna, according to Iraq, financed the fledgling BW programme directly from his annual financial allocations. Expenditures for imports were small in the period 1985 to mid 1987. Muthanna imported materials for the biological programme under its own name. Iraq declared that "There was no special financial allocations for the BW programme. The programme was financed by the establishment to which it was related. For example, at the beginning of the activity when it was supervised by MSE, the financing of the programme was part of the R&D budget of the establishment, that is, there was no special BW budget for this activity. The same thing was with the TRC which financed the same activity from its general budget."¹

After separation from Muthanna in mid-1987, payment for purchases and imports were centralized through the Technical and Scientific Materials Import Division (TSMID), subordinated to the T-4 department of TRC. Officially TSMID was part of the Ministry of Trade and was used to disguise or mask the end-user of imported goods.

Iraq declared that it used many commercial and correspondence banks for the procurement of basic technical resources for the BW programme. Prior to 1987 letters of

¹ Biological FFCD September 1997 Chapter I.5

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credit were through the Central Bank of Iraq, after 1987, the Rafidain bank was mainly used because it developed a wide network of branches in the Middle East and Western Europe. Iraq also declared that “No cash deals were done whatsoever. Bank transfers were made to Embassy bank accounts for payment for small orders not covered by L/C’s usually paid by cheques in favour of the supplier.”²

Comment

From the beginning of WMD disarmament under Security Council Resolution 687, Iraq considered financial information as sensitive, and deliberately concealed it by erasing specific information. Incidents of burning financial records and folders on the threshold of UN inspection were indicated by UNSCOM when inspected the Rafidain bank in 1991. Obviously, the direct way of approving the funding of BW activities was unusual and hard to unveil.

Procurement for the BW programme

The organizations responsible for the import of goods into Iraq have changed over time as the BW programme evolved and altered affiliation.

During the early part of the programme when it was located at Al Hazen Ibn Al Haitham Institute, equipment and materials were acquired by the institute itself or under the name of the parent department, the Ministry of Higher Education and Scientific Research.

With the demise of the Al Hazen Institute in 1978-1979 the main importation organization for biological items appears to have been the Technical Consultative Committee (TCC), established in 1979 under Ministry of Trade.³ It is likely that TCC was the principal purchasing arm for the Technical Affairs General Directorate or sometimes called the Technical Research Foundation (TRF) or Technical Research Establishment 1980–1984.⁴ The Scientific and Technical Research Centre replaced the Technical Affairs General Directorate in 1984.⁵ The activities at the Al Salman site began at the outset of 1980’s after the establishment of the Technical Affairs General Directorate. The chemical test directorate and biological test directorate’s forensic laboratory activity were performing chemical analysis of imported materials for quality and contamination control. In 1984 the Technical Affairs General Directorate was replaced by the Scientific and Technical Research Centre to conduct the same activities.

At the end of 1984, the Scientific and Technical Research Centre was reorganised, as it did not meet the aims of its establishment. In addition, it was tasked to perform services and activities for all state offices and its affiliation to a security organ was regarded unsuitable. As a result, TRC was established in 1985 and all assets and staff of the above

² Biological FFCD September 1997 Chapter 4.2.3

³ Experts technical talks, February 1995. Biological talks.

⁴ Supplier and Member State information

⁵ Biological FFCD June 1996, Chapter 11.2

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establishment were transferred to TRC. TRC was affiliated to the Presidency Office up to 1987, and then to MIC.

According to Dr. Rehab Taha, TCC provided some imports for the Salman Pak site from 1980 to 1985.⁶ This included bacterial growth media, a fume hood, spare parts for an autoclave, the inhalation chamber, and other equipment and supplies. Dr. Rehab Taha also stated that all records were destroyed since they were more than 10 years old. TCC retained the procurement function for TRC in 1986-1987 when the TSMID became the dedicated procurement arm for the TRC.

TSMID has been described as the Ministry of Trade's procurement organization specializing in scientific instruments and material. According to Iraqi information that TSMID supplied equipment to all governmental organizations in Iraq.⁷ However, later on the majority of imports were made for TRC.⁸

TSMID was originally formed in 1981 under the State Establishment for Iraqi Imports (SCIE)^{9 10} within the Ministry of Trade, but was apparently un-staffed until 1985.^{11 12} Following the termination of the SCIE in 1985 it was transferred to the State Company for Exhibitions and Commercial Services (SCECS, also known as the Fairs and Trade Service Company¹³). At about the same time as the reorganization occurred in 1985, and perhaps not coincidentally, the TRC was formed on 14 March 1985¹⁴. TSMID was formally transferred to a TRC function on 15 January 1986, by a direction stating that TSMID "*will be the civilian cover*" for TRC¹⁵. Organizationally, TSMID was to remain as part of SCECS under the Ministry of Trade, but the staff belonged to TRC and reported to the head of T-4, Finance and Administration, within TRC.

TSMID remained the acquisition arm for the programme even after it moved to Al Hakam.

⁶ Experts technical talks, Biological talks February 1995.

⁷ UNMOVIC, Report number R2003-0111-9999, 13 February 2003

⁸ UNSCOM 104/BW15, November 1994, Annex 25,

⁹ According to an interview with an Iraqi involved with the import mechanism, SCIE was established in 1982 in order to have all importation activities at one facility. SCIE contained several divisions: (1) Import of Cars and Machinery, (2) Steel and Timber, (3) Hand Tools and Construction Materials, (4) Cereals, remained attached to State Establishment for Processing Grains, (5) Science and Technology, and (6) Commercial Services. (UNSCOM 104/BW15, November 1994, Annex 25)

¹⁰ According to the Charter of the Iraqi General Organization for Importation No. 22 of 1982, the Organization and its bodies (which were formed from many specialized boards) aims were specified in addition to tasks and goals at each board including TSMID. (UNSCOM doc. no. 131). However, the Organization didn't start its real work until 1985, when TRC was formed.

¹¹ UNSCOM 96/BW 12, September 1994.

¹² UNSCOM 104/BW 15, November 1994 Annex 25,

¹³ State Company for Fairs and Commercial Services, Al Nidhal St, PO Box 5642-5760, tel 7196649, 7190354 TELEX 7190354.

¹⁴ Biological FFCD September 1997, doc. no.132

¹⁵ Biological FFCD September 1997, doc. no 133

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The relationship between TCC and TSMID is not clear. In 1986 TSMID took over contact with some of TCC's former suppliers and informed them that there was no connection between the two and that TCC was no longer involved with the division¹⁶. However, it appears that TSMID did not simply replace TCC. TCC was not abolished but continued procurement activities for organizations other than TRC. In 1990, TCC once again began making significant biological imports for Iraq's BW programme.

At the end of 1991, TRC and TSMID were liquidated, and Al Salam Factory was founded which subsequently handled the procurement activities through MIC Headquarter.¹⁷

A TSMID Ledger was handed to the UNMOVIC in 2002.¹⁸ General Amer Al Sa'adi stated that the ledger showed letters of credit (L/C) opened by the Technical Consultation Corporation (TCC) during the period from 1983 to early 1985, after which the TSMID began to open special L/Cs for the TRC.¹⁹ However, it should be noted that the ledger was missing a few entries for 1983, 1985, and 1987²⁰. The annual numbers of L/Cs opened 1983-1990 are shown in Fig. V.II.I.

¹⁶Supplier information

¹⁷ Biological CAFCD December, 2002

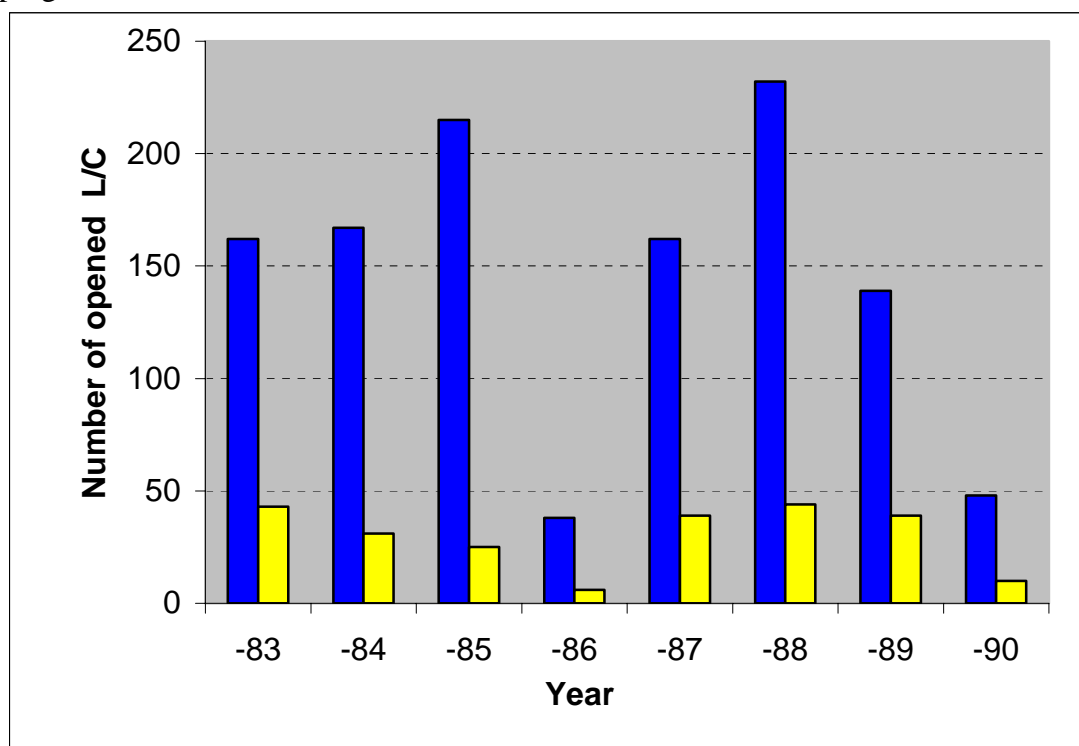
¹⁸ UNMOVIC Report number R2003-0111-9999, 13 February 2003

¹⁹ General Al-Saadi's Response to 13 January Request for Documents, 19 January 2003

²⁰ As deduced from serial numbers 69, 56, and 14 purchases are missing for 1983, 1985, and 1987, respectively.

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Figure V.II.I. Number of Letters of Credit (L/C's) opened between 1983 and 1990, according to the TSMID L/C Ledger handed to UNMOVIC in 2002. Blue, total number of L/Cs opened by TSMID, TCC and others, and Yellow, L/Cs opened with DF and T3, Forensic Department of TRC home of the BW programme in mid-1987. Some of these L/Cs were for the BW programme. Construction of a building and affiliated structures for the Forensic Department began in 1980-1981 at Salman Pak (Chapter V.I.). The major task of the Forensic Department and its predecessors was chemical and microbiological analysis of food and water. An ink analysis laboratory was also part of the Forensic Department. After the initiation of the BW programme at MSE in beginning of 1985, SEPP/MSE and Ministry of Higher Education and Scientific Research procured equipment, among them a 150 litre fermenter and several laboratory scale fermenters, for the BW programme in 1985 and 1986 (Chapter V.IV.). Thus, the decrease in opened L/Cs for year 1986 does not correspond to a decrease in procurement for the BW programme.



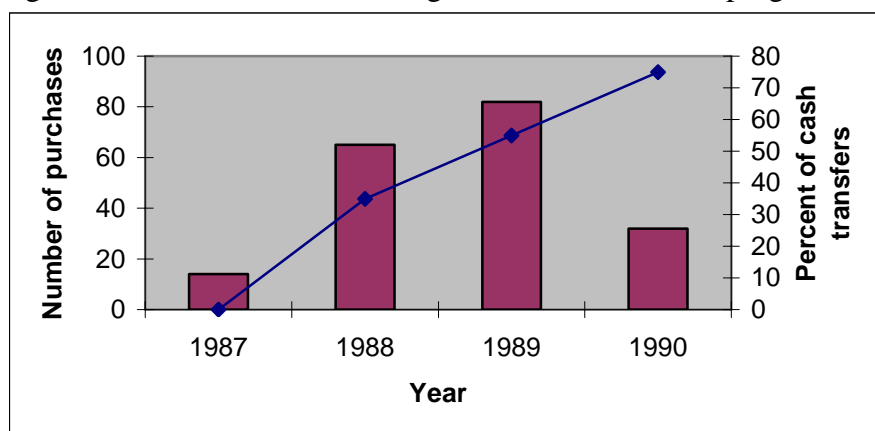
Iraq claims that there were no cash deals made; that is, where sums of money were passed by an embassy official or other person to the supplier for goods. Cash transfers, however, were made from TSMID's account in Baghdad to an Iraqi Embassy account in a foreign country and then "usually" a cheque would be issued by the embassy for the payment of goods²¹. The Iraqi side claims this was only done for transactions involving small amounts of money. Cash transfers mainly concerned the procurement of spare parts

²¹ Biological FFCD September 1997, Section 4.2.3

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and accessories, chemical materials, small amounts of media, and smaller equipment. The percentage of cash transfers of procurement transactions showed a steady increase between 1987 and 1990 (see Figure V.II.II). This could be a reflection of difficulties for Iraq to obtain larger equipment due to export restrictions or that there was a need for more materials and more quickly. The number of purchases represent a subset of those appears in Figure V.II.I under DF+T3. Columns represent number of purchases and line graph represents percent of cash transfers.

Figure V.II.II. Procurement through TSMID for the BW programme, 1987-1990.



Comment

An analysis of items procured 1983-1985 for the Forensic Department does not show any signs of procurement for a BW programme. Rather, the equipment and materials purchased are in accordance with the declared activities at the department at that time. The items procured by TCC for the Al Salman site from 1980 to 1985²² are not readily identified in the L/C Ledger. However, the ledger starts in 1983, the equipment and materials are not fully described and serial numbers are missing, hampering the accurate identification from the ledger.

²² Experts technical talks, February 1995. Biological talks.

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FACILITIES INVOLVED IN BW ACTIVITIES

Facilities involved in the production of BW agents and weapons prior 1991

Despite the BW programme being the most secretive of Iraq's WMD programmes, about 30 different facilities were involved in some way in this programme. Their contribution included the supply of personnel, equipment, agents, design and construction of BW facilities, procurement, manufacturing of equipment and weapons, R&D and production. However, the main contributing facilities are described in the specific sections relating to MSE, Al Taji SCP Plant, Salman Pak, Al Hakam Factory, Al Manal (Foot and Mouth Disease Vaccine plant at Dora), Centre for Agricultural Research and Water Resources-Fudaliyah, and TSMID while most of the other facilities are briefly alluded to below.

Facilities as a source for staff, equipment, and agents

Al Khalij Company

Al Khalij Company, a local company, supplied equipment for ventilation, air-conditioning and air-exhaust of buildings at Al Hakam Factory. These were designed to generate a negative air pressure in the building.

Al Kindi Company for the Production of Veterinary Vaccines and Drugs

The Al Kindi Company for the Production of Veterinary Vaccines and Drugs or Veterinary Research Laboratory (VRL), was engaged in the manufacture and storage of veterinary vaccines. It produced a range of viral and bacterial vaccines such as the Co-Baghdad (Enterotoxaemia and black disease), black leg, anthrax, hemorrhagic septicemia, fowl cholera, rinderpest, theileria, sheep pox, goat pox, fowl pox, Newcastle disease, infectious bronchitis and Gumboro (IBD).¹ Although the facility was not modern by Western standards it had a well-organized and dedicated staff with considerable experience in the cultivation and handling of the production quantities of microorganisms. Also, the facility had significant dual-use equipment and materials.

The Al Kindi Company for the Production of Veterinary Vaccines and Drugs had the potential to contribute to a BW programme through the production of viral and bacterial BW agents, the acquisition and diversion of dual use materials, the training of BW programme staff, the storage of bulk agent and the drying of agent (lyophilization).

Iraq stated that this site was not involved in the production of agent for biological weapons, despite being the source of a large quantity of process equipment that was used to produce BW agents at Al Hakam Factory.²

¹ UNSCOM 15/BW 2, September – October 1991

² UNMOVIC Electronic Site Package for Al Hakam (2002)

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In early 1988, a decision was made to move a fermenter line, installed in 1983 for the purpose of production of “Co-Baghdad” vaccine³, from VRL (Al Kindi) to Al Hakam^{4 5}. Iraq claimed that the fermentation line was not functional, citing as proof its attempts to get the supplier to make the necessary corrections. Professor Hindawi denied the assertion that the fermentation line was not functioning prior to its move to the Al Hakam factory⁶, in interviews and by information supplied by the company. The issue under contention with the company had to do with building features that housed the vaccine line (the company had provided a complete package that included the building) and not with the fermenter line itself. Moreover, an April 1988 document concerning requirements for the production of biological agents (Projects A and B) did not mention any problems with the line.⁷ Furthermore, another document indicates that consideration was given to the operation of the line for BW purposes in situ.

In November 1988 the fermenter line was moved to Al Hakam⁸, but the line was not setup before January 1989, and became operational in February 1989.⁹

Iraq has stated that some Al Hakam staff was assigned to Al Kindi in the summer of 1988 for training in the use and maintenance of the equipment that was to be transferred. For this purpose the Al Hakam staff used the fermenter line to produce *Clostridium perfringens*, *Clostridium novyei* and *Clostridium chauvei* vaccines.^{10 11}

The researcher¹² who was responsible for the viral work in the BW programme worked at the Al Kindi Company for the Production of Veterinary Vaccines and Drugs from October 1987 to March 1988 before transferring to the Iraqi Atomic Energy Commission (IAEC). In the 1990 Al Hakam Annual Report, it is stated that the virology group was attempting to procure equipment from the facility. Documents provided in the March 1996 FFCD suggest that three small fermenters were actually provided to Al Manal in early January 1991. These vessels were apparently returned to Al Kindi before the first biological inspection took place.

Finally, the facility was involved in the efforts to conceal the BW programme through the transfer of growth media from Al Hakam Factory. Media stated to have been part of the BW programme was subsequently destroyed under UNSCOM supervision.¹³

³ The “Co-Baghdad” vaccine is a mixture of *Clostridium* species

⁴ UNSCOM 127/BW29, December 1995

⁵ The following information was given by a person who was in charge at the time of transfer, whereas other people involved were at Salman Pak

⁶ UNSCOM 169/BW 45, January 1997

⁷ Production of Biological Warfare Agents by Iraq, 02 September 1999. Document No 920003

⁸ Biological CAFCD December 2002, Chapter 5.5.1

⁹ UNSCOM 113/BW 22, January 1995

¹⁰ Production of Biological Warfare Agents by Iraq, 02 September 1999. Document No 920003

¹¹ UNSCOM 139/BW 33, February - March 1996

¹² The head virologist worked at this site

¹³ UNSCOM 134/BW 31, May - June 1996

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Al Rasheed Military Hospital

The Al Rasheed Military Hospital in Baghdad¹⁴ supplied in 1988 isolates of the bacterium *Clostridium perfringens*, the causative agent of gas gangrene, which were used in the BW programme. According to Iraq, researching this bacterium started at Salman Pak in April 1988. The scientist conducting this research had previous experience working with effects of gas gangrene at the Al Rasheed Military hospital.

The laboratory unit of Al Rasheed Military Hospital, Baghdad located to the south of the main military complex, was established in 1958. The hospital had four departments: Bacteriology, Microbiology, Hematology and Pathology. The buildings were of very low standard and only basic laboratory equipment, such as, microscopes, small bench centrifuges and incubators were found present during UN inspections.¹⁵

Ibn Haitham Hospital

In November 1990 the Ibn Haitham Hospital supplied a clinical isolate of Enterovirus 70 for use in Iraq's BW programme. The virus isolate was cultivated on two different cell lines (Vero, HeLa) at Al Manal (FMD Vaccine Plant) many times in order to isolate, adapt and propagate the virus. A cytopathic effect was noticed on the cells. The pathogenicity of the adapted virus was unsuccessfully tested in small animals (guinea pigs) by dropping it in the animal's eyes.¹⁶

Iraqi Health Service Laboratory

In November 1990 the Iraqi Health Service Laboratory (or the Central Public Health Laboratory, CPHL) supplied Rotavirus to Al Manal. The virus was propagated in tissue culture and was, unsuccessfully, tested for pathogenicity in small animals.

The Iraqi Health Service Laboratory was undertaking routine pathology tests (biochemical, immunological and microbiological) for patients who had been referred from other medical establishments and patients who came in of their own accord. Hospitals or private physicians referred patients for routine blood testing and specimen collection (for example, cholesterol, uric acid, diabetes, cancer testing were all performed). The Laboratory also had a Food and Water testing section that was undertaking testing of food samples. This was not done on a routine basis, but was rather used as a quality control and adjudicating basis for testing conducted in other laboratories in Iraq.¹⁷

Iraqi Veterinary Central Diagnosis Laboratory

In November 1990 the Veterinary Central Diagnosis Laboratory supplied a local isolate of Camelpox virus to Al Manal. Eggs were inoculated with this isolate to propagate the virus. No further work was conducted on Camelpox. Iraq failed in obtaining a 5,000-egg incubator intended for the production of the virus.¹⁸

¹⁴ UNSCOM 113/BW 22, January 1995

¹⁵ UNSCOM 230/BW 66, May - June 1998

¹⁶ Biological CAFCD December 2002, Chapter 6.4.2

¹⁷ Biological CAFCD December 2002, Chapter 6.4.3

¹⁸ UNSCOM 125/BW 27, August 1995, Annex O.

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The Central Laboratory for Veterinary Diagnosis was a routine control laboratory that applied standard diagnostic methods for the identification of microorganisms. There was no other facility in Iraq conducting similar activities. In the histopathology unit, the most commonly encountered problem was said to be Marek's disease in poultry. The immunology unit was mostly involved with Newcastle Disease diagnosis using serological techniques. The virology unit reported using chick embryo inoculation, also for Newcastle Disease. Bacteriology work involved only basic cultures on standard media, antibiotic sensitivity testing, and basic staining. The laboratory handled 5 - 10 samples per day in 1994. The equipment was poor and partially out of order during an inspection in 1994.¹⁹

The facility performed services for veterinary hospitals and Centres in Iraq. The Central laboratory had some site laboratories performing microscopy only at some veterinary Centres. The facility was owned by the Ministry of Agriculture, and reported to the Ministry through the State Veterinary Service. The facility was previously located at Al Kindi, and was in 1988 moved to a site in Al Waziriyah.²⁰

Institute of Technology, Baghdad

Seven people who worked at Al Hakam Factory were graduates of the Institute of Technology (or Hikmah University-Baghdad, TECHNO, Baghdad Institute of Technology).

The Technical Institute of Baghdad was established in 1969 and was controlled by the Ministry of Higher Education and Scientific Research. The institute was solely a teaching institute - no research was undertaken. It offered a two year diploma. All students took the same course and on completion of their studies were awarded a technical diploma. Students were accepted after graduation and completion of secondary (high) school.

Technical Medical Institute

In 1987, Dr. Tariq Al Zubaidy working at the Technical Medical Institute submitted a report on aerosol generation for medical purpose and touched upon a method of possible dissemination of biological agents using aircraft (the Zubaidy device is discussed in more detail in the sub chapter on weaponisation). During his time at Al Salman his task was to investigate aerosol dissemination technique using *Bacillus subtilis*. The results of his work were inconclusive²¹.

University of Baghdad, Baghdad

At least 12 people who worked at the Al Hakam Factory were graduates of the University of Baghdad.

¹⁹ UNSCOM 72/BW 4, April 1994

²⁰ UNSCOM 72/BW 4, April 1994

²¹ Biological CAFCD December 2002, Chapter 3.3.5

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The university ordered bacterial isolates for the past BW programme in 1985 and 1986 through the Ministry of Higher Education and Scientific Research from overseas on the behalf of Dr Rehab Taha.

University of Mustansiriyah, Baghdad

On 31st December 1986, Professor Nasser Hindawi, an eminent Iraqi microbiologist from Al Mustansiriyah University, College of Science, who became an adviser on a part time basis, augmented the BW group at MSE. Also, some local isolates of *C. perfringens* were obtained by the BW programme from the university through Professor Hindawi.

The Al Mustansiriyah University was established in 1233. The Department of Biology, within the College of Science, was not created until 1983.²² The College of Science of the university was a large teaching college with facilities for post-graduate research. Graduate students performed research in order to meet MSc or PhD degree requirements. The College was primarily affiliated with the Yarmuk Teaching Hospital and, to a lesser extent, with the Saddam Central Hospital for Children, the Al Karama Hospital, and others.²³ The College published the Mustansiriyah Journal of Science with articles in English and Arabic.²⁴ The College of Science at the university was organized into five Departments: Physics, Mathematics, Chemistry, Biology, and Meteorology.²⁵

University of Technology, Baghdad

The plans for Al Hakam Factory were said by Iraq to be drafted in consultation with the Consultative Bureau of the University of Technology, Baghdad. The University of Technology had nine Departments and trained graduates for industry in three main areas: Unit Operations, Petroleum Industries, and Metallurgy (for chemical engineering applications).

Three, maybe four engineers at the Al Hakam Factory had obtained their education at the University of Technology.

Facilities involved in design, construction and infrastructure

Babel Electricity Directorate

This electrical company was involved in the supply of electricity to the Al Hakam Factory (Electricity Power Station, old line).

Al Fao Construction Establishment

Iraq stated that Professor Hindawi drafted the plans for Al Hakam Factory with two engineers together with the Al Fao Establishment. At Al Fao the project was referred to as Project 324 (confirmed by Dr. Taha as the designation for the entire Hakam area, representing the decision date to construct it, 24 March 1988.²⁶), and the University of

²² UNSCOM 87/BW 8, July – September 1994

²³ UNSCOM 84/BW 6, June – July 1994 Annex 30

²⁴ UNSCOM 87/BW 8, July – September 1994

²⁵ UNSCOM 87/BW 8, July – September 1994

²⁶ Biological CAFCD December 2002, Chapter 5.3.5

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Technology Project 900.²⁷ Construction and design work was undertaken by the Al Fao Company that interacted with Professor Hindawi and Dr. Taha on the priorities for the completion of buildings.

Facilities involved in procurement

PC-2, Project 85

This site was known as Petrochemical-2 (PC-2) and located in proximity to Al Hakam at Latifiyah. It appears that the facility was part of a petrochemical complex that was intended to produce plastic extrusion products. Iraq indicated that TRC was intending to modify part of the "stores" area in this complex for the receipt of a 5m³ fermenter from a foreign supplier. The decision to have the 5m³ fermenter delivered to Latifiyah was made as early as 19 July 1988.²⁸ Iraq has stated that they told the foreign supplier that the equipment was going to be installed at Site 85 of PC2 (Al Latifiyah), however the intentions was to move the equipment later on to Al Hakam Factory.²⁹ Such a plan would have allowed Iraq to maintain the secrecy of Al Hakam.³⁰ A foreign representative together with Professor Hindawi, Dr. Taha and another worker visited the facility at Al Latifiyah in 1989.³¹

Comment

Project 85 fitted well into the cover story of developing production quantities for single cell proteins as it was situated in a petrochemical complex close to feedstock and with all the necessary supporting infrastructures.

Technical Consultative Committee (TCC)

With the demise of the Al Hazen Institute in 1978 the main importation organization for biological items appears to have been the TCC, established in 1979 under Ministry of Trade³². The organisation and operation of the TCC has been covered in Chapter V.II.

TSMID

TSMID was originally formed in 1981, but was apparently un-staffed until 1985.^{33 34} The organization has been described as the Ministry of Trade's procurement organization specializing in scientific instruments and material. According to Iraqi information, the TSMID supplied equipment to all government organizations in Iraq.³⁵ However, later on

²⁷ UNSCOM 113/BW 22, January 1995

²⁸ UNSCOM 113/BW 22, January 1995

²⁹ Biological CAFCD December 2002, Chapter 5.3.6

³⁰ UNSCOM 113/BW 22, January 1995

³¹ UNSCOM104/BW15, Nov 1994

³² Experts technical talks, February 1995. Biological talks.

³³ UNSCOM 96/BW 12, September 1994

³⁴ According to an interview with an Iraqi official, he was working at TSMID as the director from 1984 (Annex 25, UNSCOM 104/BW November 1994)

³⁵ UNMOVIC Report number R2003-0111-9999, 13 February 2003

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the majority or all of the imports were made for TRC, when it was established.³⁶ TSMID's role and operation are covered in more detail in Chapter V.II and Chapter VI.

Central Bank of Iraq and Rafidain Bank

Before 1987, the Central Bank of Iraq credited all imports for the BW programme. After 1987, imports were credited by the Rafidain bank, which had the most developed infrastructure of foreign branches in the Middle East and Western Europe

Ministry of Oil

The Ministry of Oil owned and operated the single-cell protein (SCP) facility at Al Taji from the late 1970s until it was transferred to the BW programme in 1987.

Facilities involved in manufacturing of equipment and weapons

Al Nasser Al Athim State Company

The Al Nasser Al Athim State Company was formerly known as the State Establishment for Heavy Engineering Equipment (SEHEE). For simplicity purposes and to avoid confusion with the Nasr State Establishment, this site will henceforth be referred to as "SEHEE".³⁷

In 1989-90, SEHEE fabricated mobile 1m³ sterilizable stainless tanks for Al Hakam. A total of 70 such tanks were ordered from SEHEE. Iraq claims only 39 of these tanks were delivered. After Iraq acknowledged its BW programme in 1995, remnants of stainless steel tanks were given to UNSCOM and stored at the BMVC.³⁸

SEHEE was the major Iraqi producer of vessels, storage tanks, and heat exchangers used in the chemical processing and biotechnology fields. The facility also manufactured sea mines and missile components. It was subordinate to the Military Industrialization Commission (MIC) and located in the Dora section of south central Baghdad just west of the Dora petroleum refinery.

Nasr (Nasser) State Establishment

Historically, Nasr State Establishment was one of the most important military manufacturing establishments in Iraq. It supported all of Iraq's weapons of mass destruction programmes.³⁹ Nasr State Establishment, with its significant casting, forging, and machining capabilities, was one of the premier metal working facilities in Iraq. Along with Badr and Al Nida State Establishments, it was one of the few facilities that produced dies and molds for military manufacturing establishments.⁴⁰

³⁶ UNSCOM 104/BW 15 November 1994 Annex 25

³⁷ UNMOVIC Guide to Iraqi Military Manufacturing Facilities, Volume II: General Purpose Manufacturing and Military Electronics Establishments, 24 July 2001

³⁸ UNSCOM 167/BW 44 December 1996

³⁹ UNMOVIC doc. no. GP000978D, Apr 10 2001 Nasr State Establishment (Site Study)

⁴⁰ UNMOVIC doc. no. GP000978D, Apr 10 2001 Nasr State Establishment (Site Study),

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The Nasr State Establishment was involved in the design, reverse engineering and production of munitions for CBW purposes, including: (a) prototypes of binary chemical munitions, and (b) R-400 chemical and biological bombs.

Project 144 (Al Hussein Missile) at Al Taji

Iraq's conversion of the foreign R-17 missile (SCUD-B) into the Al Hussein missile was one of the most important achievements of Iraq's missile programmes prior to 1990. The final development of Project 144 was the production of chemical and biological warheads for the Al Hussein missiles in 1990, shortly prior to the Gulf war. The concept of putting BW agents into Al-Hussein warheads began after 2 August 1990. Project 144 was asked to manufacture an additional 25 special warheads to the 50 already ordered for filling with CW agent.

For more information regarding Project 144, see Chapter IV.III

Al Qaa Qaa

The Al Qaa Qaa explosives factory was involved in steaming the explosives out of two BRIP-400 conventional bombs that would be used as models on which to base the R-400 chemical and biological bombs.

Al Taji Technical Battalion

The Al Taji facility was used in the conversion and destruction of the drop-fuel tank project for the MiG.

Facilities suspected to be involved in BW activities prior 1991

Baby Milk Factory (BMF)

In the early 1990s, Coalition forces considered an infant formula plant in the Abu Ghraib area West of Baghdad, to be involved in the Iraqi BW programme. The site was bombed during the first Gulf War in 1991.

The facility was designed to produce infant formula by dissolving milk powder, adding a variety of nutritive additives and finally spray drying the product and packaging it for sale in the local market. The process involved several mixing and holding tanks, a centrifuge, a filter press and three large spray dryers.⁴¹ The facility had an original production capacity of 12,000 tonnes per year. A foreign company started construction of the plant in 1977 and it was handed over to Iraq as a complete turnkey facility. According to interview data, the site sat idle until 1990, when packaging (but not processing) of milk started at the site.⁴²

⁴¹ According to a flow diagram of the process obtained by UNSCOM.

⁴² UNSCOM 224/BW 63 April – May 1998

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The site was considered by some Coalition agencies to be involved in the Iraqi biological weapons programme. The views on the exact nature of bio-warfare activities at BMF, however, differed over time, and a variety of – at times conflicting – options have been published, both in the general media as well as in now declassified US intelligence documents.

According to one view, the BMF was a production facility for biological weapons agents. This view was voiced directly after the bombing of BMF in January 1991 by a coalition spokesperson: “The factory is in fact a production facility for biological weapons”.⁴³

According to two now declassified intelligence documents from March 1991,⁴⁴ it was suggested that the plant was planned as a back-up production facility and not in operation when attacked.

Another view was that the BMF was a filling factory for biological weapons. In contrast to the 1991 assessments outlined above, a 1992 intelligence document states that BMF “was converted to a BW filling plant. The filling factory was built within the preexisting milk factory” and “was ready to fill BW weapons” in 1990.⁴⁵ Later, it was judged that “the Iraqis reportedly were not successful in filling artillery shells with BW agents at this site”.⁴⁶

Comment

Based on circumstantial evidence as well as on the genetic analysis of samples taken from the baby milk factory (BMF) equipment in 2003, UNMOVIC concludes that there is no evidence indicating that the plant was anything else but a plant to produce infant formula, and it is highly unlikely that the site was ever used as a production or filling facility for biological weapons. The findings of the Iraq Survey Group in September 2004 also concluded that the belief that BMF was a key BW facility was “mistaken”.

The infant formula plant was designed and constructed by a European contractor for the specific purpose of producing infant formula. The equipment on site was specifically designed for this purpose. It included large mixing and holding vessels, centrifuges, and spray dryers. Fermenters, which would be an essential part for the production of bio-warfare agents, were not part of the design, and neither were specific containment measures. Hence it can be concluded that BMF was most likely not a back-up production facility for bio-warfare agents. In addition, the size of the equipment – for example, 70 m³ spray dryers – does not correspond with the parameters of the Iraqi BW programme in the late 1980s.

⁴³ Washington Post, 24 January 1991, “White House criticizes CNN report”.

⁴⁴ Document 035pgv.91d, www.fas.org/irp/gulf/intel/961031/035pgv_91d.txt, and DIA document 0901pgv.91 dated 22 March 1991
www.gulfink.osd.mil/declassdocs/dia/19961031/961031_950925_0901pgv_91.html.

⁴⁵ CIA doc. no. 331049 from April 1992, www.fas.org/irp/gulf/cia/960417/70477_01.htm.

⁴⁶ Document 008me.93d from Armed Forces Medical Intelligence, 12 November 1993,
www.fas.org/irp/gulf/intel/961031/008me_93d.txt.

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Laboratory analysis of samples taken from BMF equipment in 2003 indicates that it is highly unlikely that biological warfare agents were ever processed at BMF. In February 2003, two UNMOVIC teams took samples from a variety of items salvaged by Iraq post-1991 from the destroyed BMF site and stored at the nearby scarp yard of BMF's parent company, the State Enterprise for Dairy Products (Figure V.III.I).

*Samples were analyzed for DNA fragments of several candidate BW agents including *Bacillus anthracis*, *Francisella tularensis*, *Clostridium botulinum*, *Yersinia pestis* and *Brucella* sp. Most samples proved to be negative for these agents, but two samples yielded a positive signal for *Brucella* sp., the causative agent for brucellosis. These samples were taken from within the spray dryer (see picture below), from a location that was particularly well shielded from harsh environmental conditions over the 12 years prior to sample taking. The identified isolate matched *Brucella* present in milk circulating locally in the Iraqi market and brucella is naturally occurring in Iraq milk supplies.*



Figure V.III.I

Spray dryer from BMF where UNMOVIC took samples in February 2003.

*Subsequent analysis revealed that the *Brucella* DNA from these two samples exhibited at least three distinct DNA melting points, indicating that multiple *Brucella* strains were present. The melting points determined for DNA from these samples matches those of *Brucella abortus*, a naturally occurring disease in Iraq, and present in some milk products produced in Iraq. There were no traces of *Brucella melitensis*, a more likely candidate BW agent.*

*An analysis of commercially available milk in Iraq detected a heavy load with *Brucella* DNA, indicating that Iraqi milk is contaminated with a *Brucella* bacteria (that are obviously inactivated during the pasteurization process). A canned milk product brought to the BOMVIC from the USA was negative to any *Brucella* DNA.*

*Based on this data, it can be concluded that the *Brucella* DNA identified in the spray*

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dryer is from natural contamination of milk products processed by the equipment. In addition, the fact that Brucella DNA could be identified indicates that the analysis methodology was suited to detect bacterial DNA in the samples even after 12 years of exposure of the equipment to the elements. Hence the fact that no DNA of candidate BW agents were detected in the samples is not attributable to environmental degradation of the DNA or to flaws in the analytical method, but is most likely an indicator that these agents were in fact not used in the spray dryer.

Arabian Trading Company

Of particular concern to the UN Commission was the possible involvement of the MIC owned Arabian Trading Company in the attempt to or perhaps actual purchase of a 5m³ fermentation plant.⁴⁷ The same reference number 5/83/6072 used by TSMID in its solicitation to companies in October 1988 was used by the Arabian Trading Company to solicit bids from several companies for a 5m³ fermentation plant at the same time. Documentation obtained by the UN Commission indicated that the Arabian Trading Company (and the apparent sole employee) was engaged in equipment purchases for the BW programme.

UNSCOM inquiries were met with denials by Iraq of any or all knowledge about the Arabian Trading Company and the Iraqi FFCD denies any involvement of this company in BW procurement.

Facilities involved in Iraq's RPV/UAV programme

Iraq pursued a Remotely Piloted Vehicle/Unmanned Aerial Vehicle (RPV/UAV) programme from at least the mid-late 1980s until coalition military action in March 2003. By March 2003, Iraq had experimented with, developed or was developing a number of RPV/UAVs that varied from small target drones to modifications of jet aircraft and from controlled RPVs to UAVs capable of autonomous flight.

Between 1995 and 2001, the Ibn Fernas State Company was involved in conversion of the L-29 trainer aircraft, and with the start in 1999 and 2000 the same company, together with Khawarazmi State Company, was working on the smaller RPVs such as the RPV-20 and RPV-30⁴⁸. Iraq declared that it started a new project in May 1999 aimed at the “design and construction of a programmable drone with a flight range of 100 km and an endurance of one hour”. The project contained “the design of a self-programmed control, guidance and navigation system using a global positioning system (GPS) on the RPV-20”. The name of the project was “Al Musayara 20” (“Guided”) and later called “RPV-20”. The semi-annual declaration of January 2001 announced a new project that started in August 2000 named “Al Musayara 30” or later called “RPV-30”. More information concerning RPV/UAV programmes is contained in Chapter V.X and also in Chapter IV, the Missile section of the Compendium.

⁴⁷ UNSCOM 169/BW 45 January 1997

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Comment

The RPV/UAV programme appears to have been a continuous and naturally evolving one although extreme time constraints, pressures and demands of war might have driven some projects to premature termination. The purpose of the RPV/UAVs developed seems to have covered a spectrum of functions such as air defence training, surveillance, radar decoys, cruise missile recognition, and delivery of a munition.

No solid evidence linking the smaller-sized RPV/UAV programme to the delivery of chemical or biological agent has been found. There appears, however, to be some circumstantial evidence that this option and capability was at least considered by Iraq and perhaps not entirely dismissed. It is likely that the larger RPV/UAVs (MiG-21 Project and perhaps the L-29 RPV) may have been linked to the development of spray tanks, other dispersion devices to deliver a CBW payload.

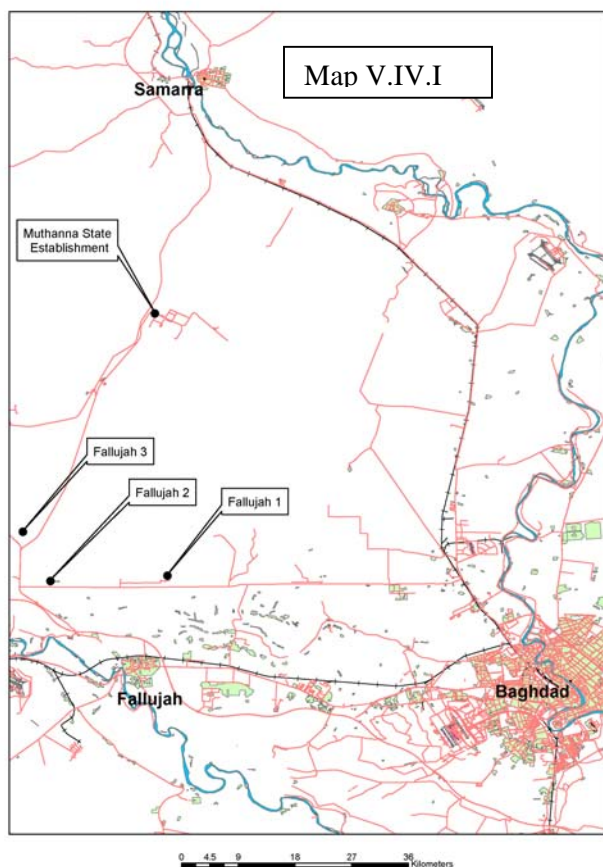
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AL MUTHANNA

Plans for BW research at the Al Muthanna State Establishment (MSE)

The Al Muthanna State Establishment (MSE), originally named Project 922, was formed in 1981 after the dissolution of Al Hazen Ibn Al Haitham Institute. From 1981 until 1987 MSE operated under the name of the State Establishment for Pesticide Production (SEPP), a cover name to disguise the real nature of the activities. According to Iraq's declarations, although the objectives of the Project 922 were aimed at developing CW munitions, in 1981 Major General Nizar Attar, the Director General of the project, sought and obtained the approval by Minister of Defense to include the biological R&D within the framework of CW activities¹. Iraq declared however, that only from 1985 to 1987 was the BW research active at this site. MSE is located about 100km north-west of Baghdad (Map V.IV.I).



From 1985 until 1987 SEPP/MSE was under the administrative control of the State Organization for Technical Industry (SOTI) but reported to the Ministry of Defence (MoD) on production requirements. Prior to 1987, SOTI was managed by a Board of Governors with MoD represented on the Board and this created an additional link between Project 922 to the MoD. The title “Chairman of the Board” was changed to “Director General” in 1987. After 1987 there was no direct link from SOTI to the MoD except for the conventional munitions activities².

Iraq declared that the biological activities within the framework of Project 922 were actually initiated in February 1985, when Dr. Rehab Taha, a specialist in the field of bacterial toxins, joined the Project 922. Iraq declared that Dr Taha “was joined later by other biologists drawn from the toxicological evaluation department at MSE and supplemented late in 1985 and early 1986 with other biologists making a total of 9 members. The task of the biology group was defined as

¹ Biological FFCD, September 1997, Chapter 1.1.2

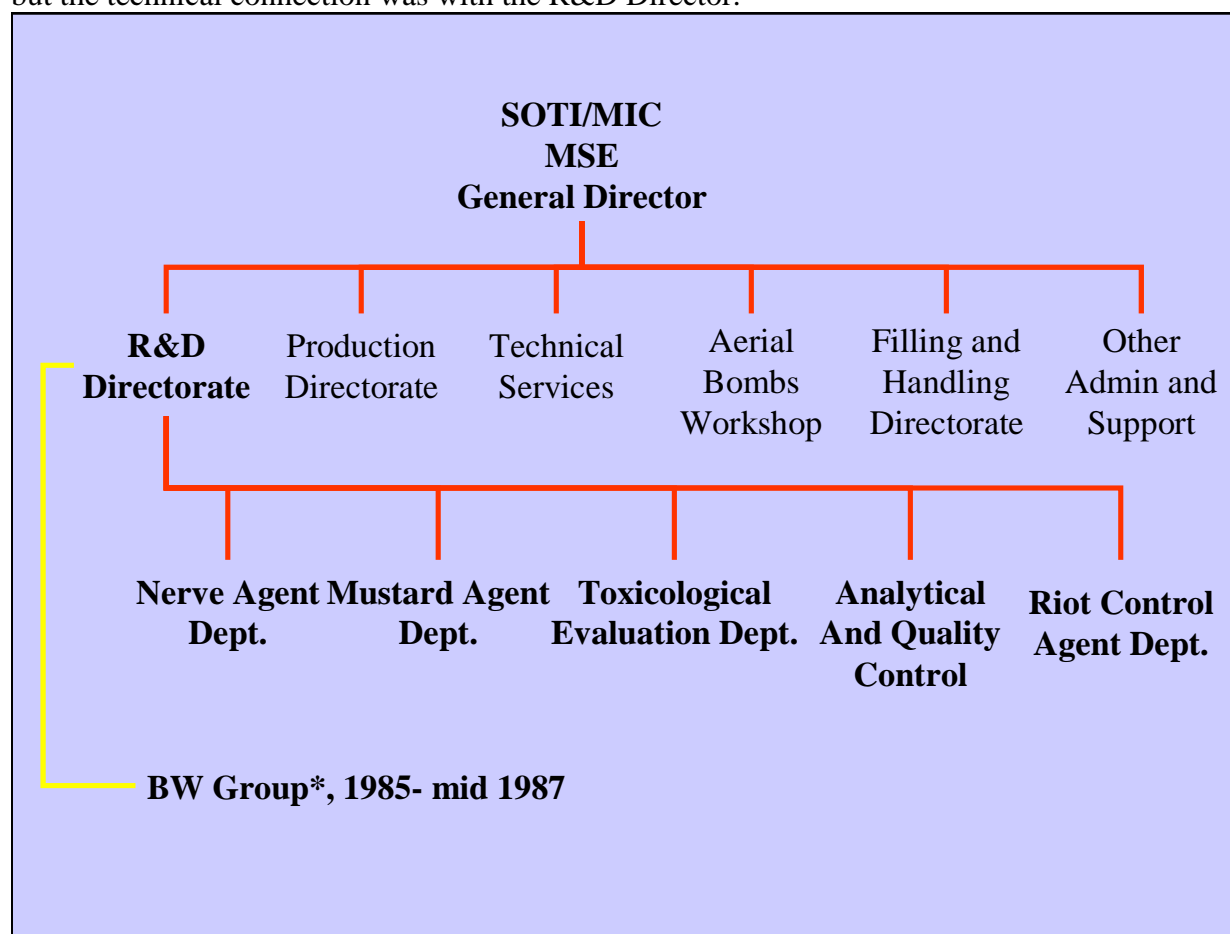
² Biological FFCD, September 1997, Chapter 3.4

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to carry out necessary R&D work which would lead to the production on laboratory scale of BW agents and to evaluate their properties and characteristics as suitable BW agents. No plans were elaborated regarding large-scale production, weaponisation and storing of BW agents. However, the DG of MSE informed his superior in 1985 about the measures taken to create a biology group as a nucleus for a BW project which would in his estimate take about 5 years to complete”.³

In Iraq’s Biological declaration, the biological group was incorporated into Muthanna as shown below in Figure V.IV.I.

Figure V.IV.I The BW group used three laboratories in the Toxicological Evaluation Department. The administrative affiliation was with the Toxicological Evaluation Department, but the technical connection was with the R&D Director.



According to Iraq, publicly available open sources were used for literature survey in Project 922 (for example Biological Abstracts, SIPRI: The Problems of Chemical and Biological Warfare vol. 1 to 5) and no classified documents or special publications were used as primary sources of information within Iraq’s past biological program⁴. Iraq declared that following the literature

³ Biological CAFCD December 2002 Chapter 2.1

⁴ Biological FFCD, September 1997, Chapter 1.7.1

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survey, “two agents were considered, *Clostridium botulinum* toxin (agent A) and *Bacillus anthracis* (agent B). Testing of the two selected agents was conducted in accordance with published literature in the second quarter of 1986; three laboratories were allocated from the toxicological evaluation department at MSE for carrying out biological research. One of those laboratories designated for agent A, the second for agent B and the third for installing and operating laboratory fermenters in addition to other services including sterilization, wash room and cold room. The animal house and inhalation chamber of MSE were used to support the need of biological experiments as well as the chemical programme”.⁵

According to Iraq’s declarations, no plans or project reports were elaborated because no specific requirement had been developed beyond the creation of the group to collect data and material for possible directions of future activity (Table V.IV.I). The only planning admitted by Iraq was planning for a component of BW research and development work at the local level and Iraq denied the existence of a master plan to develop biological weapons⁶. Dr. Taha was supposed to develop her own plans. On 31st of December 1986 the group was officially augmented by Professor Nasser Hussein Al-Hindawi, an eminent Iraqi microbiologist from Al-Mustansiriyah University (College of Science), who became an adviser to the biological group on a part time basis (two working days a week)⁷.

Table V.IV.I: Biological activities at MSE

Objective	Time Frame	Activities	Day-to-day control
Literature survey	1st quarter 1985-4th quarter 1985	Data collection and analysis	Dr. R. Taha
Procurement	1985 - mid 1987	Orders were placed for equipment and materials including bacterial isolates.	Director of planning, follow up directorate & Dr. R. Taha
Agents studies	1st quarter 1986-May 1987	Research on selected agents <i>C. botulinum</i> and <i>B. anthracis</i>	Dr. R. Taha under the supervision of DG of MSE

Procurement of items and materials for BW research

Procurement at MSE was divided into technical and support sections. The technical section (referred to as Planning and Follow Up) was responsible for processing purchase requests including contacting foreign companies. The support section (referred to as Commercial Department) continued with the arrangements after contracts had been agreed. MSE, under its

⁵ Biological FFCD, September 1997, Chapter 1.1.6

⁶ UNSCOM 253/BW70, December 1998

⁷ Biological FFCD, September 1997 Chapter 1.1.4

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own name of SEPP, acquired many of the imports for the biological group work as it did for the chemical programme.

Most of necessary material and equipment were procured by the beginning of 1986 (Tables V.IV.II and III). Isolates of *Clostridium botulinum* and *Bacillus anthracis* were imported in April 1986. Sterne and A3 Pasteur strains of *Bacillus anthracis* were imported in December 1985⁸. Although these isolates were imported for use at SEPP/MSE, they were in fact imported through the Ministry of Higher Education and Scientific Research - University of Baghdad.⁹ In addition, Iraq used local isolates of *Clostridium perfringens*.

Table V.IV.II: Procurement of equipment for BW activities at MSE and procured by SEPP

Equipment	Quantity / Procured in	Equipment	Quantity / Procured in
Loop sterilizer	5 / 1985	Base Unit	3 / 1985
Colony counter	1 / 1985	Fundalux Control Unit	3 / 1985
Colony counter	2 / 1985	Vessel 14 L	6 / 1985
Anaerobic Cabinet	1 / 1986	Vessel 7 L	6 / 1985
Anaerobic Incubator	2 / 1985	PH Probe	6 / 1985
Anaerobic Incubator*	3 / 1986	PO2 Probe	6 / 1985
Deep freezer	1 / 1985	Redox Probe	6 / 1985
Fraction Collector	1 / 1985	CO2 Probe	6 / 1985
Pronoter Press	1 / 1985	Air Filter	6 / 1985
Lyophilizer	1 / 1985	Exhaust Filter	3 / 1985
Sonicator + 6 probes	1 / 1985	Double Mechanical Seal	3 / 1985
Shaker	1 / 1985	Peristaltic Pump	3 / 1985
Flow test	1 / 1985	Fundalux Filter	9 / 1985
Autoclave	1 / 1985	Stream Generator	3 / 1985
Balance	1 / 1985	Air Compressor	3 / 1985
Cooling Incubator	1 / 1985	Laminar Air Flow	1 / 1985
Vacuum pump	1 / 1985	Phase contrast microscope	1 / 1985
Vortex	1 / 1985	PH Meter	1 / 1985
Vortex	2 / 1985	Cooling Orbital Shaker	1 / 1985
Water bath	1 / 1985	Fermenter 150 L	1 / 1985
PH Meter	2 / 1985	PH Probe	1 / 1985
Centrifuge Cryofuge 20-3	1 / 1985	PO2	1 / 1985
Centrifuge Biophuge A	1 / 1985	Electronic Cards	5 / 1985
Centrifuge Biophuge B	1 / 1985	Spectrophotometer	1 / 1985
Test Tube Shaker	3 / 1985	Microscope	1 / 1985
Laboratory Fermenter	3 / 1985	Spectrophotometer	1 / 1985
Control Unit	3 / 1985		

*Procured by TSMID

⁸ Biological FFCD, September 1997 Chapter 5.2.1.1, UNSCOM 7/BW 1, August 1991

⁹ The Riegle Report "U.S. Chemical and Biological Warfare-Related Dual Use Exports to Iraq and their Possible Impact on the Health Consequences of the Gulf War, US Senate 103rd Congress 2nd session, May 25, 1994.

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Table V.IV. III: Equipment in the MSE biological laboratories

Laboratory No. 1 (<i>Clostridium botulinum</i> toxin, Agent A)	Laboratory No. 2 (<i>Bacillus anthracis</i>, Agent B)	Laboratory No. 3 (fermentation)
2 anaerobic incubators 1 microscope 1 pH meter 1 balance 1 deep freezer	2 shaking incubators 1 microscope 1 pH meter 1 balance 1 laminar air flow 1 spectrophotometer	2 fermentors 7L 1 fermenter 14 L accessories of fermenters

Research Conducted

The task of the biology group was to conduct R&D aimed at the laboratory scale production of biological warfare agents and the evaluation of their properties and characteristics as suitable BW agents.

Table V.IV. IV. Research conducted on selected agents

Research objectives and accomplished studies for selected biological agents		
	Botulinum Toxin Type A (Agent A)	<i>Bacillus anthracis</i> (Agent B)
Research Objectives	To confirm the identity and characteristics of <i>Clostridium botulinum</i> with that published in the literature To create confidence of the personnel working with the microorganism To identify optimal conditions for cultivation of microorganism, as well as for toxin production, preservation and storage To master necessary techniques and technology To perform toxicological evaluation aimed at determination of the most toxigenic strain from 3 different imported strains	To confirm the identity and characteristics of microorganism with that published in the literature To create confidence of the personnel working with the microorganism To identify optimal conditions for cultivation, sporulation, preservation and storage To master the technique and production technology To perform pathological tests in order to determine the most virulent strain among the 4 different imported strains
Accomplished studies	Study of growth curve and toxin production Effect of botulinum toxin on laboratory animals Study of inhalation toxicity	Biochemical and morphological tests (Gram staining, fermentation of saccharides, liquefaction of gelatin, blood hemolysis test). Preliminary pathological test with vegetative cells on mice

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Figure V.IV.II Animal House at MSE

The animal house and the inhalation chamber of the MSE were used for the purpose of biological experiments (Figures V.IV.II and III). The animal house consisted of two sectors: the first sector included 3 administration offices and air-conditioning room (air-conditioning equipment and 3 blowers); the second sector was used for laboratory animal's experiments and it included 12 halls with tile ground and all round ceramic walls.



Figure V.IV.III Inhalation Chamber at MSE



The inhalation chamber used by biological group was in semi-underground building (constructed by a foreign country). It was composed of the following sectors: machines room (air compressor and water pump for washing walls), control room (main control panel for inhalation chamber), main equipment hall (inhalation chamber), and sitting room for the workmen and bathrooms. The ground and walls of the hall were made of acid resistant ceramic. The building was centrally air-conditioned and used for pathogenicity experiments on laboratory animals¹⁰.

At the end of 1986, the MSE submitted a report summarizing the achieved results together with the proposal to affiliate the Al Taji Single Cell Protein (SCP) plant to the MSE for future scaling-up of production (Chapter V.III). It was also stated, that any further development would require the extensive investments in production and test facilities. As in early 1987 the MSE wanted to transfer the BW group outside of MSE, the affiliation of the Al Taji plant remained without a decision until mid 1987, when the plant was taken over by the Technical Research Centre (TRC).

Iraq declared that in early 1987, General Faiz Shahine replaced the Director General of MSE General Nizar Attar and arrangements were made to transfer the biological group to TRC at Al Salman. Iraq stated that the biological warfare programme at MSE stopped in May 1987 and that the work was renewed at Al-Salman in July 1987¹¹. This decision was apparently taken for a

¹⁰ Biological CAFCD December, 2002 Chapter 2.2.4

¹¹ UNSCOM 253/BW70, December 1998

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variety of reasons, such as that the new Director General felt that BW activities were incompatible with CW at MSE; the BW program was about to move into large-scale production and needed large investments; concern that the site may have been inadequate for advanced biological activities and concern of possible contamination to the accommodation centers near the site¹².

Comment

MSE was established after the closure of the Al-Hazen Ibn Al-Haitham Institute and its primary objectives were aimed at producing and weaponizing CW agents. From Iraq testimony and declarations, MSE was controlled by SOTI although the Ministry of Defence was the sole customer and therefore was influential in production requirements. The Director General of MSE in a sense had to report both to SOTI and to the Ministry of Defence. According to Iraq's declarations the decision to include BW research programme within the charter of MSE in 1983 was the initiative of the Director General, General Nizar Al Attar. Other statements have indicated that a BW research programme was always inherently in the MSE charter (perhaps lying dormant) of 1981. The fact that General Attar was preoccupied with producing chemical munitions for the war effort against Iran in the early 1980's and that he has stated that he had little personal interest in the BW programme also tends to argue for a reduced role.

It is unclear what motivated the highest levels of Government to approve a BW program at MSE. Iraq has declared that it was the personal initiative of General Attar and that he sought approval from the Ministry of Defence. Other interview testimony and early declarations by Iraq suggested otherwise. It was more likely that the initiative came from senior officers within SOTI, the controlling organization for MSE. It was possible that following the briefing to the Ba'ath Party by Professor Hindawi (about this time) that SOTI may have "suggested" that a BW program (on paper anyway) was incorporated into the MSE work plan. However it seems likely that little was achieved before 1985.

General Amer Al-Sa'adi, head of SOTI stated in an interview with UN inspectors¹³ that the recruitment of Dr Taha to the BW programme in 1985 was based on his suggestion (not General Hussein Kamel's or General Attar's). According to Iraq, the biological group acted very independently in developing research aims with administrative support and reporting through General Attar. Under these circumstances with a totally new and inexperienced staff, non-dedicated facilities and no familiarity at all with BW agent production, slow progress within the BW program would be expected. However according to Iraq, the results were the opposite for much appeared to be achieved in a very short time.

If the literature search started around March 1985 at Muthanna and there was no biological group at that time (apart from Dr. Taha and some toxicologists) it seems unusually quick that bacterial isolates were ordered around August of that year. Assembling a team and establishing appropriate laboratory research facilities as well as performing a thorough literature search takes time. It seems also odd that a 150 litre fermenter was ordered in 1986 by Muthanna when

¹² Biological FFCD, September 1997 Chapter 1.1.6

¹³ UNSCOM 253/BW 70, December 1998

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no-one at Muthanna at that time had experience in working with pilot-scale production and had barely started using desk top fermenters of around 7 and 14 litres.

It was more likely that the considerable experience of Professor Hindawi, was involved in the selection of agents and ordering the fermenter, and that the decision to move to industrial scale production had already been made in 1986. Professor Hindawi admitted he was a key figure and adviser during the very early days of the BW program at MSE even if the formal transfer of his position part-time did not occur until December 1986. Professor Hindawi was a former lecturer, tutor and mentor to Dr Taha and may well have been the “invisible hand” behind the initiation and oversight of the BW programme. Professor Hindawi also trained another graduate in pilot-scale production at the Al Taji Single Cell Protein facility and these scientists subsequently became responsible for BW agent production.

At the beginning of BW activities in Muthanna, the biological group benefited from sharing some infrastructure with CW task force, for example the animal house, inhalation chamber and later the munition filling station. However, the biological R&D section seems to have been segregated already at the start, and later completely separated from the CW programme.

Iraq has made some conflicting statements about when the biological group transferred from Muthanna to the T-3 Department of the TRC at Salman Pak. According to the most recent declaration, 2002 CAFCD, the group moved in about mid-1987. However, offers for considerable quantities of culture media (about US\$10,000 worth) were issued through the T-3 section of TRC in January 1987 when, according to Iraqi declarations, the T-3 section was just a few biologists working on screening water and food samples for contaminants. This media acquisition by T-3 suggests that either the Muthanna group had already made a transition to the Salman Pak facility or that they were already anticipating it. Sometimes it was mentioned in interviews that Dr Taha split her time between Muthanna and Salman in 1986, in the 1995 Biological FFCD, 1986 was declared as the transition period. In a written statement¹⁴ to the first biological inspection team it was stated that biological research activities for military purposes were initiated in mid 1986 at the Salman site or that more activity was occurring at Salman than declared.

The ordering of the 150 litre fermenter was also unlikely to be the initiative of either Dr Taha or General Attar both of whom would have lacked experience and familiarity with fermentation equipment. It was again more likely the initiative of Professor Hindawi and perhaps some former students who had been trained at the pilot plant for the production of SCP at Al Taji.

In the biological area, SEPP/MSE acquired many of the imports for the BW programme in its own name in 1985 and 1986. However, at least one front organization was used and that was the University of Baghdad, naming Dr. Taha as the recipient. Even after the BW programme moved from Muthanna, links were maintained as Muthanna staff provided advice for the selection of BW munitions and munitions field trials.

Despite the conventional wisdom that often links CW and BW as one larger program, with the

¹⁴ UNSCOM doc. no. 007020 dated 2 August, 1991

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advancement of a BW program the incompatibilities between CW and BW programs are more pronounced. As with other countries which had CW and BW programs, although in the early research and development stages the BW and CW groups may have some common needs and could share facilities, when the decision to move to bulk production, BW and CW have been separated to cater for their specific requirements. Iraq seemed to follow this pattern.

In addition, while most of Iraq's CW programme at Muthanna was known internationally, the BW programme remained unknown and may have been compromised should expansion have occurred at this site.

CHAPTER V.V

AL TAJI SINGLE CELL PROTEIN PLANT

Background

The term single cell protein (SCP) refers to protein produced by microbes (bacteria, yeast, fungi or algae) that can ferment waste material such as those produced by the petrochemical industry or from straw, wood, food and beverage industries. Processing waste into protein used as a supplement in animal feed or human nutrition. For example, microorganisms can be grown on a cheap substrate such as carbon from crude oil derivatives and nitrogen source such as ammonia, to make a protein that would be suitable in livestock feed or as a food additive. By the early 1960's, a number of Western-based multi-national companies decided to investigate the production of microbial biomass as a source of feed protein and by the mid-1960's, some 250,000 tonnes of food yeast were being produced in different parts of the world yearly. By 1980, SCP production was cultivated from processes operating on large scale in some developed countries.

The establishment of a research plant for the production of SCP in Iraq, using oil derived products as feedstock, started in 1975. However, Iraq has declared that the project became functional in 1978 at Al Taji under the direction of Professor Nasser Hindawi ⁽¹⁾. The SCP plant was within the Al Taji Liquid Propane Gas (LPG) Factory owned by the Ministry of Oil and was located about 30 miles north-west of Baghdad (see Figure V.V.I). The Al Taji Gas Factory (or petrochemical complex) provided the feedstock for the SCP project. While in the research and development phase, the SCP facility remained affiliated to the Ministry of Oil. Equipment, including a 450 litre and several 7 and 14 litre fermenters and a spray dryer, were ordered in 1979 ⁽²⁾ and a building was constructed for the purpose of housing and operating the fermenters. ⁽³⁾ In 1980 the plant was operating, equipment was functioning and the plant had a staff comprising six or seven chemical engineers, one mechanical engineer and 11 or 12 microbiology (master degree) students. Some personnel who worked at the Taji SCP facility during 1980 were later to make a contribution to BW programme.

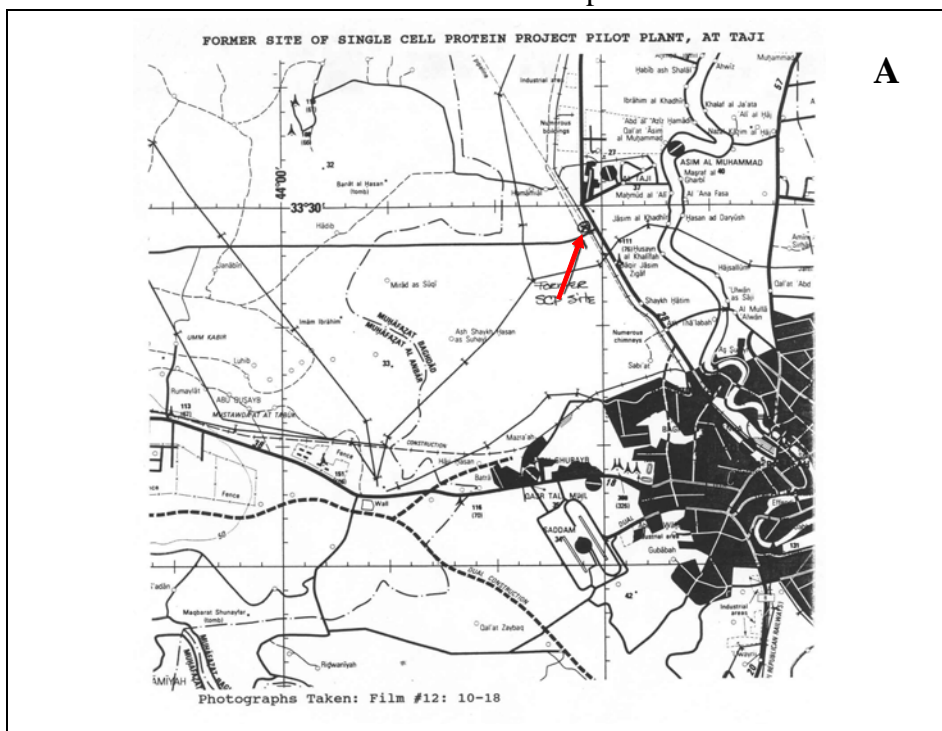
1 Professor Hindawi was released from the university for work at the SCP plant on 26 Oct 1978 (Doc. no. 174001). On the 18 Sep 1981 he was nominated as director of the SCP project (UNSCOM Doc. no. 174002).

2 Supplier information

3 UNSCOM 104/BW 15, November 1994, interview #20, with Professor Nasser Al Hindawi

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Figure V.V.I. Location of SCP plant at Al Taji. **A**; is the location in relation to the city of Baghdad which is 10km NW. **B**; is the location within the Al Taji LPG Factory site. The red arrows show the location of the SCP plant.



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The work at the plant started with research on SCP production using the 10 to 14 litres fermenters and was then moved up to pilot scale using the 450 litres fermenter. Production was in kilogram amounts for chemical analysis and testing with poultry, calves and sheep. Several local isolates obtained from soil in the Kirkuk area ⁽⁴⁾, were used (*Candida tropicalis* and *pseudotropicalis*) as well as some isolates (*Hansenula polymorpha*, *Methylomonas*) obtained from a foreign company.

On 11 May 1980 the first research paper on SCP was published by Professor Hindawi and by 1982, 51 papers had been published.⁵ Some of these publications were given to UN inspectors in 1991. As judged by the titles of the publications, the work at the plant seemed to have been focused on investigating the suitability of different types of yeast and bacteria for production of SCP with, preferentially, methanol as a substrate. However, it appears that for production in pilot-scale (experimental plant) ethanol was the substrate of choice.

Table V.V.I Types of microorganism and feedstock researched at the Al Taji SCP plant, as deduced from titles of publications. *Candida*, *C*; *Hansenula*, *H* and *Trichospora*, *T*

Microorganism	Substrate	Flasks	Fermenters	Experimental plant
<i>C. tropicalis</i>	Methanol			
<i>C. guellermendii</i>				
<i>C. B1</i>				
<i>C. B4</i>			Yes	
<i>C. X</i>				
<i>H. polymorpha</i>				
<i>H. F1</i>				
<i>T. cutaneum</i>				
<i>T. B5</i>				
Locally isolated yeast		Yes		
Bacteria (3B)				
Bacteria (3.1)				
Bacteria (5-2)				
Bacteria				
<i>C. utilis</i>	Ethanol			Yes
<i>H. (8100)</i>				Yes
Locally isolated yeast (<i>C. tropicalis</i> , <i>golomandia</i> , <i>utilis</i> and <i>H. polymorpha</i>)			Yes	
<i>C. B1</i>	Ethanol+Methanol			
<i>T. B5</i>				
Locally isolated yeast				
Locally isolated yeast	Gasoline			

4 UNSCOM 15/BW 2, September – October 1991

5 UNSCOM 15/BW 2, September – October 1991

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According to Iraq, the production of SCP was stopped in 1983 ⁽⁶⁾ and the facility was formally closed in 1984. The staff was dispersed to different places, but the equipment remained at the site. ^(7,8) The reasons for the closure of the plant were stated to have been the expense of maintaining this facility given the on-going war and that an expansion into a large-scale plant would require considerably more investment, for which neither the Ministry of Oil nor Ministry of Agriculture showed any interest.

However, it is not clear from documentary evidence and interviews, exactly when the Taji SCP plant was closed. According to a document from the Ministry of Oil to the HQ of the Presidential Bureau, the SCP project was operating in the 1983 to 1985 period and was stopped in the beginning of 1986 due to a lack of spare materials. ⁽⁹⁾ In addition, when interviewed by UNSCOM in 1997, Professor Nasser Hindawi stated that the Al Taji SCP plant produced 250-300 kg of SCP in 1986 and 1987. ⁽¹⁰⁾

The equipment present at and the activities performed by the Al Taji SCP plant later played a role in the establishment and cover-up of the BW programme. In 1987, the plant was taken over by the TRC, refurbished and used for production of botulinum toxin in 1988. At the end of 1988, equipment was transferred from Al Taji to the Al Hakam facility. In 1991 Gulf war, the plant was bombed since it was suspected as BW facility. Due to the physical damage, the site was abandoned. After the 1991 Gulf war, production of SCP was used as a cover story for Al Hakam programme, most likely relying on earlier activities carried at the Al Taji SCP plant. In August 2002, U.S. intelligence reported that satellite imagery detected the activity of 60 trucks near Al Taji. UNMOVIC inspected the site in December 2002 and found that the building was refurbished and converted to offices and one laboratory for LPG quality control.

Layout and Equipment

Layout

The Al Taji Gas Factory specifically constructed a building for SCP production. ⁽¹¹⁾ Later, it was affiliated to the Technical Research Center (TRC) in August 1987 after the BW group at Muthanna State Establishment had been transferred to the TRC facilities at Salman Pak.

The building was air-conditioned by a central air-conditioner, capacity of 20 tonnes, which later transferred to Al Hakam Factory. Ventilation was performed through normal air ventilators situated in the production hall and laboratories. Water was pumped to the building through the central purification unit situated at the Al Taji Gas Factory.

6 In February 1983 Professor Hindawi ended his work at the SCP plant and he started work at the Salah Al-Din University (UNSCOM Doc. no. 174006)

7 UNSCOM 126/BW 28, September – October 1995, Annex K

8 UNSCOM 104/BW 15, November 1994, interview with Professor Hindawi,

9 FFCD March 1996, Chapter 10, Doc. no. 173

10 UNSCOM 169/BW 45, January 1997

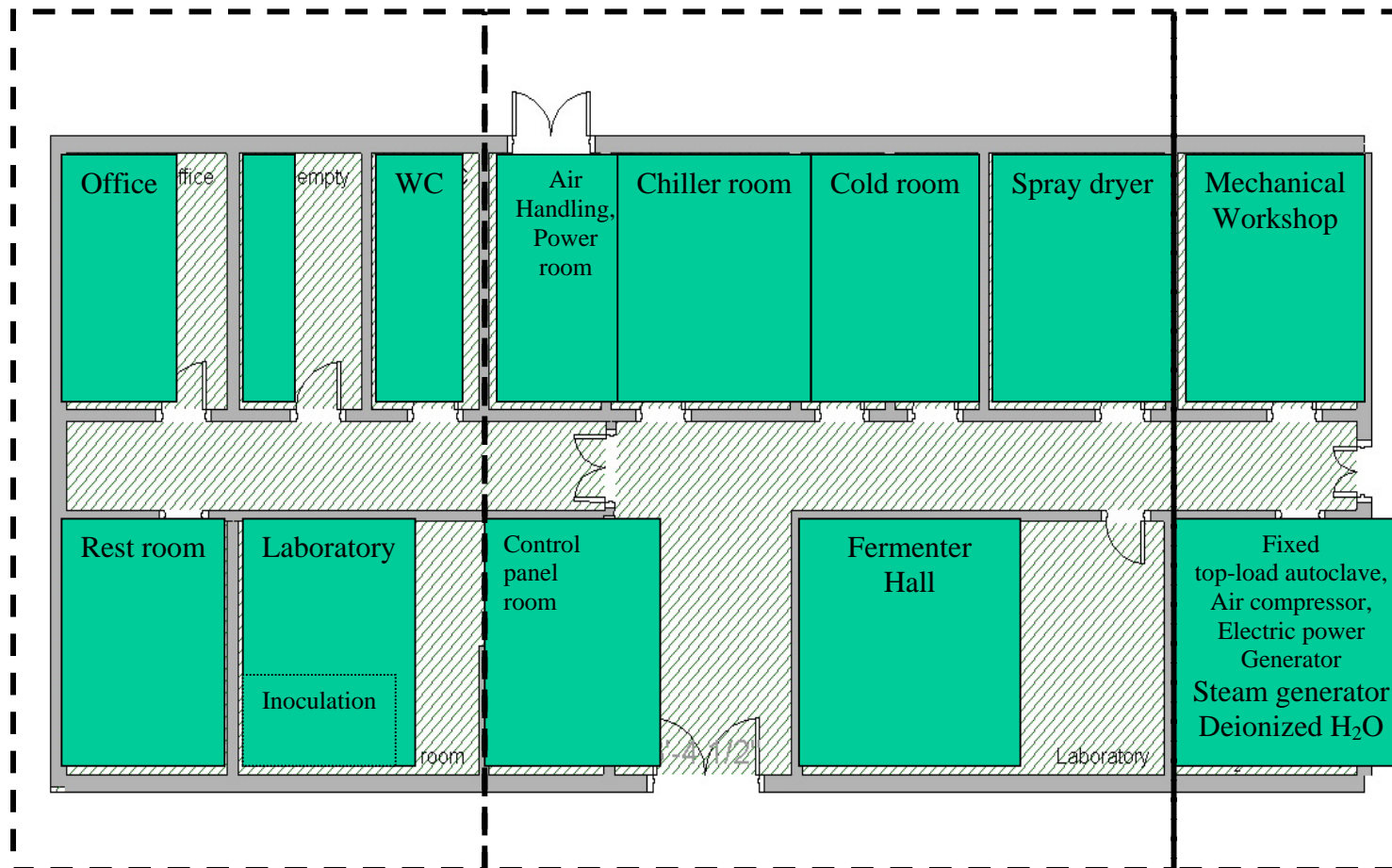
11 Biological CAFCD December 2002 Chapter 4.2.1

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In Figure V.V.II, the building was divided into an administrative section, a laboratory, a spray dryer room and service and maintenance rooms. Annexed to the main building was a smaller building that housed the methanol and other substrates. Metal pipes connected the two buildings.

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Figure V.V.II Diagram of the SCP building at Al Taji (UNSCOM 126/BW 28, Sep/Oct 1995)



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Equipment

A variety of research and pilot-scale equipment was declared by Iraq to be present at the SCP plant and later after the TRC takeover it was transferred to the Al Hakam Factory (Table V.V.II).

The presence of small-scale fermenters at the SCP plant at Al Taji was not declared by Iraq in the CAFCD. In 1987, four bases and a number of 7 and 14 litre vessels for the BW effort were available with the Al Taji SCP plant acquisition. These were transferred to Fudaliyah in 1989, and in 1990 further transferred to Al Hakam Factory.¹²

According to supplier information, one small fermenter with a 14 litre vessel was already present at Fudaliyah. Three bases with 12 vessels (7 and 14 litres) were available through the purchase in 1985/1986 by Muthanna State Establishment (SEPP). These were probably transferred to Salman Pak in 1987, and later to Al Hakam Factory. Thus, eight small-scale fermenters and a number of 7 and 14 litre vessels could have been available for the BW programme.¹³ Eight base units were present at Al Hakam Factory during a UN inspection during December 1995 of which one was declared to have been transferred from Al Taji in 1988, four were transferred from Fudaliyah in 1990 and 1992, and three were transferred from Salman Pak in 1990. In 1994, during a UN inspection, nine vessels of 7 litres and 16 vessels of 14 litres capacity were observed at Al Hakam Factory.¹⁴

The State Organization for Distribution of Oil Products and Gas ordered equipment related to the SCP plant at Al Taji between 1985 and 1987 (Table V.V.III), indicating the possible involvement of this organization in procurement for the BW programme or an earlier involvement of the SCP plant in the programme. In the same time frame as Muthanna State Establishment (SEPP) ordered fermenters for the biological group, the State Organization for Distribution of Oil Products and Gas ordered a spare part for a small-scale fermenter of the type present at the SCP plant. In 1986, they ordered a spare part for an atomizer from the manufacturer of the SCP plant fermenters, which links the spare part to the spray dryer of the plant. Furthermore, two HEPA filters were delivered in May 1987, coincident with the take over of the Al Taji SCP plant by TRC.

¹² UNSCOM 127/BW29, December 1995

¹³ Supplier information

¹⁴ UNSCOM 87/BW 8, July – September 1994

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Table V.V.II Equipment at Al Taji SCP plant in 1987 and transferred in 1988 to Al Hakam Factory as declared by Iraq and listed by UN inspectors¹².

Item	Procurement year
Balance	n.a.
Shaker incubator	Before 1985
Spectrophotometer	
Fermenter, 450 L (including vessels, control panels, and accessories)	1979 (order), delivery 1980
Buffer tank	1980 (import)
Spray dryer	1980
Air compressor	1980
Steam generator	1980
Electrical board	
Water chiller	1980
Autoclave	Before 1985
Microscope (2 pcs)	n.a.
<i>Tank, 600 L (2 pcs)</i>	<i>1980 (import)</i>
<i>Preparation tank, 400 L</i>	<i>1980 (import)</i>
Water tank, 400 L (2 pcs)	1980 (import)
Pumps	
Centrifuge	Before 1985
Centrifuge, continues flow (J2-21)	n.a.
Separator/Centrifuge, continues flow	1980
Oven	Before 1985
Pasteurization unit	Before 1985
Washing tank, capacity 50 L	
Silo	
pH-metre	
Stand by electrical generator	1980
BSC Class I	n.a.
Anaerobic jar, 2 pieces	n.a.
Microscope power supply	n.a.
Inoculation chamber (2 pieces)	n.a.
Freeze dryer, 2 L (2 pcs)	n.a.
3 x Laboratory Fermenter, + 6(?) vessels, 7 and 14 L, including control panels and accessories	1979 (order), delivery 1980
1 x Lab. Fermenter, 14 L vessels (2 pcs ?) and 1 x 7 L vessel	1979 (import)
Fermenter, 100 L	
Storage tank	1980 (import)
Water tank, 2 chambers 750 L each	n.a.
Bag filler	n.a.
PH probes (3 pcs)	n.a.
Heat converter/Filter units	
Water heater	n.a.

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Table V.V.III Equipment procured 1985-1987 by State Organization for Distribution of Oil Products and Gas for Al Taji SCP plant.

Year	Item	Import/ Beneficiary	L/C	Order no	Date	Comment/ Delivery
1985	Spare part, complete motor for LF fermenter (laboratory fermenter 7/14 L ?)	State Organization for Distribution of Oil Products and Gas	85/2/1540 (Central Bank of Iraq)	21419		13.2.1986 (invoice)
1986	Spare parts for Atomizer Type FU-11 (fuses, switches, O-rings, valves....) <i>This is probably spare parts for an atomizer of a spray dryer</i>	State Organization for Distribution of Oil Products and Gas	86/2/577 (Central Bank of Iraq)	21856	Import license dated 26.6.1986	Invoice dated 25.3.1987
1987	HEPA-filters, 2 pcs	State Co. for Oil Products				Delivery 05-87 Invoice no 87/342

Take over of Al Taji SCP plant by TRC

At the end of 1986 a decision was made to scale up the production of BW agents. This followed a report by the biological group to the Director General of Muthanna on the progress made since the BW programme commenced at that facility in early 1985. Being a former head of the Al Taji SCP project, Professor Nasser Hindawi submitted a plan to make full use of the equipment and materials that were at Al Taji.¹⁵ The plan incorporated a proposal to affiliate the Al Taji SCP plant (facility, equipment, and personnel) to MSE for the future requirement of scaling-up production. However, such an expansion in the BW activity implied that extensive investments in production and test facilities were needed.^(16,17,18)

According to a document from the Presidential Bureau to the Ministry of Oil on 7 March 1987, the ownership of the building and equipment was to be transferred to the General Establishment for the Production of Agriculture Pesticides (SEPP/MSE).¹⁹ Also, some technical staff was to be transferred. Several meetings took place between representatives of the Ministry of Oil and MSE to find the best solution for taking over the equipment either in its place or to transfer it to MSE. Members from MSE visited the SCP plant to

15 UNSCOM 169/BW 45, January 1997

16 CAFCD, Biological Chapter 4.1

17 UNSCOM 125/BW 27, August 1995

18 UNSCOM 125/BW 27, August 1995 interview with General Attar

19 FFCD March 1996, Chapter 10, Doc. no.172

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observe the available equipment and instruments.²⁰ As MSE had an intention to transfer the BW group outside of MSE the matter remained without a decision until TRC was made responsible for the BW programme. On 1 August 1987, it was decided to transfer the SCP plant to TRC instead of MSE.²¹ Most of the equipment and material was going to be transferred with start 19 August, and the large fermenter (450 litres) and its accessories after examination by experts.²² This is after Iraq declared that Dr. Taha and her staff had moved from Muthanna to Salman Pak.

Documents provided by Iraq do not make it clear whether the transfer was in situ or to another location.²³ UNSCOM assessed that the specific word used implied a transfer of location as well as possession, and UNSCOM found no evidence to support Iraq's assertion that the 450 litre fermenter was operated in situ at Taji versus being moved to Al Salman. The "fermenter building" at Salman Pak appeared to be designed for more than the 150 litre fermenter alleged to be the only one in it ²⁴, and the Taji transfer documents hint that the transfer was a physical transfer and not just an administrative transfer.²⁵

Iraq claimed that the equipment was transferred in situ and that it took some months to get the equipment operable. The "fermenter building" at Al Salman has been declared as being built in 1988 ²⁶, and the 150 litre fermenter was installed in it during autumn that year ²⁷. One document cites problems with some of the equipment being transferred. Iraq asserts that this included the 450 litre fermenter. The specific problems, however, are in reference to the smaller fermenters that were transferred from Al Taji to Salman. This is supported by supplier information in that spare parts were ordered by TSMID for a smaller fermenter in mid-1987 (the laboratory fermenters that were transferred), but not for the 450 litre fermenter.

Thus, in UNMOVIC's view, all available evidence (documentary, testimonial, or supplier information) seems to be in accordance with the Iraqi declaration that the equipment was used for production of Botulinum toxin A at the Al Taji facility.

At the end of 1987, consideration was given to the amounts of growth media needed. At this time Iraq declared that it also considered using the fermenters at VRL (Al Kindi) for production of agents. ²⁸

20 FFCD March 1996, Chapter X, Doc. no. 175

21 FFCD March 1996, Chapter X, Doc. no. 176

22 FFCD March 1996, Chapter X, Doc. no. 177

23 FFCD March 1996 Reference doc. no. 172-180

24 Report of UNSCOM 7/BW 1, August 1991.

25 FFCD Doc. no. 172-180.

26 Biological CAFCD December, 2002 Chapter 3.2.2

27 Biological CAFCD December, 2002 Chapter 3.2.2

28 UNSCOM 169/BW 45, January 1997

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Comment

In its various declarations, Iraq has changed its testimony on the role played by the Al Taji SCP facility. In the 1995 FFCD for example, Iraq declared that the BW group was originally recruited to Muthanna to produce SCP but later in 1985 switched its aim to researching and producing BW agent. It also declared that the BW group moved from Muthanna to Salman Pak in April 1986 (not mid-1987 as in later declarations) as a result of the direction by SOTI following its agreement to scale-up the BW programme. There was no mention of using the facility at Al Taji as part of the past programme. In later declaration, Iraq stated that “The equipment of the obliterated Oil Protein Factory at Al Taji – designed for SCP production – were used without any conversion for the production of the biological agent Bacillus anthracis of the past programme. Production equipment of the obliterated Veterinary Research Laboratory, designed for veterinary vaccines production, were converted and used for the production of the toxin of agent Clostridium botulinum in the past programme”. Later Iraq declared that Al Taji was used for botulinum toxin production and not anthrax.

BW activities

Much of the equipment at the SCP plant was out of order and required an extensive overhaul and many spare parts.²⁹ Therefore, after the affiliation of the building to the TRC, spare parts were ordered for conducting maintenance and repair on the equipment, like the fermenter.³⁰ In October 1987, TRC produced a list of equipment that was out of order or had lost some parts.³¹ The equipment list included centrifuges, Amino acid analyzer, colony counter, two lyophilizers, a distillation unit, a shaker and three fermenters. At the beginning of 1988, an operational test of the equipment was carried out.³²

Production

Shortly after the testing of the equipment had been completed, the production of botulinum toxin A (Agent A) began and continued until the equipment was transferred to Al Hakam Factory late 1988.³³

According to Iraqi declarations the production of botulinum toxin was carried out in the 450 litre fermenter.³⁴ The total amount of material produced in batches before concentration was about 8,000 litres. 3,600 litres were concentrated 10 times and 4,400 litres were concentrated 20 times for field tests requirements. About 30 batches were completed, 12 batches produced 360 litres of toxin concentrated (10 times) and 15 batches produced 220 litres toxin, concentrated (20 times) and three batches were

29 Biological CAFCD December, 2002, Chapter 4.1

30 UNSCOM 169/BW45, January 1997, Interview with Professor Hindawi

31 FFCD March 1996, Chapter 10, Doc. No. 179

32 Biological CAFCD December, 2002, Chapter 4.2.2

33 Biological CAFCD December, 2002, Chapter 4.2.2

34 Biological CAFCD December, 2002, Chapter 4.3

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discarded due to contamination of the culture medium (Table V.V.IV). The concentrated toxin was collected in 20 litre glass jars and stored in the SCP unit itself. In accordance with this, in the December 1988 annual report the Bacterial Unit stated the production of 800 litres concentrated material (Project A, botulinum toxin), equivalent to 8,000 litres.³⁵

According to Iraq, the production took place during two periods, January/February to March and July to October 1988. In March, the steam generator and the 450 litre fermenter had to be repaired and there were problems with the drive shaft seals.³⁶ A lack of media has also been declared as a cause for the stop in production. Growth media were obtained from Salman, though some was already present at the SCP plant.³⁷ It has also been stated that growth media were received from the Veterinary Research Laboratories (Al Kindi) and MSE.³⁸ Transfer of Agent A from Al Taji to Salman occurred on two occasions³⁹, in two types of flasks (10 and 20 litres) in boxes.

Table V.V.IV Production of botulinum toxin at the Al Taji SCP plant

Period	UNSCOM assessment(40)	CAFCD
1987	2,700 – 3,300 L* (10 x, 270-330 L)	Not declared
First Jan/Feb-Mar 1988	Approx. 30 batches (10 x, 870-900 L)	3,600 L/12 batches (10 x, 360 L)
Second Jul-Oct 1988		4,400 L/15 batches (20 x, 220 L)
<i>Total production</i>	<i>11,400-12,300 L</i>	<i>8,000 L</i>

* The working volume of the 450 litre fermenter was 300 litres.

The move of equipment from Al Taji to Al Hakam Factory

According to Iraqi declarations, the biological group used the Al Taji facility to produce botulinum toxin A during the period from January to September/October 1988. The equipment at the facility was moved to the Al Hakam Factory in October, after which the building was handed back to the Ministry of Petroleum at the end of 1988.

Personnel

Dr. Rehab Taha was declared in charge of the BW programme including the BW work performed at the Al Taji facility. Professor Nasser Hindawi, the former director of the SCP plant, was a consultant and in charge of science and specifications.

35 'The Secret Annual report' of Al Hakam, for the period 1988 till 31 Dec 1988. (Doc. no. 100104)

36 UNSCOM 169/BW45, January 1997

37 UNSCOM 260/BW 73, December 1998

38 UNSCOM 169/BW45, January 1997

39 UNSCOM 169/BW45, January 1997

40 Details of the UNSCOM assessment is contained in an internal document "Production of Biological Warfare Agents by Iraq" (UNSCOM Doc. No. 920003 of 02 September 1999)

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Ten people worked at the Al Taji facility⁴¹ were later transferred to Al Hakam Factory and four, maybe five, participated in the production of botulinum toxin A at Al Manal (FMD Vaccine plant at Al Dora).

Comment

UNMOVIC posed the question of whether the single cell protein facility was developed by Iraq as a legitimate facility producing yeast as an animal feed supplement or whether it was in some sense developed as a part of the BW programme which may have evolved following the closure of the Al Hazen Institute. Two developments appear to be occurring simultaneously in Iraq in the late 1970s and early 1980s. The first of these is Iraq's continuing policy of increasing domestic industrialization and self-reliance particularly in critical areas such as food supply. Several biological related industries were either being established during this time (such as the Foot and Mouth Disease Vaccine Facility in Dora and the Baby Milk Factory in Abu Ghraib) or were being expanded (such as the Al Kindi Veterinary Vaccines Company). However, also occurring during this time was the building of the forensic laboratories at Salman Pak as part of the Scientific and Technical Research Centre and the development of Muthanna. Given these two simultaneous developments UNMOVIC has tried to analyze whether it was more likely for the Al Taji SCP facility to be just a part of the greater move towards self reliance or whether it was planned to be part of a future BW programme. To do this it is necessary to examine what was occurring outside Iraq as well as inside it.

By the early 1960s a number of multi-national companies based in the West, decided to investigate the production of microbial biomass as a source of feed protein. To make this an economically viable proposition, the microorganisms would need to use waste industrial products as a feed stock to produce single cell proteins to compete with the expected rise in the feed grain prices. Therefore abundant substrates with low prices were required and several by-products were chosen to sustain commercial processes. By the mid 1960s, some 250,000 tonnes of food yeast were being produced in different parts of the world. By 1980, SCP production processes were operating on large scale in developed countries.

At that time (1978/1979) Iraq, through the Ministry of Oil, started up the activities at the Al Taji SCP plant. The project was running as a technology assessment or pilot-scale project with successful results. The plant was located 29 km from Baghdad and integrated into the site of the Al Taji Gas Factory, thus in close proximity to the feedstock.

The decision to stop full-scale production by Iraq could have been influenced by a number of technical and political developments that occurred internationally in the 1980s and that affected the SCP industry. World agricultural output increased as a consequence of improvements in plant breeding and crop protection, and agricultural reforms. Moreover, agricultural reserve stocks in several major exporting countries were

41 UNSCOM 126/BW 28, September – October 1995

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liberated for market trading. As a consequence, the price of agricultural feed crops did not increase as expected earlier and this made the use of SCP as an animal supplement less attractive. Thus, SCP was out-marketed and many industrial SCP processes worldwide were discontinued. In addition, large-scale production of SCP found to generate a diluted product, about 5%, requiring concentration using expansive downstream equipment making the produced protein uneconomical. Stabilization of the produced protein was considered challenging.

Time-wise, the start-up and closure of the Al Taji SCP plant coincided with other events in Iraq connected to the WMD programmes:

- In January 1979, the Al-Hazen Ibn Al-Haitham Institute (started 1974) was dissolved and the assets were transferred to SOTI. Iraq stated that there were no direct links and continuity between this organization and following developments in the field of biological and chemical weapons. However, as it became evident from interviews with its former employees, all assets and most personnel of Al Rashad laboratory and Ibn Sina Centre were taken over by other organizations and continued to operate. Thus, the demise of the Al Hazen Institute did not imply a termination of its substantive activities but in reality its functions continued with the transfer of some personnel and assets into other organizational structures.*
- Project 922, later known as the Al-Muthanna State Establishment (MSE), was formed in 1981. Although the objectives of Project 922 were aimed at the CW programme, in 1983 Major General Nizar Al-Attar, the Director General of the project, sought and obtained the approval of his superiors to include the biological R&D within the framework of CW activities.*
- The biological activities within the framework of Project 922 were actually initiated in February 1985, when Dr. Rehab Taha, the specialist in the field of bacterial toxins, joined Project 922 and started with literature survey and identification of initial requirements for the R&D work for the BW programme.*

The start-up and closure of the Al Taji SCP Plant is in well accordance with international developments in the SCP area. The localization of the plant is in well accordance with the feedstock requirements and the types of yeasts worked with and known to be utilized for petroleum-derived feedstock.

There are some uncertainties regarding what type of work that was performed at the Al Taji SCP pilot plant. Firstly, the facility started at the time of dissolution of the Ibn Sina Centre. Secondly, according to the titles of the research reports most of the work seems to have been focused on basic studies of yeast strains. Thirdly, the director Professor Hindawi does not appear as an author on any open source publications on SCP, while other groups were publishing in 1978 and 1982. Fourth, at the time of closure of the Al Taji SCP plant; MSE had the approval of including BW programme into Project 922. Fifth, the Ministry of Oil was active in procurement for the CW programme and thus had a direct linkage to WMD activities in Iraq.

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Whether these are linked or a coincident event is hard to tell and no evidence is available to UNMOVIC that points unambiguously to one direction only. However, it could be argued that if BW related work had been performed at Al Taji the BW work at MSE should have started earlier than 1985, and that the procedure for taking over the facility in 1987 would have been simpler than the actual one as deduced from retrieved documents. Therefore it seems more likely that the Al Taji facility was developed as a legitimate facility that was used on an opportunistic basis for the BW programme rather than being established as part of a future programme.

Regardless of the reason for its existence, the Al Taji facility had, at a minimum, provided excellent hands-on training for pilot and small industrial-scale production. Professor Hindawi claimed that he trained up to 50 on the scale-up procedures for a 450 litre fermenter. Also available at this facility was training on the down-stream processing equipment such as larger centrifuges and spray dryers. Therefore when the BW programme was re-established not only was there a sense of urgency because of the continuing war with Iran but also there was a pool of qualified people with experience in pilot-scale production to draw on. Professor Hindawi, when he submitted his paper to the Ba'ath Party in the early 1980s was probably confident that a BW programme could move relatively quickly towards bulk production of agent.

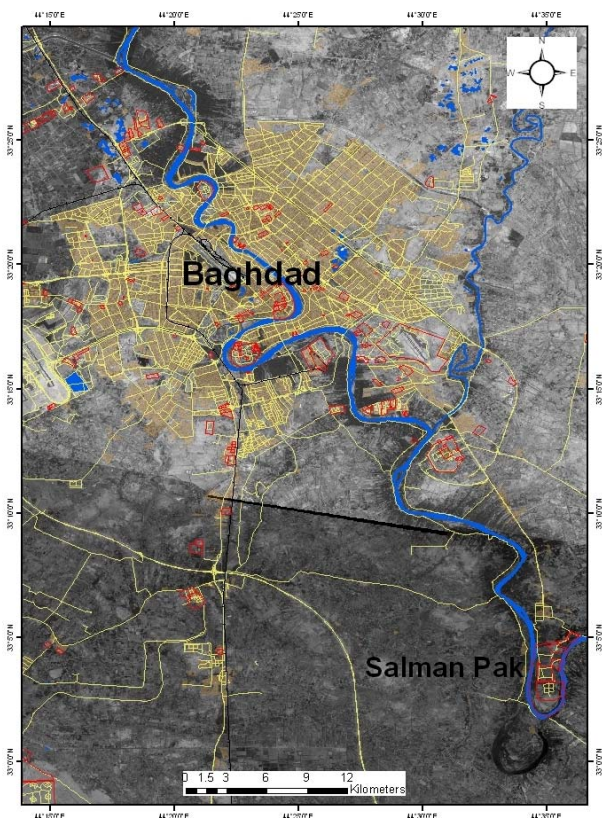
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Overview

The key research and development facility of Iraq's former BW programme was located on the Salman Peninsula near the town of Salman Pak some 35kms south east of Baghdad (Map V.VI.I). According to Iraq's declarations, while the initial stages of the BW programme were performed at Muthanna State Establishment, the BW group with all its research equipment was moved to Salman Pak in the summer of 1987. The BW group was formally attached to the Forensic Research Department of the Technical Research Centre (TRC), which became part of the Military Industry Commission (MIC). The Forensic Research Department of the TRC was also known as the T-3 Directorate, within which the BW group formed a separate section.

Map V.VI.I Salman Pak Location



Much of the work started at Muthanna was further developed at Salman Pak, including the scaling up of agent production, initial production of some agents, toxicity tests using a broad range of animals on site, and the filling of munitions for some field tests. After the establishment of Al Hakam, the dedicated large-scale BW agent production facility, several research projects were transferred from Salman Pak to Al Hakam in 1989 and 1990.

Iraq stated that the following BW agents were investigated and, were in limited quantities, produced at Salman Pak:

- Botulinum toxin type A (agent A) from *Clostridium botulinum*
- *Bacillus anthracis* (agent B) the causative agent of anthrax,
- *Clostridium perfringens* (agent G), the causative agent of gas gangrene
- Mycotoxins, especially aflatoxins (agent C) from *Aspergillus* (sp) and to a lesser extent trichothecenes from *Fusarium*.
- Ricin from the castor bean plant
- Wheat cover smut (agent D), *Tilletia* spp.
- Bacterial simulants (*Bacillus subtilis*, *Bacillus megaterium*, *Bacillus thuringiensis*).

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In addition to the work on BW agents, Salman Pak was also involved in the development of an aerosolisation device for biological agents. This project was pursued in 1987 and 1988, and also involved field tests of an aerosol generator that became known as the “Zubaidy” device, so named after its inventor.

It was mentioned earlier in the Compendium that the Salman peninsula housed several different entities that were apparently connected to the Iraqi security apparatus and that may have pursued some projects in the biological area for clandestine purposes that were not directly linked to the military oriented BW group. Not all projects mentioned above were performed within the same organisational framework. The work on wheat cover smut, for example, started about two years before the BW group was transferred from Muthanna to Salman Pak. The work on ricin was conducted by a separate group at Salman Pak and was, according to Dr. Taha’s testimony, not known to her or others of her group. Also the development of the Zubaidy device was not directly embedded into the research and development work of the BW group as declared by Iraq.¹

The Forensic laboratory building which housed the BW group at Salman Pak was well equipped to support all key necessities of a biological warfare research and development programme. The following were present in the building:

- A suite of laboratories in a building with a central air handling system providing some (UV) outlet air decontamination;
- Basic laboratory scale equipment for microbiological work, such as aerobic and anaerobic incubators, a laminar flow cabinet, autoclaves, freeze dryers and microscopes.
- A small scale fermentation laboratory with at least three fermenters of 7 and 14 litres capacity, and its accessories;
- One 150 litre fermenter with all necessary accessories;
- An animal building for laboratory animals, including mice, rats, guinea pigs, rabbits, dogs, sheep, donkeys and monkeys;
- An incinerator;
- A state of the art inhalation chamber of 3m³ capacity;
- A large cold storage area.

During the 1991 Gulf war, several buildings in Salman Pak suffered bomb damage, including the main forensic laboratory building. After the war and prior to the first UNSCOM inspections, Iraq demolished most buildings that had been part in the BW programme. In August 1991, UNSCOM’s first biological weapons team inspected Salman Pak and Iraq informed the team that a military biological research programme took place on-site and delivered 90 unopened imported vials of biological agents to the team.

¹ FFCD September 1997 Chapter 5.2.5

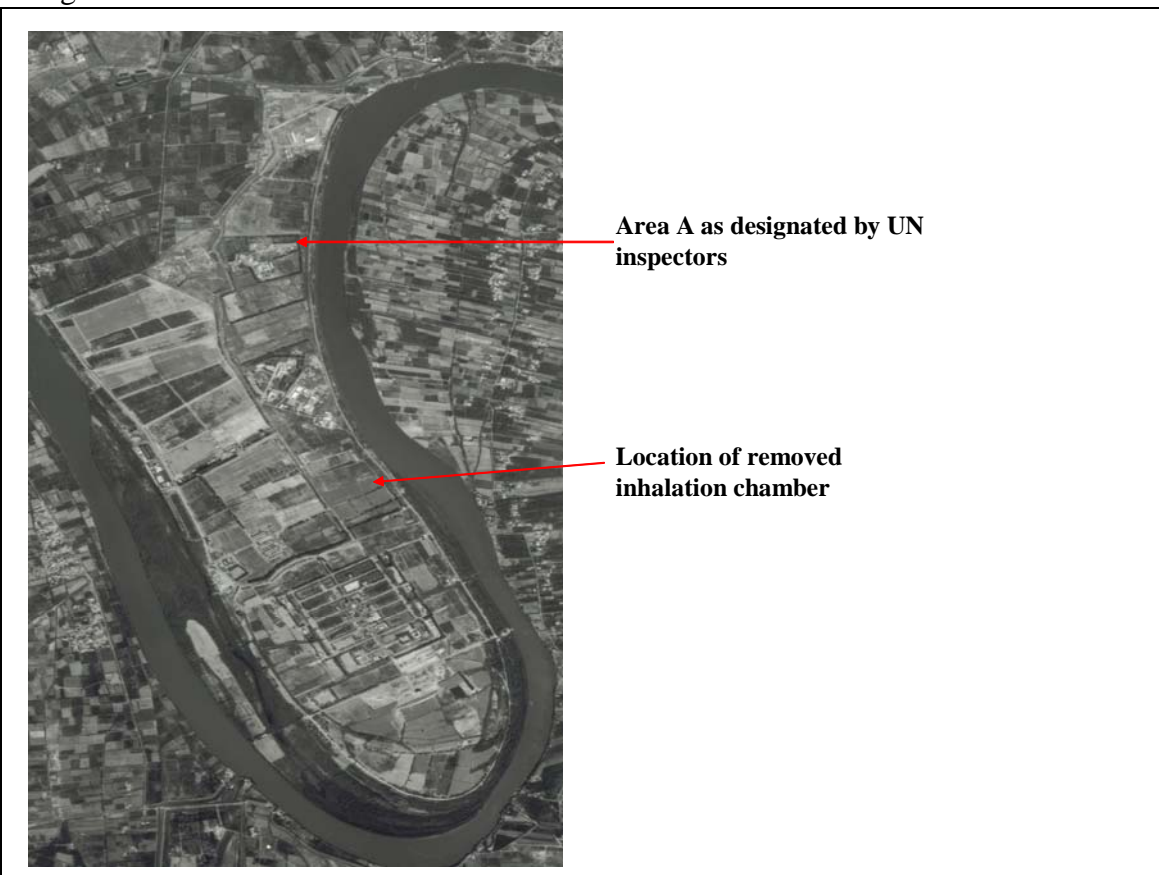
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After 1991, Iraq constructed new buildings on the Salman peninsula for the “Al Salaam Factory” that engaged in electronics research, development and production. No biological work was conducted after 1991 at Salman Pak.

Location and Site

The Salman peninsula is situated about 35km south east of the centre of Baghdad (map V.VI.I). The Forensic Department (or T-3 Department), which housed the BW group, was located in the northeast area of the Salman peninsula (see Figure V.VI.I). UN inspectors designated this area as ‘Area A’.

Figure V.VI.I: Al Salman Peninsula, aerial picture taken by the UN in 2003. The Forensic Laboratories are located in the northeastern area of the peninsula, UNSCOM/UNMOVIC designator ‘Area A’.



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History

The Salman peninsula housed several entities that were apparently connected to the Iraqi security apparatus, including an anti-terrorist training camp as declared by Iraq, the Ibn Sina Centre of the Al Hazen Ibn Al Haitham Institute and a VIP Guest House.

Following the closure of the Al Hazen Ibn Al Haitham Institute, construction commenced in 1980 on facilities which, according to Iraq, would be part of the Technical Affairs Directorate under the Office of the President but controlled by the intelligence and security apparatus. Buildings were constructed only about a kilometre from the Ibn Sina Centre at Area A (Figure V.VI.I). The Technical Affairs Directorate was, *inter alia*, responsible for regime protection by testing for food and water contaminants. The Technical Affairs Directorate was renamed the Scientific and Technical Research Centre, and then in 1985 became the Technical Research Centre. Thus, at the time when the BW group was transferred from Muthanna to Salman Pak, most facilities were already installed in the TRC including the forensic laboratory.

The main forensic laboratory building was planned in 1980 and completed by the end of 1983.² According to Iraq, it was equipped with a central air-handling system, and provided an Ultra-Violet (UV)-based air decontamination system for the exhaust air. One of the two sewage disposal systems was equipped with a chlorination tank.³ Similarly, the building for the inhalation chamber was constructed in 1982, and the chamber itself was imported in 1983 from a Western supplier. The building was equipped with “*filters for sterilizing the exhausted air from inside the building*”,⁴ although Iraq’s declaration does not state whether these filters were HEPA filters.

Also a large cold storage facility was on site in 1987, as was another major laboratory building, which was dedicated to chemical research (building No. 13 in figure V.VI.II), and used for pesticide investigations.

According to information provided by Iraq in 1991⁵ and in the CAFCD, the major task of the Forensic Department was chemical and microbiological analysis of food, for chemical and biological contaminants such as heavy metals, bacterial and fungal contamination. The Forensic section worked also on food contaminants such as *Salmonella typhi*, and mycotoxins. An ink analysis laboratory was also part of the Forensic Department.

Capabilities: Infrastructure and Equipment

‘Area A’ of Salman Pak was bombed during the 1991 Gulf war and several buildings were heavily damaged. In addition, Iraq destroyed some additional buildings in a post-

² Biological CAFCD December, 2002 Chapter 3.2.1

³ Biological CAFCD December, 2002 Chapter 3.2.1

⁴ Biological CAFCD December, 2002 Chapter 3.2.1

⁵ UNSCOM 7/BW 1, August 1991

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war reconstruction campaign in June 1991 in the course of the unilateral destruction of elements of the past BW programme.⁶

When the first UN biological inspection team arrived at Salman Pak in August 1991, most physical evidence of the past BW activities at that location was destroyed. No biological activities could be conducted in 'Area A' of Salman Pak after 1991. This was confirmed by later UN inspections.⁷ Most of the information obtained with regard to the BW work at Salman Pak was based on information provided by Iraq and on interviews and documentation obtained during the inspection process, due to building damage, little physical evidence could be gathered on-site to support and verify this information, except the presence of the bunker and the animal facility as there was no extensive damage to these structures.

Figure V.VI.II provides an overview of 'Area A' at Salman Pak prior to the 1991 war. This diagram was annexed to the report of the first biological inspection⁸, but it does not represent the layout of the site at the time of that inspection in August 1991. Most likely, this diagram was based on aerial imagery obtained prior to the war. It shows all buildings and structures before their destruction in 1991. The main forensic laboratory building (No. 30) and most structures around it were destroyed during 1991 bombardment.

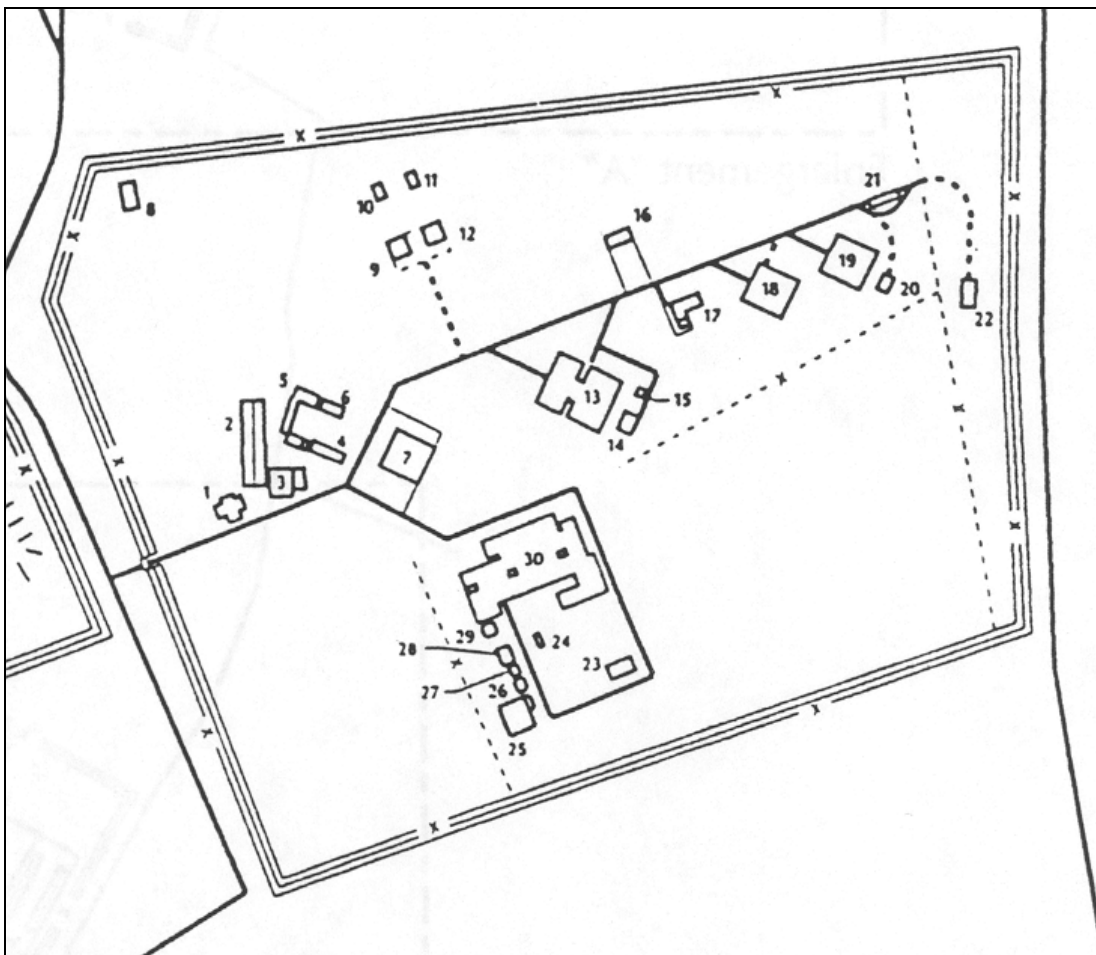
⁶ Biological CAFCD December, 2002 Chapter 3.2.1

⁷ UNSCOM 53/BW 3, March 1993 or UNSCOM 72/BW 4, April 1994

⁸ UNSCOM 7/BW 1, August 1991

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Figure V.VI.II: Salman Pak, Area A including the Forensic laboratories, layout before bombardment destruction in 1991. This diagram and the description below are from the Annex of the report of the first UN biological inspection in August 1991.



- | | | | |
|--------|--|--------|--|
| 1 | Guard House | 14, 15 | Destroyed structures which provided air scrubbing to laboratory fume hood exhaust. |
| 2 | Warehouse | 16 | Maintenance building |
| 3 | Guard Rest Station | 17 | Cold storage facility |
| 4-6 | Bus/Car parks | 18 | Chemical Storage building, destroyed |
| 7 | Administrative building with classrooms and security system to monitor 13, 18 and 19. | 19 | Ordinary Storage Building (e.g. glassware, nutrient broth) |
| 8 | Guard Rest Station | 20 | A small concrete structure of unknown purpose. |
| 9, 12 | Laboratory buildings with fume hoods and lab tables: according to Iraq used for CS | 21 | Gas cylinder storage |
| 10, 11 | Small vans with exhaust fan, rubber floor. | 22 | Guard rest station with guard tower |
| 10 | Used for storage of wheat smut infected spikes. | 23 | Site of the removed incinerator |
| 13 | Chemical laboratory, destroyed. According to Iraq, it was used for pesticide research. BW 1 found several fume hoods, a freeze dryer, GC-MS and NMR in the rubble. | 24 | Site of removed small structure |
| | | 25 | Site of removed fermenter building. |
| | | 26-29 | Sites of removed small buildings |
| | | 30 | Main forensic laboratory building |

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Bacterial research laboratories

Work on three bacterial agents (*B. anthracis*, *C. botulinum*, *C. perfringens*) and simulants was conducted in the main forensic research building (No. 30). This was a high standard concrete building with a reinforced concrete roof. It consisted of a single story containing animal rooms, laboratories and some administrative areas.⁹

Figure V.VI.III shows a diagram presented by Iraq to the first biological inspection team in 1991¹⁰, outlining the different rooms within the main forensic laboratory building and adjacent structures. According to the inspection team, this diagram was not entirely correct but conformed more or less with the layout of the building as observed during the inspection process. With the exception of two small areas the building was destroyed at that time. The exact size, layout and type of the structures adjacent to building No. 30 could not be verified by the inspection team, because all traces of these buildings above ground had been removed and covered with soil before the team arrived.

According to Iraq's declaration, in the main forensic laboratory building, at least six rooms were used for the BW work. Three rooms (No. 7, 8, 10 in Figure V.VI.III) at the rear were used for the three bacterial agents of the BW programme (*Bacillus anthracis*, *Clostridium botulinum*, *Clostridium perfringens*), and Room No. 9 was used for washing and decontamination. Also the CAFCD stated that they were equipped with basic laboratory instruments (see Table V.VI.I).

Table V.VI.I. Equipment in rooms utilized by the BW group

Room	Equipment	
No. 7, 8, 10	4 anaerobic incubators	1 laminar flow cabinet
	1 anaerobic incubator cabinet	1 hood
	1 orbital shaker	2 freeze dryers
	1 water bath	1 fraction collector
	1 cooling incubator	1 microscope
	Standard laboratory equipment such as freezers, refrigerators, pH-meters, ovens, and balances	
No. 9	2 autoclaves	2 water distillers
	2 ovens	1 balance

⁹ Information provided by Iraq to UNSCOM 7/BW 1, August 1991

¹⁰ UNSCOM 7/BW 1, August 1991

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Figure V.VI.III: Plan of the main forensic laboratory building (building number 30) at Salman Pak. This diagram was provided by Iraq to the first biological inspection team in 1991. Room numbers were also reported by Iraq in its 2002 CAFCD.

Room 6: Isolation room for lab animals for biological research

Room 7: *Clostridium perfringens* lab

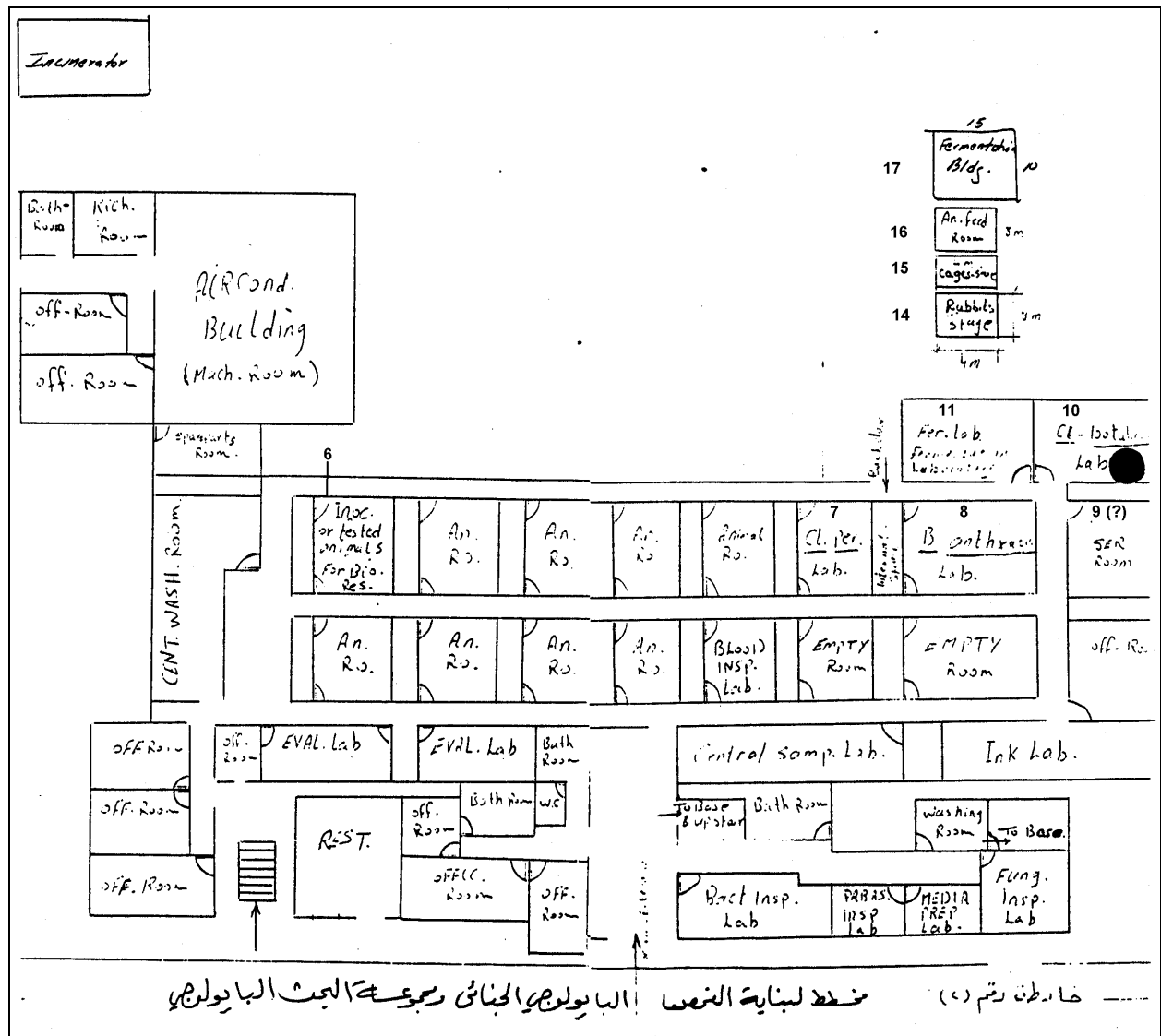
Room 8: *Bacillus anthracis* lab

Room 9: Washing room

Room 10: *Clostridium botulinum* lab

Room 11: Small scale fermenters

Other buildings that were used included rabbit yard, animal cage storage, animal feed storage, and 150 litre fermenter building.



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Laboratory fermenters

In one adjacent room (room no. 11, Figure V.VI.III), several small-scale fermenters were installed, together with the necessary supply systems including electric steam generator, water cooler, and an air compressor. The total number of small-scale fermenters remains unclear. The CAFCD mentions at one time the use of three 14 litre fermenters for the production of bacterial agents, while later it refers to “7,14L fermenters”. It is also possible that meant two fermenters, one of seven and the other of 14 litre capacity. An internal TRC memo from 1988 indicates that fermenters of both sizes, seven litres and 14 litres, were available at Salman Pak.¹¹ According to one letter of credit, three laboratory fermenter units were delivered to Muthanna in 1986, together with six 7 litre vessels and six 14 litre vessels for these units.¹² It seems likely that these fermenters were transferred to Salman Pak with the BW group in 1987. Additional fermenters of this size were delivered to Taji, but according to Iraqi declarations these were transferred to Al Hakam, so it is unlikely that they ever were available at Salman Pak.

Mycotoxin research laboratories

Iraq declared that some laboratories at Salman Pak were used for mycotoxin research, development and production, but the exact location and size of these laboratories are not indicated in the CAFCD. Iraq stated that three rooms in the main forensic building were used for fungal research; the floor plan in Figure V.VI.III was marked with one room for fungal inspection laboratory and two empty rooms opposite to rooms 7 and 8. These two empty rooms may have been used for fungal research. The three laboratories were equipped, according to the CAFCD, with an autoclave, three incubators, an oven, a microscope, a balance and refrigerators. No sizes or capacities of any of these items are specified in the CAFCD.

In addition, one laboratory outside the main forensic building was used for aflatoxin extraction, building No. 9 (Figure V.VI.II). Iraq declared that building 9 contained the following equipment: five incubators, two balances, two refrigerators, one microscope, one UV cabinet, one autoclave, two hoods, two rotary evaporators, and one oven.

Fermenter building

According to the CAFCD, in 1988 Iraq built a new building (No. 25 Figure V.VI.II) labelled fermentation building to house the 150 litre fermenter that was transferred to Salman Pak from Muthanna. It was used from late 1988 to train staff on fermenter operation and later for the production of BW agents as well as bacterial simulants. The fermenter was installed in a 45m² hall; other rooms in the building included two offices, a laboratory equipped with a shaker incubator and a microscope, and an adjacent shed for utilities such as a steam generator, air compressor and a cooling system.¹³ The fermenter

¹¹ TRC plan for the year 1988, internal memo to the Biological Research Committee

¹² Letter of Credit No. 85/3/1260

¹³ Biological CAFCD December, 2002 Chapter 3.1

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building was destroyed during the 1991 war and completely demolished by Iraq thereafter.¹⁴

Animal facilities

Small and large animals were used for toxicity tests during the BW work. Within the main forensic building, one room (room No. 6, Figure V.VI.III) was used to keep animals during experiments. The animal house was behind the main building (Figure V.VI.III), and was used to store cages and animal feed. Building No 16 was used for the isolation of animals during experiments. It had two rooms, with an opportunity to observe animals in one room from the other during experiments. It was equipped with a window-type air-conditioning system. Much of this building was destroyed by Iraq in June 1991 in the course of the unilateral destruction of the past BW programme¹⁵ but wall structures and other rooms were still intact. Animals used in experiments were burnt in an incinerator located on site (upper left hand corner of Fig. V.VI.III.). In an underground annex of the main forensic laboratory building, the first biological inspection team in 1991 found extensive unassembled large animal cages.

Inhalation chamber

According to the CAFCD, in 1982 Iraq constructed a building for an inhalation chamber at Salman Pak. This was used in 1988 for animal inhalation experiments. The room containing the inhalation chamber had a rooftop ventilation system equipped with filters. The CAFCD does not specify the type of these filters.

According to testimony given to UNSCOM¹⁶ in 1995, the inhalation chamber building was located 2 km south of 'Area A', in the eastern part of the Salman peninsula (Figure V.VI.I), but no physical evidence of its existence remained for UN inspectors to be able to verify this account because the building was destroyed during the 1991 war. During the first biological inspection in 1991, Iraq offered at least three different sites for the location of the inhalation chamber. On the final day of the inspection, inspectors were led to the site indicated in Figure V.VI.I, south of 'Area A'. No remains of any building were visible, and the area had been bulldozed flat only a few days prior to the inspection. There was no evidence of any piped water or sewer. Hence it remains unclear whether or not this was the actual site of the inhalation chamber building.

¹⁴ Biological CAFCD December, 2002 Chapter 3.2.2

¹⁵ Biological CAFCD December, 2002 Chapter 3.2.1

¹⁶ UNSCOM 126/BW 28, September – October 1995

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Figure V.VI.IV Destroyed Inhalation Chamber



The inhalation chamber, which had been imported in 1983 from a Western supplier, had a capacity of 3m³ according to a manual provided to the first biological inspection team. The team was led to a garbage dump where the heavily damaged chamber was found (Figure V.VI.IV).

Equipment transferred to Al Hakam under UN supervision -1996

Iraq transferred, under UN supervision, some biological equipment for destruction to the Al Hakam site in June-July of 1996. The equipment was claimed to have been located at Salman Pak in the 1980s. Allegedly, these items were sold by TRC to a local dealer in 1991 and were returned from the dealer in March 1996. According to Iraq, these items had two different origins:

Some pieces of equipment belonged to the Al Hazen Ibn Al Haitham Institute and were stored at Salman in the 1980s. They were never unpacked or used¹⁷ by the BW group who worked at Salman Pak from 1987 to 1990. These items included large animal cages, ovens, UV sterilizers, a double-ended autoclave, a small tabletop centrifuge and a freezer.

The other equipment obtained and used by the BW group in Salman Pak included: six Anderson samplers, five aerosol-generating devices, and a tank used in the aerosol generation, all of which were part of Dr Zubaidy's work on an aerosol generating device.¹⁸

BW research, development and production activities

According to Iraq, some of the experiments that were conducted by the BW group in Muthanna were repeated at Salman Pak after the transfer of the group there in 1987. In addition, pathogenicity studies and scaling-up experiments using small-scale fermenters were conducted, and in early 1988 *Clostridium perfringens* were added to the BW

¹⁷ UNSCOM 151/BW 37 June 1996

¹⁸ UNSCOM 151/BW 37 June 1996

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programme.¹⁹ In 1991, Iraq described to UN inspectors' details of its military-related biological research work that were subsequently included in Iraq's formal declarations. Experiments and production efforts as declared by Iraq in its FFCDs and CAFCD are listed below.

R & D and production work at Salman Pak

- ***Clostridium botulinum***: Research, development and small-scale production of botulinum toxin continued at Salman Pak until September 1990, when it was transferred to Al Hakam. The following experiments are described in the CAFCD:
 - Toxin precipitation effectiveness and confirmation in animal tests (mice);
 - Determining optimum toxin production conditions in 14 litre fermenters, using different growth media;
 - Inhalation toxicity studies with 12 guinea pigs and one monkey, using the inhalation chamber;
 - Ingestion (feed and water) toxicity studies with four donkeys and two dogs;
 - Intramuscular injection toxicity study with one donkey;
 - Effect of storage conditions on toxin activity over one year at different temperatures and with different media, using mice for toxicity testing;
 - Determining optimum storage conditions for bacterial seed stock, using also lyophilization;
 - Effects of preservative agents on toxin;
 - Determining optimum spore production conditions, with a view of using *Clostridium botulinum* spores as an infectious BW agent (as opposed to the isolated toxin);
 - Spore pathogenicity in injection, inhalation and ingestion experiments, using mice and guinea pigs.
- ***Bacillus anthracis***: Research and development was conducted at Salman Pak from mid-1987 until July 1989, when it was transferred to Al Hakam.
 - Media selection for optimum growth and sporulation;
 - Antibiotic sensitivity of different isolates;
 - Growth curve determination for different isolates;
 - Selecting chemicals for spore precipitation;
 - Injection pathogenicity tests with mice, guinea pigs, rabbits, dogs and sheep to determine the most virulent strain and lethal doses;
 - Inhalation test with lyophilized spores on two sheep, using a wooden box;
 - Effect of skin irritants on spore penetration, using guinea pigs;
 - Determining optimum storage conditions for spore suspension over one year.
 - Scaling up production to 14 litre laboratory fermenter and 150 litre fermenter;
 - Production: 15-16 production runs with the 150 litre fermenters produced 150 litres of 10 times concentrated anthrax suspension. This information was provided orally to UNSCOM²⁰.

¹⁹ Biological CAFCD December, 2002 Chapter 3.3.3

²⁰ UNSCOM 125/BW 27, August 1995

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- ***Clostridium perfringens***: Work on this agent was conducted at Salman Pak from April 1988 to March 1989, although some experiments were obviously conducted for a longer time at Salman Pak²¹.
 - Isolation of *Clostridium perfringens* from a variety of sources;
 - Antibiotic sensitivity tests for different isolates;
 - Growth curve determination;
 - Injection pathogenicity of different isolates using mice and guinea pigs;
 - Media selection for optimum sporulation;
 - Selecting chemicals for spore precipitation;
 - Pathogenicity test on deep wounds using guinea pigs;
 - Effect of skin irritants on spore penetration, using guinea pigs;
 - Inhalation pathogenicity using the inhalation chamber, with guinea pigs;
 - Determining optimum storage conditions for spore suspension and lyophilised spores;
 - Scaling up production to 14 litre laboratory fermenter. This work was not successful, and it required expensive media. Therefore, according to the CAFCD, the scaling up of *Clostridium perfringens* production was stopped.
- **Bacterial simulants**: Some 300 litres of unconcentrated *Bacillus subtilis* suspension were produced for field experiments using 14 litre fermenters in 1988. In January and February 1989, 150 litres of ten times concentrated *Bacillus subtilis* suspension were produced using the 150 litre fermenter. According to testimony given to UNSCOM²², also 50 litres of ten times concentrated *Bacillus megaterium* and 20 litres of ten times concentrated *Bacillus thuringiensis* were produced using the 150 litre fermenter at Salman Pak. This, however, is not mentioned in the CAFCD.
- **Wheat cover smut**: This project started at Salman Pak at the end of 1984, more than two years before the BW group from Muthanna was transferred to Salman Pak. One of its objectives was to investigate the possible use of wheat cover smut as an economic weapon.
 - For two years, an area of 100 m² was planted with wheat seedlings and a variety of different infestation methods were tested.
 - In 1987, a large-scale field test at a site near Mosul belonging to TRC was conducted. Five hectare of land were planted with wheat and infested with wheat cover smut using two different methods. The experiment was successful in that one method caused an infection of 80% of the spikes. The spikes were harvested, but no isolation of fungal spores was done and the spikes were later burned in April or May 1991 in Al Fudaliyah.
 - The CAFCD also mentions one static test with a 122mm warhead filled with one-two kg of infested grains, without being entirely clear as to whether this field test did indeed happen.

²¹ Chapter 3.2.1 of the Biological CAFCD indicates that work on *C. perfringens* was transferred to Al Hakam in March 1989, while one experiment mentioned in Chapter 3.3.8 of the Biological CAFCD is described to have run until June 1990 at Salman Pak.

²² UNSCOM 125/BW 27, August 1995

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- **Mycotoxins:** Initial work on mycotoxins focussed on T-2 trichothecene mycotoxins (associated with the “yellow rain” incidents in south-east Asia). Iraq stated that following the departure of the leading scientist working on T-2, a specialist was transferred from the Ministry of Agriculture to Salman Pak in May 1988 to continue research on fungal toxins. The research on T-2 mycotoxins extracted from *Fusarium* species included some toxicity tests on laboratory animals, but not more than 20ml of toxin was produced before the project was abandoned in September 1990. The research then focused on aflatoxin extracted from a species of *Aspergillus*. The production of fungal toxins was transferred to Fudaliyah in September 1990. The following research projects were conducted:
 - Isolation of *Aspergillus* specimen from infested plants around Baghdad and cultivation on rice medium in conical flasks. In mid-1989, about one litre of concentrated toxin extract had been prepared.
 - Injection and inhalation toxicity tests with guinea pigs and rabbits;
 - Optimisation of extraction process and storage conditions, evaluation of influence of environmental parameters on aflatoxin toxicity;
 - Field test with 122mm rockets in 1989 and 1990.
 - Evaluation of the effect of mixing aflatoxin with chemical agents (CN, CS, mustard) with the aim to “impede the detection of mycotoxin in field”.²³ These mixtures were also tested in inhalation tests with guinea pigs in the inhalation chamber.
 - Production: The CAFCD states²⁴ that a total of 65 litres of aflatoxin in solvent was produced at Salman Pak until July 1990. UNSCOM²⁵ reported that, according to statements by the Iraqi scientist who was head of the mycotoxin project, a total of 300 – 400 litres of aflatoxin in solvent were produced at Salman Pak.
- **Ricin:** Experiments with ricin started in 1989 at Salman Pak and went on for one year:
 - Ricin extraction from castor beans;
 - Toxicity tests (injection and ingestion) on mice and rats;
 - Heat stability testing;
 - Production: About 10 litres of “crude ricin” liquid extract were produced at Salman Pak. According to Iraqi testimony given to UN inspectors²⁶, this contained about 270 grams of ricin, extracted from 100 kg of castor beans. According to Iraqi declarations and statements to UN inspectors²⁷, the 10 litres were used in a static test with four 155mm artillery shells, which were unsuccessful and led to an abandonment of the ricin work.
- **Genetic engineering:** In March 1990, a researcher was hired by TRC to initiate genetic engineering research for the BW programme. But according to the CAFCD, the researcher never actually started any work prior to the 1991 war, because first it took some time to get the security approvals, and then to establish a suitable

²³ Biological CAFCD December, 2002 Chapter 3.3.5 (iii)

²⁴ Biological CAFCD December, 2002 Chapter 12.2.6

²⁵ UNSCOM 127/BW29, December 1995

²⁶ UNSCOM 125/BW 27, August 1995

²⁷ UNSCOM 125/BW 27, August 1995

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laboratory and procure appropriate equipment. The researcher was transferred to Al Hakam in September 1990, and finally, in November 1990 to Al Fudaliyah. At none of the sites did the researcher have the appropriate equipment and was thus still in a preparatory phase when the war started in January 1991. After the war, the researcher was then transferred to the University of Baghdad.²⁸

This Iraqi account of limited genetic engineering activities that never went beyond a declaration of intent is backed by original Iraqi documents supplied to UN inspectors. The 1990 Secret Annual Report of the Iraqi BW division, which is considered by UNMOVIC to be a reliable source, stated that the Genetic Engineering Unit was founded in March 1990 and did nothing more than “preparing the materials and equipment and making a survey of the scientific periodicals”.

- **Weaponization:** Many of the BW agents that were produced at Salman Pak were also filled into weapons at Salman Pak for field trials. According to testimony given to UNSCOM²⁹, at least the following weapons were filled at Salman:

Agent	Munition Type	Quantity (capacity)	Experiment Location
<i>C. botulinum</i>	LD-250 aerial bombs	4 x 60 litres	Al-Muhammadiyah
<i>B. subtilis</i>	LD-250 aerial bombs	4 x 60 litres	Al-Muhammadiyah
Ricin	155mm Artillery Shells	4 x 2.5 litres	Jerf Al Sakhar Firing Range
Aflatoxin	Sakr-18 122mm rockets	31 x 8 litres	Al-Muhammadiyah

The Zubaidy device

From 1987 until August 1988, Iraq conducted at Salman Pak research, development and tests on a series of devices for the dissemination of BW agent stimulant by aerosol. The lead researcher was Dr. Zubaidy, assisted by several TRC engineers. According to the CAFCD, the following experiments were conducted using the stimulant *Bacillus subtilis* suspension: tests with nebulizers mounted at different heights (1 to 3 metres) and field tests with a helicopter conducted at Khan Bani Saad.

The CAFCD stated that all the results of field tests were inconclusive; the project was therefore abandoned and that this work had no relationship to the fuel drop tank experiments that were commenced in late 1990.

²⁸ UNSCOM 125/BW 27, August 1995

²⁹ UNSCOM 125/BW 27, August 1995 and UNSCOM 126/BW 28, September – October 1995

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Comment

Facilities on the Salman Peninsula

The purpose and the history of different facilities at Salman Pak that were not directly related to weapons of mass destruction were not investigated in great detail by UN inspectors. It is intended here to analyse the past BW work at Salman Pak excluding other activities conducted on the Salman Peninsula that were not related to weapons of mass destruction.

There appears to be some inconsistencies between what Iraq has declared with regard to both the construction and other activities that occurred at this site. For food and water contamination analysis it is unlikely that an inhalation-testing chamber would be required or that such standards for the building specifications were necessary.

Storage

The first biological inspection team concluded that a large cold storage facility (Building No. 17 of 'Area A'- see Figure V.VI.II) was not intended to hold chemicals, as declared by Iraq, but most likely to store biological material. This judgement was based on a variety of indicators such as; the lack of any specific building features typical for chemical storage, such as spark proof lights, or chemical resistant floor and wall covering. It was judged that this store could be used to store tonnes of biological material.

Wheat Cover Smut

Iraq found that wheat smut was an ineffective economic weapon and stated that the project was terminated in 1989. It is unclear why the contaminated wheat spikes were stored until their destruction in 1991.

Iraq acknowledged that wheat smut was being considered as a biological agent before the resurrected BW programme began at Muthanna in 1985. This implies that the Forensic section of the STRC was engaged in research other than that for food safety and regime protection. Being under the umbrella of the intelligence and security apparatus, it seems more likely that some research was conducted on behalf of the intelligence services (so called "dirty tricks" activities).

Examination of Iraq's declarations, other documentation and interview testimony sheds little light on which higher authority was responsible for the decision to conduct research into the use of wheat smut. However, Iraq did declare this activity and referred to it as their first attempt to produce a biological agent.

Research and Development

The CAFCD account of the research and development projects at Salman Pak is supported by a variety of documents provided to UN inspectors. These include the TRC research plan for the year 1988, an internal memo to the Biological Research Committee

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that outlines several of the experiments on the three bacterial BW agents as well as mentioning the 7 litre, 14 litre and 150 litre fermenters. The research plan indicates basic activities, and it refers to a general plan and annual plans for 1986 and 1987. It appears that work on botulinum toxin was further ahead than anthrax and this is not surprising given some work on Botulinum toxin at the Al Hazen Institute and work with Clostridial species conducted by Professor Hindawi. Also, the 'Secret Annual Report of the Biological Research Department for the period 1988 until 31 December 1988', coordinated by Dr. Taha, outlined experiments and achievements on bacterial agents and mycotoxins, with reference to the conclusion of the wheat cover smut project.

Moreover, a variety of Iraqi research papers support the CAFCD account regarding R & D on the three bacterial agents. Initially, ten of these papers had been provided by Iraq to the first UN biological inspection team in August 1991. Subsequently, more comprehensive versions of these papers were provided by Iraq amongst the Haidar Farm documents in the summer of 1995.

A photo album was among the Haidar Farm documents contained a series of photographs showing laboratory scale fermenters, results of animal tests on nearly all types of animals mentioned above, a vial collection representing storage condition tests, and a selection of agar plates representing a field trial with botulinum toxin. While this album does not attribute all of these pictures to Salman Pak, it supports the nature of the experiments listed in the CAFCD.

Iraqi declarations lacked details regarding the planning and management of the programme. However, interviews and document searches conducted by UN inspectors could not find evidence that Iraq's BW programme researched any additional BW agents than those declared. Iraq did import a number of isolates for its BW programme. Apart from one isolate, all other unused isolates (not declared as part of the BW programme) were returned unopened to the first BW inspection team to visit Iraq in August 1991. UNMOVIC has no evidence to suggest that the R & D programme was larger or more sophisticated than declared by Iraq.

Mycotoxin research: Trichothecenes and aflatoxin

UNMOVIC concludes that the development of the trichothecene research programme did not progress much beyond the research and laboratory stage. The 1990 Al Hakam Division's Annual Report, which refers to two minor research studies in 1990 and did not mention any production of trichothecene mycotoxins, lends some support to this conclusion. UNMOVIC assesses that the quantity of trichothecene mycotoxins produced was probably quite small and militarily insignificant.

Aflatoxin can have a carcinogenic effect after long-term oral or pulmonary exposure. It has been documented that there is an increased risk of lung and liver cancer among humans continuously exposed to low levels of aflatoxin in grain dust. It is also known from scientific literature that high concentrations of aflatoxin can cause acute toxic effects in animals both through oral and inhalation routes. The toxicity is, however, low

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in comparison to many other plant and animal toxins.

The assertion that aflatoxin was one of the agents investigated in Iraq's BW programme is supported by video tapes of field trials found in the Haidar Farm cache, as well as documents and information provided by Iraq. There is little doubt that, as Iraq declared, aflatoxin was designated as agent C for the purpose of research, development and production.

There is no evidence that Iraq continued to produce aflatoxin or any other fungal agent after 1991. However, small quantities of aflatoxin have been declared by Iraq as being used for civilian purposes (in its 2003 semi-annual monitoring declarations) at a number of universities and as a standard at agricultural laboratories.

The most puzzling part of Iraq's account of Agent C is the rationale for the agent: why did Iraq devote military, financial and human resources to an agent that had such a low toxicity compared to other biological warfare agents available to it? The choice of aflatoxin as a BW agent is unconventional, since the immediate toxicity is not very high and its negative health effect is mainly long term. It can only be speculated as to why Iraq chose to produce and weaponize large amounts of aflatoxin. There may be an explanation, in the personal ambition and expertise with aflatoxin of the leading scientist who worked on the agent to achieve results, even if ultimately a less than optimal weapon was produced.

Work with C. perfringens

Iraq may have understated the extent of its work on Clostridium perfringens (called agent G by Iraq). This agent was of concern to Iraq following infections among its armed forces in border areas near Iran. Iraq has stated that it initially had concerns that these infections were the deliberate result of actions by Iran. Once isolated, the Clostridial species were identified and found to be the same as the local species. Iraq then concluded that the injuries were likely to be the result of natural wound infections. However this may have given impetus to the inclusion of this agent for further studies and the research plan for 1985 described studies of C. perfringens. Thus, there had been an interest for developing this bacterium into a BW agent already at the re-start of the BW programme at MSE.

Iraq's research work on C. perfringens included tests on the effects of the agent as a contaminant of wounds and also the effects of inhaling the spores. Iraq concluded that both routes were effective, suggesting that Iraq may have envisaged the concept of use to be in devices such as fragmentation weapons as well as those producing an aerosol hazard.

A document from the Haidar Farm cache outlined Iraq's BW work plan for 1988. The document referred to Iraq in 1988 being ready to start studies of production of agent G as submitted in a previous general plan. Although the plan is undated, UNMOVIC assesses that it was submitted towards the end of 1987. A reference in the document to a "previous general plan" suggests that basic research could have commenced earlier;

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perhaps even in 1986, since the acquisition of strains of C. perfringens was in 1986. A register of bacterial strains dated July 1986 and signed by Dr. Taha indicates that several isolates of C. perfringens had already been obtained from infected individuals at that time. Hence the work on this agent that started according to the CAFCD at Salman Pak in April 1988 was preceded by sample collection and isolate acquisition at least two years earlier.

According to Iraq, the scaling up of the production of C. perfringens was stopped due to unsuccessful attempts and the need for expensive media. This was strongly questioned by UNSCOM and again by UNMOVIC. Some of the minor components that Iraq stated were not available and expensive to import are actually commonly available amino acids. For research purposes, only gram quantities would have been required. The cost of these would have been insignificant in the context of the whole research programme and especially compared with the 1.5 tonnes of peptone imported in 1988, which, according to Iraq, was solely for the production of agent G.

Documents from the Haidar Farm and in particular, Iraq's 1988 annual report for the Biological Research Department, stated that work had started on the production of agent G from local and imported isolates: this confirms that local isolates as well as imported strains were used. The 1988 annual report also refers to research for optimum production parameters indicating research was continuing and perhaps some small-scale production had taken place.

Ricin research and development

Ricin is a highly toxic substance and has been used as an agent in assassinations. It is listed in the Chemical Weapons Convention and was considered for inclusion in the draft Biological Weapons Convention protocol. Ricin can readily be extracted from castor beans using basic equipment. Castor bean trees grow in abundance in Iraq, and indeed, there is an industry in the country for processing the beans to extract castor oil for a variety of civilian purposes. The mash remaining from this process is rich in ricin. UNSCOM monitored and placed sensors so that the ricin in the mash was fully inactivated.

Iraq's ricin research was not initiated within the BW programme, but rather from a suggestion of an individual in the Internal Security Service. The work on ricin was conducted by a separate group at Salman Pak, and was not known to the lead researcher of the BW group according to her testimony. The ricin work was performed within the chemical group. Progress on ricin work was found among the chemical weapons papers from the Haidar Farm. Extraction and toxicity studies were done at Muthanna.

It is possible that the ricin toxin was intended as a special operations weapon, and that the intelligence and security apparatus, which controlled the TRC and the Salman Pak site, had their own research programme. Ricin toxin may have only later become of interest for possible military applications.

UN inspectors recovered several documents relating to the ricin project in April 1997.

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Information in these documents contradicts Iraq's account both in regard to the starting date of the project and to quantities of agent produced. Iraq stated that a single static field test was conducted in November 1990, it was considered to be a failure and that the project was abandoned. Apart from this static test using 155 mm artillery shells, there is no evidence to suggest that Iraq weaponized ricin for military purposes.

The Zubaidy device

After initial experiments using small nebulizers, Dr. Zubaidy started to work with spray generators used with aircraft to spray pesticides (crop dusters). In order to decrease the particle size generated by these sprayers, he intended to cover the outlet with a fine mesh of sufficiently small pore size. While efforts to manufacture this material failed, it was later imported from a Western supplier.

To test the effectiveness of the device and the resulting droplet size, Iraq imported six cascade impactors, so called Andersen samplers. In two tests, a simulant was sprayed from a helicopter and the droplet size assessed using the Andersen samplers. The assessment team submitted a positive evaluation report that was part of the Haider farm document, concluding that "the modified apparatus is useful for use as an aerosol for spraying fluids containing micro organisms and their products (bacteria, fungi and their toxins)", contradicting the CAFCD account that the results of the experiments were inconclusive.

UN inspectors noted that a second, parallel development of aerosol generators took place at Salman Pak. Several letters exchanged with a Western supplier indicated that another, smaller system with different specification was also sought. Most notably, this system was supposed to be vibration free, suggesting that this might indicate an intended use with rather other than with helicopters.

Genetic Engineering

Although in the lead up to the Gulf war, Iraq's BW programme was focused on the production of bulk agents and weaponisation, some attention was given to diversifying the BW programme and making it more robust, as evidenced by the establishment of a genetic engineering programme with one scientist. Although the programme was short-lived and achieved nothing, it demonstrates an intent and commitment to a more diversified and dynamic BW programme.

It is clear from statements by senior Iraqi officials, such as Dr. Taha and Lieutenant General Amer al Sa'adi, that the potential for genetic engineering for BW purposes was well understood. There is documentary evidence and testimony supporting the existence of three separate plans to establish genetic engineering units in Iraq in 1990: the TRC unit, the MSE unit, and a third unit at the FMDV plant at Al Dora. The 1990 Al Hakam Annual report provided by Iraq supports its declaration with regard to the starting date of the TRC unit and that minor progress had been made at the unit by the end of 1990.

Iraq's BW genetic engineering programme was in the embryonic stages of development in 1991 when the scientist involved was transferred to Baghdad University.

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Iraq's declarations of activities

It appears that, prior to the first biological UN inspection in 1991, Iraq made two decisions: (1) to destroy or remove all physical evidence of former BW activities at Salman Pak, and (2) to declare a limited research programme on BW agents at Salman Pak.

Prior to the inspection, Iraq denied in its declarations to UNSCOM any kind of BW related work, and this declaration was reversed on the first day of the first inspection, although at no time during this inspection Iraq ever acknowledged an offensive programme. In a statement to the first inspection team, Iraq left it open whether the military research work was for defensive and/or offensive purposes. During the first inspection, Iraq also handed over many bacterial isolates and 10 research papers on classic BW agents to the UN, and declared the presence of a 150 litre fermenter as well as a large inhalation chamber at Salman Pak, although no physical evidence at the site would have revealed their former presence. The main forensic building had been bombed during the 1991 Gulf War, indicating to Iraq that the coalition had at least some knowledge about militarily significant activities at the site.

Most noteworthy is Iraq's strategy to declare items that were imported – for example, isolates from culture collections, the fermenter, and inhalation chamber - and thus were known to the outside world. In addition, the presence of the 150 litre fermenter at Salman Pak was known to at least one expert from a foreign country who, according to the CAFCD, installed this fermenter in Salman Pak in September 1988.³⁰

³⁰ Biological CAFCD December, 2002 Chapter 3.4.2

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AL HAKAM 1988 TO 1991

Introductory overview

The Al Hakam Factory was built as a dedicated biological warfare agent production facility, which produced about a half a million litres of unconcentrated BW agents; was also involved to a small degree in agent development and to a larger degree in weaponisation.

The planning for a dedicated production facility for BW agents started at least in 1987, maybe even in 1986 not long after Iraq's declared restart of its biological weapons programme. According to Iraq, the selection of the site was formally approved on 24 March 1988 by General Hussein Kamel, the director of MIC and the date of approval led to the Al Hakam project being referred to as Project 324. General Hussein Kamel issued an order, which stipulated the construction of an independent site for biological activities, and the plan envisaged biological warfare agent research and development (R&D), and production and storage of agent.

Of the available MIC owned property, an area of approximately 3km by 6km near Latifiyah about 60kms southwest of Baghdad (Map V.VII.I) was selected by Dr. Taha and Professor Hindawi (and possibly others) as the most appropriate site. The location of the site met the required safety and security criteria, was distant from population centres yet was in proximity to a small petrochemical complex (PC-2) being constructed. Besides having roads and electric power connected to PC-2, this facility played a role as an alternative site for procurement activities for Al Hakam. Iraq modeled the layout of Al Hakam along the lines of its CW facility Al Muthanna. The total size of the site was large and was divided into four areas; the Northern area, the Southern Area, the R&D Area, and the Single Cell Protein Area each separated geographically by at least 1km. The site was enclosed by a two metre high chain-linked fence with three strands of barbed wire on top, and there were guard towers at each corner and at the midpoints of the sides.

Iraq stated that the plans were drafted by Professor Hindawi and two engineers, together with the Al Fao General Establishment, and at least in the later stages in consultation with the Consultative Bureau of the University of Technology, Baghdad. The fence around Al Hakam factory was installed in the period May to July 1988.

The construction of buildings started in the second half of 1988, and the various buildings were prioritized starting with the construction of some of the storage and support facilities. Subsequently, production buildings in the northern and southern areas, including the building for the 5m³ fermenters, were constructed in 1989. The name Al Hakam was given to the project following the completion of the building constructions in mid-1990.

In 1988, personnel from the biology group were sent overseas to get offers for fermenters and other production equipment. Iraq told foreign suppliers that the three 5m³ fermenters

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that it was seeking were to be used for single cell protein production. However, due to high prices only one fermenter was ordered, together with a required steam generator and an air compressor. After completing a contract for a 5m³ fermenter, however, an export license was not granted and it was not delivered: negotiations however, continued with another foreign company.

Iraq understood the importance of drying its BW agents to enhance their long-term storability and to reduce their bulk. Thus, the production of dried agent was a strategic objective from the earliest days of the BW programme. In April 1988, when Iraq was considering the large-scale production of BW agent, the need to acquire dryers for anthrax was highlighted in a memorandum from the head of bacteriology for the BW programme to higher authorities. Although a spray drier was transferred from Al Taji and installed at Al Hakam Factory in 1988, Iraq declared that this was not used because the system was not aseptic, the unsuitable pore size of the atomizer, inefficiency of the filter bags of the dryer and a lack of experience in drying techniques. Although two spray dryers were air-freighted into Baghdad in 1989, these had similar features to the Taji spray drier. Attempts to import aseptic spray driers failed and attempts at local manufacture were not successful.

During 1990, construction at Al Hakam included the following: a security perimeter road around the fence of the project, a parking area outside the site, storage buildings including two cold stores with access roads and decoy sites, six temporary underground shelters and a sand berm around the northern area. Also during 1990, numerous other constructions also occurred including a water network for agricultural purposes, water and sewage connections and fuel tanks were put in place. Buildings and tanks were painted with khaki colour for camouflage purposes.

Once completed, the buildings in the northern area, as well as the adjacent storage building, the cooled storage bunker at the southern site, and the animal house with an evaluation unit were immediately used for BW production, evaluation and storage of BW agents. The administration building, the service, transport and gas filling station, were also used during the programme.

Iraq declared that the fermentation and other equipment needed for production of biological warfare agent was transferred from the Veterinary Research Laboratories (VRL, later called Al Kindi) and Al Taji Single Cell Protein plant in 1988. Most of the other equipment was transferred in 1990, at which time many of the buildings planned for BW activities at Al Hakam Factory were completed. All types of equipment were transferred from other facilities, like equipment for infrastructure (air, water, steam, and sterilization), small-scale production equipment, and equipment for down-stream processing.

The number of employees at the Al Hakam Factory showed a steady annual increase, especially after 1991 and the obliteration of the BW programme. During the period 1988 to 1991, the number of employees increased from at least 25 to more than 60 people. The majority of the personnel employed or working at Al Hakam Factory were transferred

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from the Al Salman site. Several of the Al Hakam staff obtained their scientific training at the University of Baghdad and were then employed at MSE and/or Al Salman before being transferred to the Al Hakam Factory. The majority of the engineers recruited for Al Salman and Al Hakam Factory obtained their education and training at the University of Technology and the Institute of Technology.

At the start of production at Al Hakam Factory, at least 16 people had been earlier trained on fermenters, either at the Al Taji site or at VRL. Ten out of eleven people involved in the production at Al Taji worked on at Al Hakam Factory. At least eight people were also trained on the imported fermenter line in 1988 at VRL.

Little basic scientific work appears to have been undertaken at the Al Hakam Factory. The Annual Confidential Report for 1990 indicates that most of the activities seem to have been related to quality control of agents produced on an industrial scale at the site.

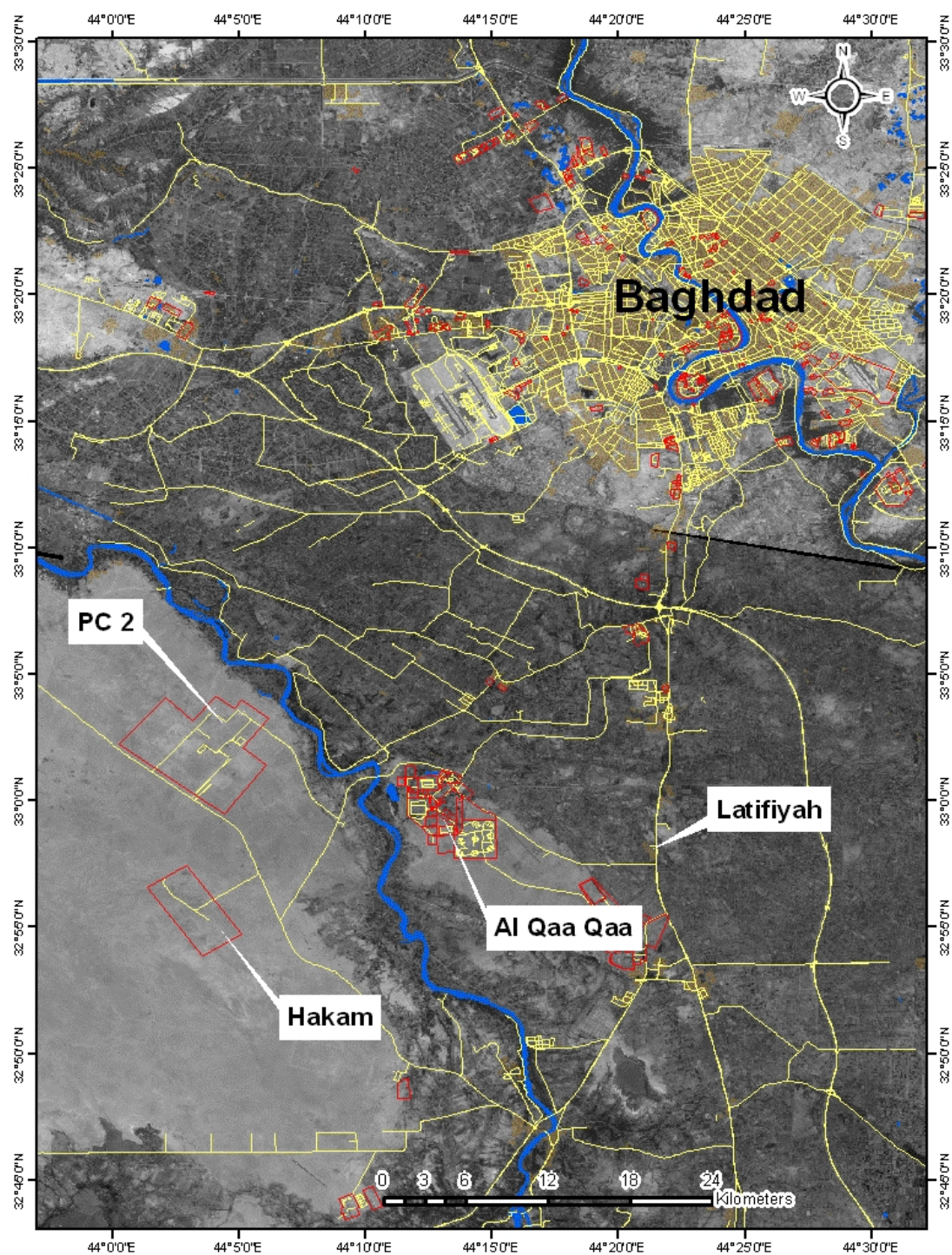
Iraq declared that the production of agent A (Botulinum toxin type A) at the Al Hakam Factory began in January 1989 and continued to August 1989, using the 450 litre fermenter transferred from Al Taji. Beginning in February 1989, and continuing to August 1990, the imported fermenter system from VRL was also used to produce botulinum toxin. The total volume of each batch was about 9m³, and the mean number of batches per month was two to three. In total, Iraq has declared the production of about 13,600 litres of 20 times concentrated toxin, collected in 5m³ storage tanks.

According to Iraq, the production of agent B (*Bacillus anthracis*) was more demanding than that for agent A and therefore production of B lagged that of A. Although pilot production of agent B spores started in March 1989 at the Al Salman site, it was not until the following year that Iraq started bulk production of anthrax. When the production group was transferred to the Al Hakam site, the 450 litre fermenter was used to produce 150 litres of spores concentrated 10 times during the period May 1990 until the end of June 1990. After August 1990, an order was issued to increase the production capacity of all biological warfare agents. Given that Iraq already had substantial quantities of botulinum toxin, the imported fermenter line was switched from producing agent A to producing agent B. The average production of concentrated product per month was 75 litres in June and July 1990, and 2,069 litres per month during August to December 1990. Iraq stated that in total about 8,425 litres of 10 times concentrated agent B spores in suspension was produced at Al Hakam Factory. The concentrated spores were stored in flasks of 20 litres capacity and mobile tanks of 1m³.

In addition to the two main biological warfare agents, Iraq also produced 340 litres of 10 times concentrated *Clostridium perfringens* (Agent G) spores between August and November 1990, around 550 litres of *Bacillus subtilis* and 50 litres of more than 10 times concentrated *Bacillus thuringiensis* at the Al Hakam Factory

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Map V.VII.I Location of Al Hakam



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Construction of Al Hakam, Dedicated BW Facility

Decision and Planning

Several elements may suggest that planning for a dedicated production site for BW agents started at least in 1987, maybe even in 1986. For a variety of reasons, Iraq had rejected expansion of the biological programme at Al Muthanna and probably concluded that expansion at either Al Taji or Salman Pak was inappropriate or impractical for operational, safety or security reasons. Iraq stated that the Al Salman site was not suitable to conduct production activities because it was too close to Baghdad and was valuable for other purposes.¹ The Al Taji site was not an option either because it belonged to the Ministry of Oil.²

Given the unsuitability of existing sites, authorization was given by General Hussein Kamel to select from MIC owned land a site to build a dedicated BW production complex. The MIC owned land from Ameriyah all the way to Mussajib, and had established many other facilities there. A working group led by Dr Taha and Professor Hindawi inspected this land and selected a site later known as Al Hakam, 60 km south west of Baghdad and adjacent to a missile firing range. This was authorized, or recommended for authorization, by General Ahmed Murtada. According to Iraq, General Hussein Kamel the Director of MIC, formally approved the selection of the site on 24 March 1988, (hence the name of Project 324 – March 24th) and actions were started to design and equip the facility.³

Between 1987 and 1991, TRC was managed by General Ahmad Murtada as the Director. He reported directly to General Hussein Kamel. According to Iraq's declarations Dr. Taha reported directly to the head of the TRC General Murtada even though administratively Dr. Taha's biological group was attached to the T-3 Forensic Division, headed at that time by Dr. Ali Mukhlif.⁴ From interview testimony Dr Ali Mukhlif stated that he regarded Dr. Taha's group as separate from his own and they operated independently.

According to Iraq's declarations, initially Dr. Rehab Taha was the project manager for the construction of the Al Hakam Project but because she believed that it would detract from other scientific duties and given some difficulties with the management, Dr. Ali Mukhlif became the Al Hakam Factory project manager from 1988 to 1990.

Construction and design work was undertaken by the Al Fao General Establishment, which interacted with Dr. Taha and Professor Hindawi on the priorities for buildings.

¹ Biological Technical Evaluation Meeting, Vienna, March 1998

² Biological Technical Evaluation Meeting, Vienna, March 1998

³ UNSCOM 125/BW 27, 22 - 31 August 1995

⁴ UNSCOM 7/BW 1, 2-8 August 1991

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Production of BW agents was the first priority since the research and development phase had been undertaken for some time.⁵

An engineer was recruited from the Al Fao General Establishment as the site engineer for the Al Hakam Factory. Foreign construction workers were used for some of the site facilities.⁶ Iraq declared that the plans were drafted by Professor Hindawi with two engineers, together with the Al Fao Construction Establishment, and at least in the later stages in consultation with the Consultative Bureau of the University of Technology, Baghdad. At Al Fao the project was referred to as Project 324, and at the University of Technology as Project 900.⁷

Apart from the construction workers, no other foreign personnel were declared to have visited or been involved in BW agent production at Al Hakam. The first foreign professionals to visit Al Hakam according to Iraq were UN inspectors in October 1991.⁸

Comment

Although Iraq declared that General Hussein Kamel issued an order on 24 March 1988 for the construction of Project 324, several elements suggest that planning of Al Hakam factory started at least in 1987, and perhaps even in 1986:

- 1. During an interview with Dr. Taha in 1998 she said that Professor Hindawi, when he officially joined Al Muthanna at the end of 1986, suggested the use of equipment at Al Taji.⁹ According to an interview with Professor Hindawi, the biology group already at Muthanna were considering large-scale production. A request to acquire the imported fermenters from Al Kindi was made in early 1987, before he and Dr. Taha visited foreign manufacturers of production equipment.¹⁰*
- 2. General Faiz Abdullah Shahine¹¹ has stated that he and General Hussein Kamel visited the Al Taji site in March 1987 to have a look at fermenters.¹² Maybe this visit was not only for the stated reason, but also to determine the possible use of the Al Taji site for large-scale production. At about the end of 1986 a report was submitted by Al Muthanna, reporting results achieved and with a proposal to affiliate the Al Taji fermenter to Al Muthanna. The proposal was made based upon future requirement of scaling-up of production. It was also noted that any further development would require extensive investments in production and test*

⁵ Biological Technical Evaluation Meeting, Vienna, March 1998

⁶ UNSCOM 113/BW 22, 23 Jan-3 February 1995

⁷ UNSCOM 113/BW 22, 23 Jan-3 February 1995

⁸ UNSCOM 113/BW 22, 23 Jan-3 February 1995

⁹ UNSCOM 253/BW 70, 28 November-9 December 1998

¹⁰ UNSCOM 169/BW 45, 9-20 January 1997

¹¹ General Faiz Abdullah Shahine was head of the T-3 Directorate only until 1985, then DG of Al Qaa Qaa from 1985 until 1987. He then headed Muthanna State Establishment.

¹² UNSCOM 253/BW 70, 28 November-9 December 1998

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facilities.

It seems most unlikely that two people of this extremely senior rank would visit a single cell protein facility to inspect or view equipment. In a document dated 17 August 1987 from TRC to Ministry of Oil, and with reference to a letter dated 1 August 1987 and a meeting held on 12 August 1987, a time schedule was given for moving equipment and materials of the petroleum protein project (SCP project at Al Taji site).¹³ However, the equipment was never moved, the production of botulinum toxin took place at the Al Taji site, which could indicate that the decision to build a new facility for large-scale production was already taken in mid 1987.

- 3. Towards the end of 1987 a report on the success of research work at the Al Salman site was submitted to the Director of MIC, General Hussein Kamel. This resulted in a decision to enter the production phase for biological agents.¹⁴*
- 4. Attempts to learn mean of dispersing the biological agents, in cooperation with the military, was one activity mentioned in the submitted plan for 1988 of the BW group.¹⁵ Iraq declared that, in early 1988, all types of munitions produced or imported by Iraq had been reviewed for their suitability for BW weapons tests.¹⁶ The planning for these activities must have occurred in 1987.*
- 5. There is information implying that Project 324¹⁷ was already running during 1987. In a logbook showing purchases made by TSMID, three entries occur for Project 324 in 1987.¹⁸ During that time the Al Taji SCP 450 litre fermenter was taken over by TRC and several items in need of repair on the fermenter and associated vessels occurred. Thus, it is possible that Project 324 actually started with the take over of Al Taji in mid-1987. This could mean that Project 324 actually had large-scale production of BW agents as it's goal of which Al Hakam Factory was only a part, although perhaps the major part. The decision taken the 24 March 1988 could have been the formal decision to start building the Al Hakam Factory at the chosen site, not a decision per se to build a dedicated BW production facility.*
- 6. In an interview Dr. Ali Mukhlif has stated that at the end of 1987 the Biological Research Division was to locate separately. The location was outside the Al Salman site. The first step was to determine location and putting in a plan for 2*

¹³. Biological FFCD March 1996, Chapter X doc.no. 177 (docu no. 700101.177)

¹⁴ UNSCOM 125/BW 27, 19 August - 4 September 1995

¹⁵ UNSCOM document no. 100103 (Plan for the year 1988, Technical Research Centre, Internal Memo)

¹⁶ Biological CAFCD, December 2002, Chapter 8, paragraph 8.1.

¹⁷ Confirmed by Dr. Taha as the designation for the entire Al Hakam area, and the name has been said to represent the decision date to construct it, 24 March 1988.(Biological CAFCD, Chapter 5, paragraph 5.1.)

¹⁸ These concerns procurement of spare parts from one foreign supplier (L/C 464/4/87, closed 5/1/88- glasses and spare parts), a second (date of issuance 14/10/87 and 15/11/87, L/C 488/4/87, closed 20/7/88), and a third supplier (date of issuance 31/10/87 and 8/12/87, L/C 587/4/87, closed 20/7/88).

¹⁹ UNSCOM 169/BW 45, 09 - 20 January 1997. Annex O

²⁰ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

²¹ UNSCOM 125/BW 27, 19 August - 4 September 1995

²² Biological Technical Evaluation Meeting, Vienna, March 1998. Statement by General Al Sa'adi

²³ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

²⁴ UNSCOM 53/BW 3, 11-15 March 1993

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major sheds.¹⁹ An instruction along these lines was issued to the Director General of TRC, General Ahmed Murtada, presumably late 1987 or early 1988.²⁰

The decision to build Al Hakam probably came from the Office of the President and through General Hussein Kamel as both head of MIC and head of the security and intelligence apparatus. The Al Hakam site was chosen from MIC-owned land and therefore would have had to be approved for allocation by General Hussein Kamel.

Since the biological group was absorbed into the TRC, and the TRC had become part of the MIC in 1987 under General Hussein Kamel's directorship, choosing a site from MIC owned property was a logical next step.

Several pieces of information lends support to the assumption that the Al Hakam Factory was initially planned to be the centrepiece of BW research and production, and that this was thought of already in the start of the project:

- In the initial drawings 1988 of the Al Hakam Factory three sub-areas (the Northern site, the Southern site, and the R&D, Administration and Maintenance area) were outlined. According to information regarding attempts to procure equipment in 1988, it is obvious that Iraq initially planned to build-up two separate production lines, one in the Northern area and one in the Southern area.*
- In the design phase of Al Hakam, there were plans for diversification including facilities to work on viruses and laboratory space for genetic engineering studies.²¹*
- The BW programme was not designed to just produce agents A and B, but was envisaged to develop further. That was the reason for including the R&D tract and the intention for the specific air handling system²², with dual air supply and dual air exhaust for buildings E (Animal House) and H (R&D Building), HEPA filtration of both input and output air, and creation of a negative pressure.²³ Furthermore, each of the laboratories in the R&D Building contained a primitive chemical shower.²⁴*

Concept of the facility

The order issued on 24 March 1988 stipulated the construction of an independent site for biological warfare agent production activities.²⁵ The plan envisaged agent R & D, production and storage of agent, but not weaponisation in the early stage.

The Al Hakam Factory Plant was a site southwest of Baghdad and distant to urban, rural, or industrial areas (Map V.VII.I). The site is at a desert location remote from population centers, but not too far from another site selected for an oil refinery thus providing the

²⁵ Biological CAFCD December 2002, Chapter 5, paragraph 5.1.

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necessary services. The Al Hakam site was deliberately made large (3km x 6 km) to safeguard against accidental contamination.²⁶

Iraq stated that it adopted the design philosophy from Muthanna State Establishment when constructing the Al Hakam complex. The buildings were well separated so that they became a more difficult target in the event of air strikes; research areas were separated from production areas, and the architectural features of Muthanna buildings copied where appropriate.²⁷ During an interview, Professor Hindawi stated that the wide spatial arrangement was a requirement introduced after the Iraq/Iran war, and to introduce safety measures for the storage of solvents. However, the Director General of Al Fao General Establishment, denied that there were any laws requiring such arrangements, and did not support these statements.²⁸

When the Al Hakam Factory was first declared to the UN in May 1991, the plant was said to be in a preparatory stage. Maintenance and repair were carried out on “old imported production systems in an attempt to return them to service..” and use them for “.. production of vaccines or other materials produced by microorganisms such as SCP or other synthetic products..”.²⁹ The Al Hakam Factory was also declared in November 1991 as a fermentation site to “. produce enzymes from simple culture media, and add them in a dried form as concentrated protein to animal feed.”.³⁰

Facility Design

The Al Hakam Factory was enclosed by a two metre high chain-linked fence with three strands of barbed wire on top. There were guard towers at each corner and at the midpoints of the sides. The site was accessible by a single road. Access was gained through an arched gate (Figure V.VII.I), with a tyre shredder between two guard houses at either side of the arch.³¹

The layout of the factory was unusual in that all the various steps of the production lines were physically and geographically separated from each other. This generated working compartments that did not overlap and could function independently.

²⁶ UNSCOM 15/BW 2, 2-8 August 1991

²⁷ UNSCOM 125/BW 27, 19 August - 4 September 1995

²⁸ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

²⁹ Letter from the Permanent Mission of Iraq to Executive chairman, dated 22 May 1991 (UNSCOM document DD000040T)

³⁰ Document HAYES/91-46798 (UNSCOM document, hard copy)

³¹ UNSCOM 15/BW 2, 2-8 August 1991

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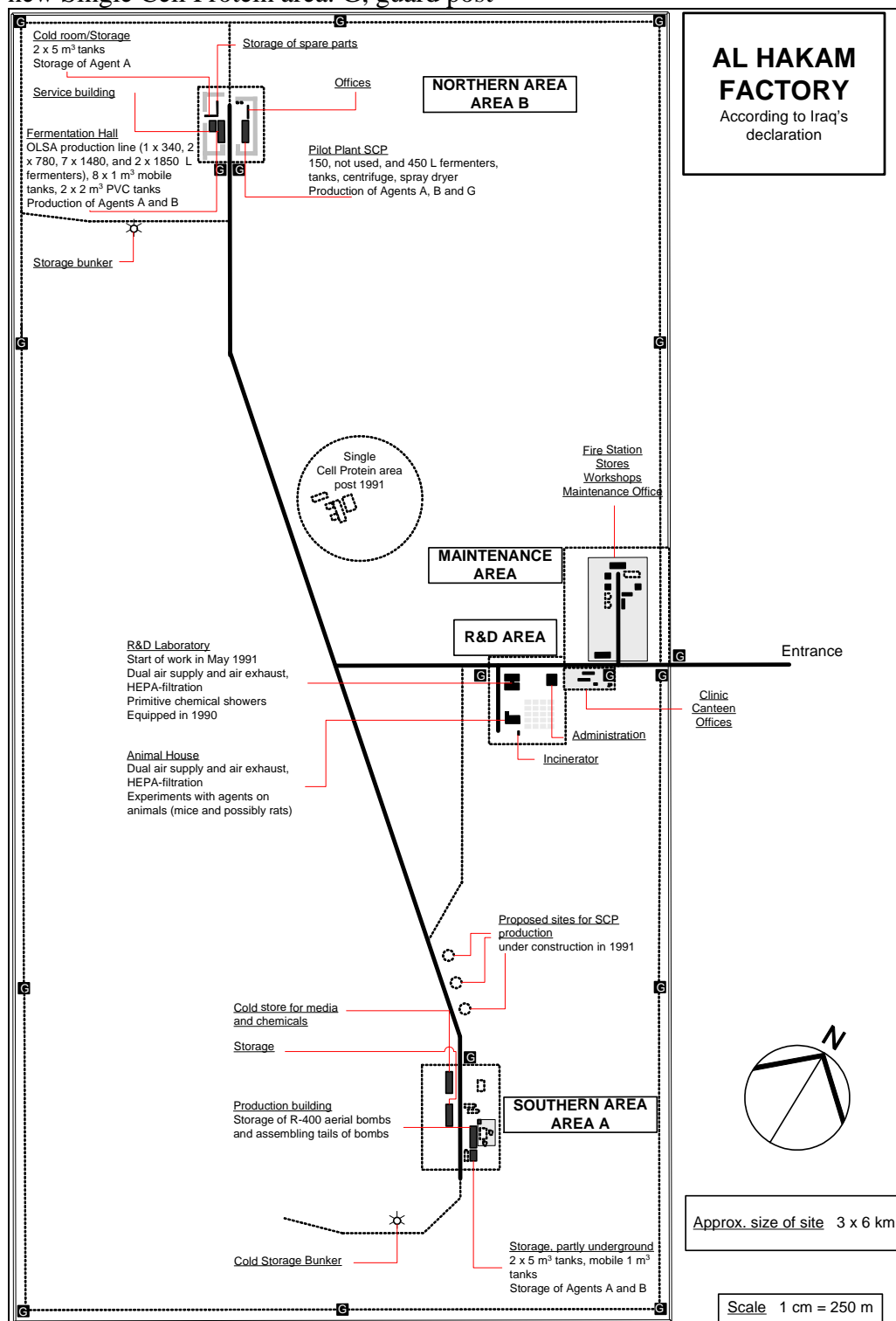
Figure V.VII.I. The entrance gate to Al Hakam Factory seen from the inside of the facility.



The site was operationally divided into four separate and widely dispersed areas: area A- the Southern area, area B- the Northern area, area C- the Administration, the R&D area with a R&D building and an Animal house, and the Maintenance area, and area D- the planned new site for single cell protein (SCP) production. A diagram of the site containing these areas is shown in Figure V.VII.II.

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Figure V.VII.II Site Plan for the Al Hakam Factory. Area A- the Southern area, area B- the Northern area, area C- the R&D area and Maintenance area, and Area D, the planned new Single Cell Protein area. G, guard post³²



³² Biological CAFCD December 2002, Chapter 5

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Construction and Building, 1988-1995

According to Iraqi declarations, the construction of Al Hakam Factory buildings started in the second half of 1988, and went through separate steps as follows³³ summarized in Figure V. VII.III

First – The fence around Al Hakam Factory was installed in the period May to July 1988.³⁴ Two buildings; Sheds A1 and A2, as well as the adjacent storage building (building 17/18) at the Northern site were then constructed. The sketch of those buildings was designed by Al Fao General Establishment and implemented by Al Hakam engineers.³⁵ The two sheds did not contain any specifications regarding biological hazard containment.

Second – construction of maintenance, diesel, transportation, stores, clinic, administration and fire fighting buildings in Area C,

Third - construction of Administration, R&D building, and Animal House³⁶ in Area C. Other dummy buildings, building camouflage and an earth mound were constructed at the site.

Final - construction of the 5m³ fermenter building³⁷ at Area A, the Southern site. The construction of this building started in the last quarter of 1989. This was at the same time as the production equipment was expected to arrive according to the contract with the manufacturer.

The start of construction activities in 1988 is corroborated by a research report for 1988, indicating that Project 324 (later to be named Al Hakam) planning and follow-up occurred, and that this was outside the scope of the original plan put forward in 1988.³⁸

³³ Biological FFCD, 1 March 1995

³⁴ UNSCOM 125/BW 27, 19 August - 4 September 1995

³⁵ Construction of the production buildings at the northern end of the site was largely complete by September 1988, after which work commenced on the laboratory area. (Biological CAFCD December 2002, Chapter 5) The engineers responsible for the construction were previously connected with Salman Pak. They confirmed that construction began in mid to late 1988 with the Northern area nearly completed by the end of 1988. They also stated that no outside contractors were involved; rather the construction was accomplished under their direct supervision by relatively unskilled workers. (UNSCOM 104/BW 15, 15-22 November 1994)

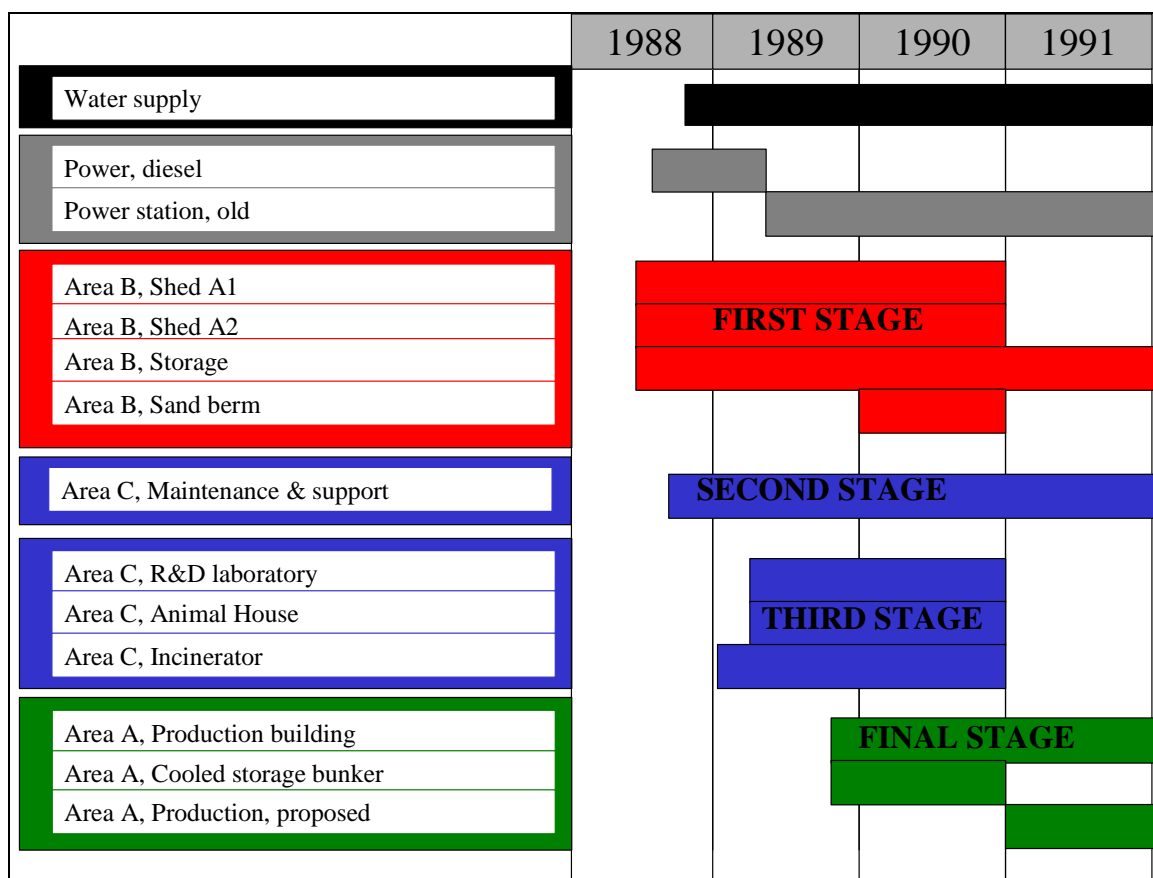
³⁶ The Animal House was completed in the second half of 1990. (Biological Technical Evaluation Meeting, Vienna, March 1998. Part 3, Sites)

³⁷ Building 1, Production building, was supposed to accommodate imported production equipment. It was however used for storing R-400 bombs instead. The cooled storage was built before the production building because there was a need to store the accumulated botulinum toxin product. (Biological Technical Evaluation Meeting, Vienna, March 1998. Part 3, Sites)

³⁸ Annual secret report for 1988. UNSCOM document no. 100104

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Figure V.VII.III: Construction at Al Hakam Factory during the period 1988 to 1991.



The storage buildings for spare parts and services, as well as the adjacent storage building in the Northern area, the cooled storage bunker in the Southern area, and the Animal House with evaluation unit were immediately used for BW production, evaluation and storage of BW agents. The administration building, services, transport and gas filling station, were also used during the programme.³⁹

The R&D building and the storage for electrical and mechanical equipment were completed in 1989 and 1990. None of these units were used during the BW programme and no BW research was performed in the R&D building.⁴⁰

After the completion of the building construction in mid-1990 the name Al Hakam was given to the project.

During 1990, Iraq constructed two cold stores, one ordinary store, a parking area outside the site, six temporary shelters underground, a sand berm around the Northern site, six

³⁹ UNSCOM 127/BW 29, 7 - 14 December 1995

⁴⁰ UNSCOM 127/BW 29, 7 - 14 December 1995

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decoy sites for the cold stores, a security perimeter road around the fence of the project, and access roads to cold stores and decoy sites. Also, all buildings and tanks were painted with khaki color for camouflage purposes.⁴¹ The necessary electrical works were completed for the cold stores and the ordinary store, a high tension electricity line was installed and transformers mounted, light poles were mounted in the Southern area, electrical works were completed for the air conditioning (AC) units and other equipment, and six diesel generators were mounted for the completed buildings. Wall-type AC-units (90 pieces) were mounted for the R&D building and Animal House as well as for the cold stores. Two AC-units were mounted with their air-ducts in the Northern area.

In 1990, a water network for agricultural purposes was laid down at the Northern area and Area C, the water and sewage connections for trailers and the Northern area were completed, water tanks were mounted in the various sites, and five tanks for underground storage of fuel were installed. Wheat, barley, alfalfa, and eucalyptus were also planted at the Al Hakam site in 1990.⁴²

During this period, Iraq declared that it had ordered 70 1m³ stainless steel storage vessels and four 5m³ stainless steel tanks from the State Enterprise for Heavy Engineering Equipment (SEHEE).⁴³

The bunkers and storage units at the Southern site were completed after 1991. Iraq stated that in 1993 it completed both the 50m³ fermenter production building in area D and the electricity control building.⁴⁴

Water Treatment Station

At the end of 1988, Iraq built a temporary water station with a capacity of 50m³ per hour on the Euphrates River, near the Saddam Bridge.⁴⁵ Iraq declared that it lay a 15 km long water main from the water station to a housing complex outside Al Hakam, and from that point water was transferred by tankers to the factory for use in the agricultural plots. Since Al Hakam had no water supply of its own, treated water was also trucked into the facility for use in production and for human consumption.

In each of the four sites there were three carbon steel tanks; two ground tanks with 25m³ capacities and a suspended (on a stand) tank with capacity of 50m³. The water was pumped from the ground tanks to the suspended tank by electrical pumps. Buildings were connected to the water tank by different sized galvanized pipes.

⁴¹ Al Hakam Annual Confidential Report for 1990. Draft Biological FFCD March 1996. UNSCOM document nos. 100102 and 700101.013

⁴² Al Hakam Annual Confidential Report for 1990. Draft Biological FFCD March 1996. UNSCOM document nos. 100102 and 700101.013

⁴³ Al Hakam Annual Confidential Report for 1990. Draft Biological FFCD March 1996. UNSCOM document nos. 100102 and 700101.013

⁴⁴ UNSCOM 127/BW 29, 7 - 14 December 1995

⁴⁵ Biological CAFCD December 2002, Chapter 5, paragraph 5.3.4.

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Electricity Power Station

Iraq stated that in 1988, the Al Hakam Factory depended on diesel generators at the different sites. Later, in mid-1989 the Babel Electricity Directorate connected Al Hakam to a line supplying the PC-2 site at Latifiyah from Al Qaa Qaa transformer station. This temporary power line⁴⁶ extended for 17 km. This line was connected to all sites of the facility through power transformers⁴⁷. The power supplied at the time was enough for the key buildings Shed A1 and Shed A2 in the Northern area.⁴⁸

Al Hakam Northern area

The Northern production area, which accommodated the fermenters and other production equipment transferred from Al Kindi and Al Taji, was the first to be constructed. The rapidly erected industrial buildings were completed in late 1988, before the higher quality administrative, research, and animal facilities were constructed.⁴⁹ The locations of buildings in the Northern site are shown in Figure V.VII.IV.

Iraq stated that after the obliteration of the BW programme in 1991, the buildings in the northern area were used to house the production lines for SCP. The factory produced SCP as an animal feed from various carbon sources on a pilot scale (Chapter V.XII). The northern area consisted of two main buildings, Shed A1 and Shed A2 as well as other supporting buildings such as those used for storage and supplies, dummy bunkers and other smaller utility sheds. The drainage system for waste fluid from production Shed A1 and Shed A2⁵⁰ was separated from human waste.

Iraq stated that the northern production buildings were not ready for use until January 1989 when production began using the 450 litre fermenter, which was transferred in late 1988 from Al Taji SCP. The process line from VRL (Al Kindi) was also transferred in late 1988 and was operational by February 1989. A seven metre high sand berm around the site was constructed in 1990.⁵¹

⁴⁶ of 33 KVA

⁴⁷ of 33/0.4 KVA and capacity of 400 KVA

⁴⁸ Biological CAFCD December 2002, Chapter 5, paragraph 5.3.5.

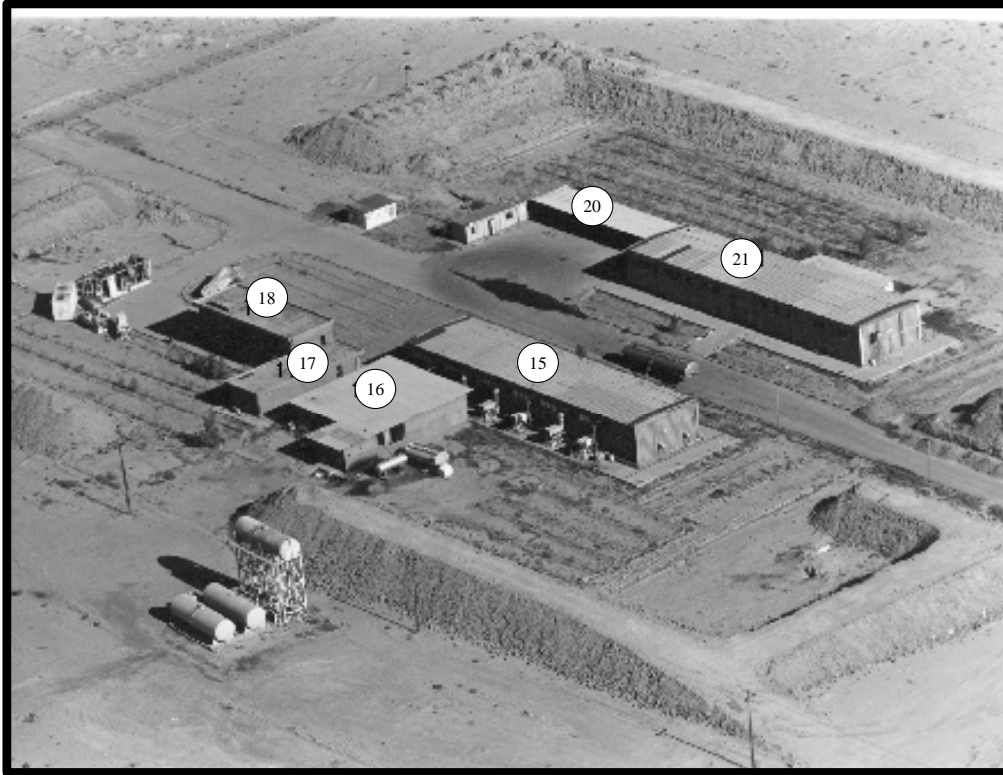
⁴⁹ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

⁵⁰ UNSCOM BG-1 report, 24 July 1995

⁵¹ Al Hakam Annual Confidential Report for 1990. Draft Biological FFCD March 1996. UNSCOM document nos. 100102 and 700101.013

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Figure V.VII.IV. Localization of buildings in the Northern area⁵²: 15, Shed A1, 16, Boiler Building, 17/18, Storage facility, 20, Trailer building, and 21, Shed A2



Shed A1

The primary design of Shed A1 was according to the design of the building for the Single Cell Protein Project at Al Taji, and it contained a break room, production equipment hall, service equipment hall, bathrooms, toilettes and a laboratory. There was an annexed shed containing service equipment.⁵³

The basic and detailed designs of the electrical, mechanical and civil works were implemented by the Consultancy Engineering Office, Al Fao General Establishment.

Service equipment comprised the following: a compressor, two imported chillers, a tank for cooled water and water distillation equipment. Inside the annexed shed there were two steam generators, 1000 kg/hour capacity, an ionically neutralized water unit; a tank for distilled water, a tank for neutralized water, and two cooling towers and pumps.⁵⁴

⁵² UNSCOM photo AITO 340 & 341, November 1994

⁵³ FFCD BW Draft July 1995, Chapter 4, paragraph 4.4, and Biological CAFCD December 2002, Chapter 5, paragraph 5.3.2

⁵⁴ Biological CAFCD December 2002, Chapter 5, paragraph 5.3.2

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The shed contained five air-conditioning units brought from the VRL (Al Kindi) at Abu Ghraib. After two of them failed they were replaced by five tonne capacity air-conditioning units purchased from local markets. The laboratory and adjoining room were supplied with window-type two tonne capacity air-conditioning units, also purchased from local markets. Air-ventilation was handled by normal ventilators.⁵⁵

Outside the building there were three large tanks holding drinking water, one on a platform and two on cradles. The water and sewage piping was a normal network.⁵⁶

The shed was supplied with electricity by a transformer⁵⁷ located near the diesel generator station, 500 metres from the site. A system of cables was connected to main distribution boards and then to distribution boards inside the hall, for operating the production equipment and for light.⁵⁸

The laboratory in Shed A1 contained the following equipment: incubator, oven, two pH metres, microscope, refrigerator, spectrophotometer, and an autoclave.⁵⁹

The shed also contained equipment transferred from the VRL (Al Kindi) at Abu Ghraib in 1988, and its installation in the shed began in October 1988. The equipment included two jacketed and insulated 780 litre preparation tanks, a 340 litre fermenter, two 1,850 litre fermenters, and seven jacketed and insulated 1,480 litre inactivator tanks. The equipment was modified before being used.⁶⁰

The installation, modification, trial operation and tests of the equipment were completed in January 1989. This equipment was used to produce agent A from February 1989 to August 1990. When the production of agent A was transferred to the FMDV site at Al Dora (Al Manal), the equipment in Shed A1 at Al Hakam was used for the production of agent B until the end of 1990.⁶¹

Shed A2

Shed A2 was similar to Shed A1 in size and construction and was divided into three rooms. The shed had a central air conditioning unit with a capacity of 20 tonnes. The cold room of the shed was provided with a five tonne air conditioning unit.⁶²

The shed contained a 450 litre fermenter, which was transferred from Al Taji, two jacketed and insulated mixing tanks, a buffer tank, a jacketed and insulated assembly tank, a centrifuge, a spray dryer, a chiller, and service equipment. The laboratory in the

⁵⁵ Biological CAFCD December 2002, Chapter 5, paragraph 5.3.2

⁵⁶ FFCD BW Draft July 1995, Chapter 4, paragraph 4.4

⁵⁷ 630 KVA capacity, transforming capacity 33/0.4 KVA

⁵⁸ Biological CAFCD December 2002, Chapter 5, paragraph 5.3.2.

⁵⁹ Biological CAFCD December 2002, Chapter 5, paragraph 5.3.2

⁶⁰ Biological CAFCD December 2002, Chapter 5, paragraph 5.3.2

⁶¹ Biological CAFCD December 2002, Chapter 5, paragraph 5.3.2

⁶² FFCD BW Draft July 1995, Chapter 4, paragraph 4.4

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shed contained an orbital shaker, a phase contrast microscope, a balance, a water bath, an oven, a freezer, a refrigerator, glassware and an autoclave.

As for Shed A1, the drainage systems for shed A2 production waste fluids were separated from human waste.

Storage facility

The storage facility was located adjacent to Shed A1. The preliminary drawings were carried out by the Al Hakam engineers, while the detailed and construction drawings were made by Al Fao General Establishment's Consulting Engineering Office.⁶³

The building consisted of two parts. The first part was a cold room provided with air-conditioning system, and the second part was a normal store for spare parts.⁶⁴ The air-conditioned room in the building was used for storage of agent. There was a concrete walkway leading to this building from Shed A1, which made the movement of tanks as described by the Iraq easier.⁶⁵

Iraq stated that during the latter part of 1990, this building was going to be used for the filling of R-400A bombs and warheads with BW agents A, B, and C. However, given a decision by General Hussein Kamel, weaponisation occurred at Muthanna and not at Al Hakam.⁶⁶

Boiler Building

The so-called Boiler Building was an open-air building, which contained two large boilers and associated equipment.⁶⁷

Trailer building

The building was a trailer that had been used for temporary office accommodation.⁶⁸

Dump sites for waste

According to Iraq, there were two dump sites for waste in or close to the Northern area. Human waste was dumped in a sewage pit area about 100 metres north of a guard tower, along the rear perimeter boundary fence. The dump site for production waste was in an area northwest of Shed A1. The fluid waste was taken to this site, dumped, soaked with fuel and burned, then covered with earth.⁶⁹

⁶³ FFCD BW Draft July 1995, Chapter 4, paragraph 4.4

⁶⁴ FFCD BW Draft July 1995, Chapter 4, paragraph 4.4

⁶⁵ UNSCOM BG-1 Report, 24 July 1995

⁶⁶ Further Clarification for Biological FFCD, 12 May 1998, paragraph 2.9. Received by UNSCOM after TEM meeting in Vienna, 1998. UNSCOM document no. DD000116T

⁶⁷ UNSCOM 53/BW 3, 11-15 March 1993

⁶⁸ UNSCOM 53/BW 3, 11-15 March 1993

⁶⁹ UNSCOM BG-1 Report, 24 July 1995

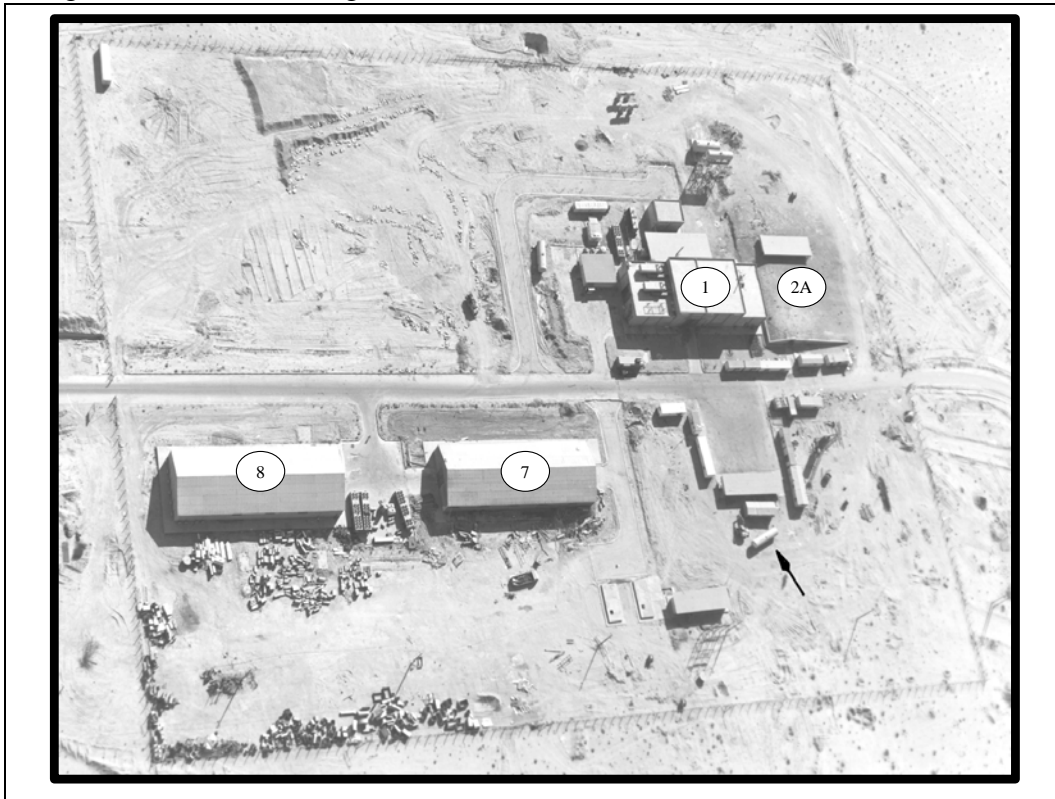
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Al Hakam Southern area

The chronology of the Southern site, which Iraq declared was constructed to accommodate 5m³ fermenter(s)⁷⁰, is less well documented. It was presumably erected in 1990.

The area was constructed before 1991, but the buildings were not fitted out as planned prior to the first Gulf War. After 1991 the area was used for the production of biopesticide and bio-fertilizer on pilot and laboratory scales, respectively; the area also contained several stores and warehouses and smaller administration buildings (Figure V.VII.V). The area contained the main building 1 or Biopesticide production building, 2 storage warehouses, a cold storage where BW agents were stored, a cleaning plant, other support buildings, and a bunker.⁷¹

Figure V.VII.V Locations of buildings in Area A: Building 1, main building 1 or biopesticide production building. 2A is semi underground cooled bunker for storage, 7, storage, and 8, media storage



⁷⁰ An agreement was initially made with a European company to export three production units (each of 5 m³). The order was reduced to one unit due to the cost. The contract was signed at the end of 1988. The equipment was supposed to arrive at the last quarter of 1989, and the civilian engineering plans for the building to accommodate this equipment were received at the first quarter of 1989. At the end of 1989, the company cancelled the order since they could not obtain an export license from their government.

⁷¹ UNSCOM 127/BW 29, 7 - 14 December 1995

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Main building 1, Biopesticide production building

Main building 1 was designed according to a foreign manufacturer's specification to accommodate the 5m³ fermenters.⁷² The fermenters which were never delivered were planned to be delivered to Site 85 nearby to Al Qaa Qaa site some 20 km away.⁷³

The building consisted of 3 main parts: (i) two laboratories on the ground floor and three offices on the upper floor and bathrooms, (ii) a hall for the 5m³ fermenter and (iii) a hall for support equipment.⁷⁴

Vertical columns divided the building into fifteen 5 by 6 metre bays. Six of these bays held equipment and pipes to a height of about 7 metres. Five other bays held equipment and pipes up to the level of 1.5 to 3 metres. Four bays, centered on and adjacent to a double-door entrance, were used for circulation. An annex to this building contained steam pipes up to a level of 4 metres. The steam production control was in one corner of this building, which had little open space.⁷⁵

The construction of the building started at the last quarter of 1989, but was not completed until 1992. During an UNSCOM⁷⁶ inspection in 1992 the building was undergoing civil engineering work to complete it. Iraq stated that the work was halted in the summer of 1990. A full-scale production line for bacterial pesticides was installed in the building around 1993.

Iraq has declared that the building was used in 1991 for storage of R-400 bombs, and for assembling of the tails of the bombs.⁷⁷

Storage facility, underground bunker

The preliminary drawings for the storage facility were done by the engineers and technicians of Al Hakam Factory, while the detailed and construction drawings were made by Al Fao General Establishment's Consulting Engineering Office.⁷⁸

The storage facility was L-shaped and consisted of two parts: (i) a concrete roofed entry of 3 metres width and 29 metres length, and (ii) a large cold hall of dimensions 3.9 x 5.6 x 17.5 metres. It was provided with 10 split units for air-conditioning.

Due to protection and storage safety requirements, the store was built 2 metres underground and the above-ground 2 metres were buried by soil (except for the roof). In

⁷² FFCD BW Draft July 1995, Chapter 4, paragraph 4.4

⁷³ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

⁷⁴ FFCD BW Draft July 1995, Chapter 4, paragraph 4.4

⁷⁵ UNSCOM 72/BW 4, 8-26 April 1994

⁷⁶ UNSCOM 35/CW 8, 15-29 April 1992

⁷⁷ Biological CAFCD December 2002, Chapter 5, paragraph 5.3.2

⁷⁸ FFCD BW Draft July 1995, Chapter 4, paragraph 4.4

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one of the store corners there was a pit, containing an immersion pump to get rid of sewage water.

Storage

The storage was one large warehouse, divided into by a six-foot wall. It was used for storage of electrical and mechanical equipment, and equipment from Fudaliyah and Kuwait.⁷⁹

Media Storage

The Media Storage consisted of a cold hall with dimensions of 6 x 12 x 4 metres and provided with 14 air-conditioning units. It was built for the storage of culture media and salts, as well as for other raw materials used for the production of BW agents.⁸⁰

Other Buildings

The Southern area also contained a Cleaning Plant, behind the production building with cleaning and sterilization equipment, and other accessory buildings.

Al Hakam R & D and Administrative Area (Area C)

In 1989, third stage plans were drawn up by the Baghdad University of Technology, for an administrative building, the Animal house, and the Research & Development (R&D) building at Al Hakam Factory. Subsequently, these were built close to the road toward the production buildings. The Northern site was by then fully assembled.⁸¹

The R&D and Administrative Area followed immediately after building the entrance to Al Hakam site (Figure V.VII.VI). The area consisted of three main buildings: the R & D laboratory, the Animal house, and Administration. A building containing the incinerator, 13 other minor buildings, and dummy and storage bunkers were also present in the area.⁸²

UNSCOM obtained a set of drawings⁸³ for buildings in Area C dated from 15 May to 21 July 1989 corroborating the declared period of construction (Figure V.VII.III).

⁷⁹ UNSCOM 15/BW 2, 20 September-3 October 1991

⁸⁰ FFCD BW Draft July 1995, Chapter 4, paragraph 4.4

⁸¹ UNSCOM 113/BW 22, 23 Jan - 3 February 1995

⁸² UNSCOM 127/BW 29 7 - 14 December 1995

⁸³ 21 drawings produced by University of Technology, Consulting Engineering Bureau/Office

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Figure V.VII.VI. Location of buildings in Area C. 30, Administration, 34, R&D Building, 36, Incinerator Building, and 37/38, Animal House.



R&D Building

The layout of the R&D building was based on a similar building at the Al Salman site. There was a service room annexed to the building in the rear part.⁸⁴ The R&D building was completed around the end of 1989, or the beginning of 1990, and in 1990 equipment was transferred from Al Taji, Al Salman and Al Kindi.⁸⁵

The proposed air handling system of the R&D building has been of specific interest. Project 324 included such systems with dual air supply and dual air exhaust for both the R&D building and the Animal House. Input and output air was to be HEPA filtered.⁸⁶ The design of the central air-conditioning system was prepared by the Consulting Engineering Office, University of Technology. The system was planned to supply 100% fresh air and create negative pressure. The exhaust air was to flow through a treatment unit and sucked through a blower outside the building. This air-conditioning system was

⁸⁴ FFCD BW Draft July 1995, Chapter 4, para 4.4

⁸⁵ Biological CAFCD December 2002, Chapter 5, para 5.3.1.

⁸⁶ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

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never supplied⁸⁷, and therefore replaced by a split type air-conditioning unit. Each of the laboratories in the R&D Building contained a basic chemical shower.⁸⁸

There was neither research nor animal experiment work performed in the building. Some research was performed at the Northern production site⁸⁹. The actual laboratory work in the building has been stated to have started on 4 May 1991 (SCP research).⁹⁰

Animal House

The Animal house, or Evaluation building, was located 250 metres behind the R&D building. Dr. Taha stated that the design of the animal house was similar to that of the animal house at Muthanna State Establishment.⁹¹

The building was designed with offices and laboratories in the front part. The laboratories were used for pathology and sample preparation. Six animal rooms were present on each side at the rear of the building. Partitions were added to a number of rooms for the purpose of breeding animals (mice and guinea pigs). In addition, an external shed was built for breeding rabbits. There were four sheds annexed to the building used for animals.⁹² The animal house had multiple exits⁹³ to the exterior through glass doors; the building also contained basic amenities for the staff

The air-cooling appeared to be distributed from the central corridor through ducts, with air exhausted through separate ducts running along the exterior wall. On the roof, the duct work implied separate cool air feeds for the laboratories and the animal rooms. The exhaust air ducts did not allow for re-circulation or filtration. All exhaust air from the laboratories and animal rooms fed to a common exhaust above the laboratory building blowing toward a parking lot.⁹⁴ The air conditioning system of the building was designed to provide negative pressure to the animal rooms and the laboratory access, and was similar to that requested for the R&D building.⁹⁵ As for the R&D building, the planned air-conditioning system was substituted with split units.⁹⁶

⁸⁷ The air-conditioning system was requested and ordered from companies abroad. Due to the August 1990 events it was never supplied.

⁸⁸ UNSCOM 53/BW 3, 11-15 March 1993

⁸⁹ Work performed on *Bacillus anthracis* included increasing total numbers of spores using additives such as maltose, dextrose etc. These experiments were performed because there was an intention to obtain a spray drier. Also, the effect of different pH to improve sporulation of *Bacillus anthracis* was studied. Furthermore, experiments were done to scale up production of *Clostridium botulinum*.

⁹⁰ UNSCOM 126/BW 28, 27 September - 11 October 1995

⁹¹ UNSCOM 126/BW 28, 27 September - 11 October 1995

⁹² FFCD BW Draft July 1995, Chapter 4, paragraph 4.4

⁹³ According to a report by the biological monitoring group (May 1995), room 6 was interesting since it had a shower room with separate exit to the exterior

⁹⁴ UNSCOM BG-1 site report, May 1995

⁹⁵ UNSCOM 126/BW 28, 27 September - 11 October 1995

⁹⁶ FFCD BW Draft July 1995, Chapter 4, paragraph 4.4

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Projected animal species to be housed in the animal building were rabbits, guinea pigs, mice, dogs, primates and later sheep for SCP.⁹⁷ It was stated by the veterinarian in charge that they did not exactly project the numbers of animals needed, however he estimated that the animal house could provide space for 20-30 dogs, over 2000 mice and approximately 8 primates.⁹⁸

The veterinarian arrived at Al Hakam from Al Salman around August-September 1990. At the time of his transition to Al Hakam he used to transit between Al Hakam and Al Salman since there were no facilities at Al Hakam, and he only came when he was needed. In 1995, animal cages were found at the back of the animal house. When asked, the veterinarian said he brought them from Salman Pak in 1990 on the instructions of TRC. He claimed they had never been used at Al Hakam.⁹⁹

Munitions and Agricultural Test Sites

Munitions Test site

In August 1990¹⁰⁰, shortly after MIC ordered the manufacture of an additional 200 R-400 bombs from Nasr State Establishment, a group from Al Hakam Factory together with a weapons expert from MSE conducted static tests for R-400. The test was carried out at a test area near Al Hakam Factory (Figure V.VII.VII) to determine the effect of different size burster tubes on the spread and viability of the agent. This test and other tests are covered in Chapter V.X.

Agricultural test site

Iraq stated that the agricultural test fields with wheat and corn, in the vicinity of the R&D and animal house buildings, were to be used for fertilizer experiments.

⁹⁷ UNSCOM 125/BW 27, 19 August - 4 September 1995, and UNSCOM 126/BW 28, 27 September - 11 October 1995

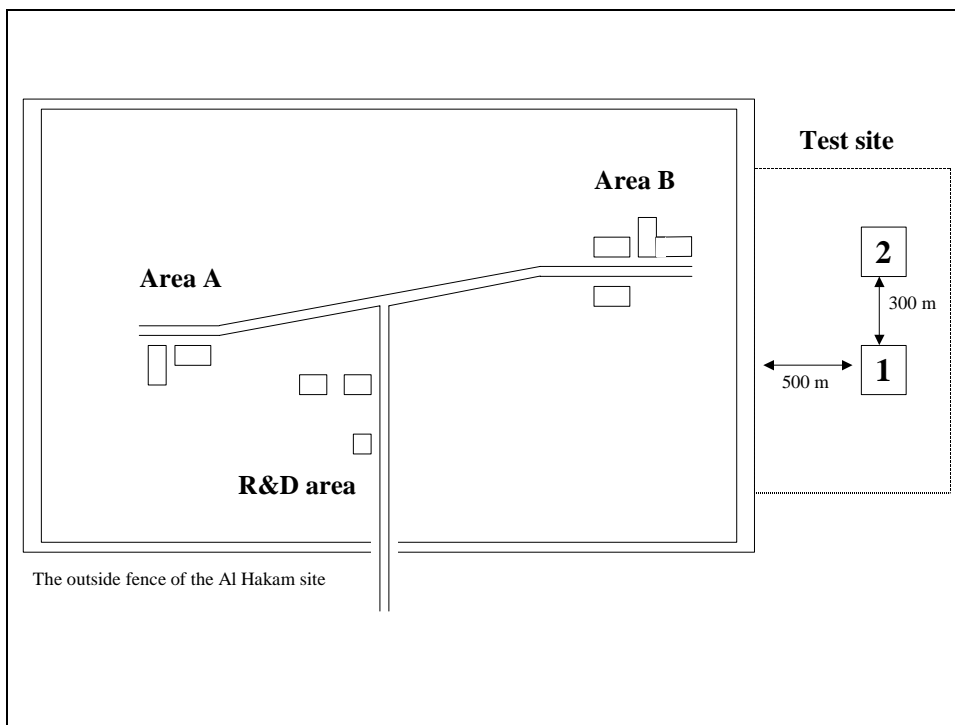
⁹⁸ UNSCOM 126/BW 28, 27 September - 11 October 1995

⁹⁹ UNSCOM BG-2 Report, 18 September 1995

¹⁰⁰ In the second week of Aug. 1990, tests were conducted to determine the booster size suitable for exploding the bomb and to check the dissemination of the agent. These tests were conducted with two bombs, the first one used a complete booster and the second used a half booster. The agent used was simulant B (*Bacillus subtilis*). (Biological FFCD 1997, Chapter 1, annex 1)

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Figure V.VII.VII Diagram of test site near Al Hakam Factory. 1, location of the 1st bomb, and 2, location of 2nd bomb¹⁰¹



Equipment

The majority of the equipment present at Al Hakam Factory in 1991 was obtained through transfer from other Iraqi facilities (Figure V.VII.VIII). This enabled Iraq to maintain the secrecy of the facility. The factory received equipment from mainly Salman Pak, Al Taji, VRL (Al Kindi), Agriculture and Water Resources Research (Fudaliyah), and removed from Kuwait.

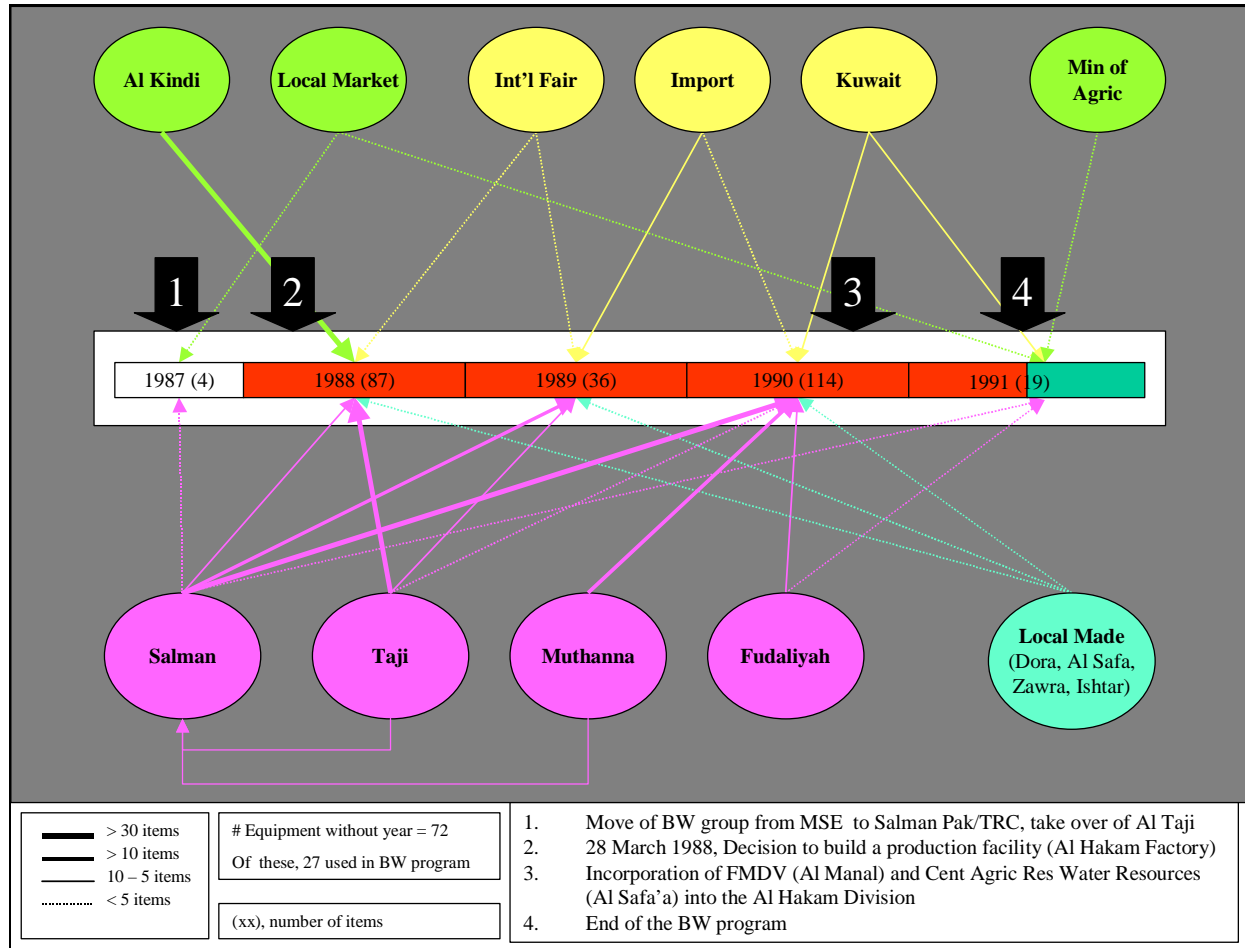
The equipment needed for production was transferred from the VRL (Al Kindi) and Al Taji in 1988. According to an interview with Professor Hindawi, the request to acquire the fermentation line from Al Kindi was made in beginning of 1987, before Professor Hindawi and Dr. Taha visited manufacturing companies abroad. Furthermore, he stated in the interview that already at Muthanna State Establishment they were considering large-scale production, and that both local and foreign companies were approached for procuring fermenters.¹⁰²

¹⁰¹ Further Clarification for Biological FFCD, 12 May 1998, diagram of test site. Received by UNSCOM after TEM meeting in Vienna, 1998. UNSCOM document no. DD000116T

¹⁰² UNSCOM 169/BW 45, 9 - 20 January 1997, Annex D

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Figure V.VII.VIII. Year of delivery and source of equipment for Project 324 and present at Al Hakam Factory in 1996.¹⁰³ Some equipment transferred from Salman came originally from MSE and Al Taji. Fudaliyah (Al Safa'a) and FMDV (Al Manal) were part of the Al Hakam Division from the second half of 1990.



¹⁰³ UNSCOM 127/BW 29, 7 - 14 December 1995

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Fermenters

Iraq provided several supporting letters and documents highlighting the requirement for additional production equipment for the BW programme. In a 1988 document, the leader of the Biological team stated the need to import fermenters, estimated to take 5-6 months, for Project A (botulinum toxin). This was necessary in order to produce sufficient quantities of biological agent to fill more than one bomb per day.¹⁰⁴ The document also stated the need to disassemble the fermenters at Al Kindi and move them to another site where they could be operated within 1 to 2 months. The Biological team also stated that additional fermenters were also required for Project B (anthrax). The 150 litre fermenter at the Al Salman site was suggested to be used for research and development.

Furthermore, on 20 April 1988 a letter was sent to the Director General of TRC stressing the need to procure three 5m³ fermenters and to use available fermenters in Iraq at the VRL (Al Kindi). It was also stressed that Project B further called for importing dryers and a continuous centrifuge.¹⁰⁵

In the Annual Report on Biological Research for 1988¹⁰⁶, reference was made to work outside of the plan for 1988. The biological group had been planning, doing follow-up, and preparing work (including production equipment and instruments) for Project 324. Also, negotiations had been carried out with foreign companies for the purchase of equipment for Project B within Project 324. Work towards maintaining, modification, and moving equipment from VRL (Al Kindi) for the production of botulinum toxin was completed.

Transfer of fermenters/process lines from other facilities in Iraq

The equipment procured by Iraq prior to 1988 was not designed for the production of BW agent. The fermentation and downstream process equipment was procured for the purpose of veterinary vaccine production and SCP production, but was adapted and utilized for the production of BW agents. In addition, the scale-up process was helped by the availability of small-scale laboratory fermenters (7 and 14 litres capacity).¹⁰⁷

Transfer of equipment from Al Taji

In 1979 and 1980, Iraq had acquired and installed a pilot fermentation plant at Al Taji for SCP production studies.¹⁰⁸ Beginning in late 1986, the BW program tried to acquire the SCP facility, equipment, and personnel¹⁰⁹, and by mid-1987 the transfer to TRC was complete (Chapter V.V). The 450 litre pilot-scale fermenter, with accessory equipment, and several laboratory fermenters with vessels of 7 and 14 litre capacity were transferred.

In 1988, the 450 litre fermenter at Al Taji was used for the production of botulinum toxin. However, preparations for the transfer of this equipment and its accessories to Al Hakam

¹⁰⁴ Biological FFCD March 1996, Iraqi doc. no. 169

¹⁰⁵ Biological FFCD March 1996, Iraqi doc. no. 5

¹⁰⁶ UNSCOM document no. 100104

¹⁰⁷ Biological CAFCD December 2002, Chapter 10.10.7

¹⁰⁸ Biological CAFCD December 2002, Chapter 4, and Supplier information

¹⁰⁹ UNSCOM 125/BW 27, 19 August - 4 September 1995

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started in October 1988. It arrived at Al Hakam in December 1988¹¹⁰, and was installed before January 1989¹¹¹, which was the starting date for production of botulinum toxin using this fermenter. According to Iraqi declarations, the 7 and 14 litres fermenters arrived at Al Hakam in 1990.

Transfer of equipment from the VRL (Al Kindi), Abu Ghraib

A fermenter line with ancillary equipment had been installed at the VRL in 1983 for the production of “Co-Baghdad” vaccine, a trivalent vaccine against infections by certain clostridial species. The production line (Table V.VII.I) had been given final acceptance in March 1984, although Iraq maintained that it had problems with vaccine production because of problems with contamination. Professor Hindawi identified this fermentation line as being suitable, with modification, for the production of BW agents. The mixing tank and one inactivation tank were not transferred, but retained by VRL (Al Kindi).

Table V.VII.I Items of the production line for “Co-Baghdad” vaccine at VRL and other equipment transferred from VRL to Al Hakam.

Item	Number of items	Used for production at Al Hakam	Capacity/Working volume (litres)
Seed fermenter	1	1	340/200
Production fermenter	2	2	1,850/1,500
Mixing tank ¹¹²	1	-	1,850
Inactivation tank ¹¹³	8	7	1,480/1,000 (6) or 600 (1)
Mobile tank ¹¹⁴	8	Presumably taken over	800
Mixer tank ¹¹⁵	n.a.	2	780/600

In 1988, Iraq had considered the use of the line *in situ* at the VRL for the production of botulinum toxin.¹¹⁶ Alternatively, it was thought that the line could be moved to another location. Iraq claimed that the fermentation line was not functional, citing as proof its attempts to get the manufacturing company to make the necessary corrections. This assertion was denied by interviews with Professor Hindawi¹¹⁷, and by information supplied by the company. The issue under contention with the company had to do with features of the building housing the vaccine line and not with the fermenter line *per se*. A document dated April 1988, does not mention any problems with the line.¹¹⁸

¹¹⁰ UNSCOM 126/BW 28, 27 September - 11 October 1995, and UNSCOM 127/BW 29, 7 - 14 December 1995

¹¹¹ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

¹¹² The mixing tank was, according to the supplier, identical to the fermenters

¹¹³ According to the supplier, fermenters were delivered to be used in this capacity

¹¹⁴ The mobile tanks were functionally fermenters

¹¹⁵ The mixer tanks were not part of the production line for “Co-Baghdad” vaccine

¹¹⁶ Biological FFCD March 1996, Document no. 169

¹¹⁷ UNSCOM 169/BW 45, 9 - 20 January 1997

¹¹⁸ Biological FFCD March 1996, Document No 5.

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In early 1988 the decision was made to move the production line from VRL to Al Hakam Factory (to Shed A1). The equipment was tested, modified and dismantled before being removed in June 1988. The modifications were performed by an engineer from TRC. The Al Kindi director was aware that the equipment was going to TRC, but not that it was actually installed at the Al Hakam Factory.¹¹⁹

TSMID ordered spare parts (not operational limiting) and filters for the line in June 1988.¹²⁰ According to interview testimony, the fermentation line was moved to Al Hakam in November 1988, but not setup before January 1989. The line became operational in February 1989.¹²¹ No documentation has been provided by Iraq to support when the physical transfer was accomplished.

The production line transferred to Al Hakam Factory was modified at the end of 1988.¹²² The modifications were conducted particularly, on the seven jacketed inactivating tanks, and the modified equipment was used directly to produce BW agents. The modifications included:

- Connecting the 340 litre fermenter with the first 1,480 litre tank in order to make the latter an inoculum tank for the other six tanks.
- The equipment was originally designed for an anaerobic process, and there was no need for a specific mixer. Thus, it was only needed to replace oxygen, which should be driven out, with nitrogen. A stainless steel tube was inserted inside the tank to pump filtered gas into the tank to make bubbles to replace air by pure nitrogen in the medium.
- Addition of a stainless steel pipe as a sampling port.
- Adding a small hole in the tank beside the hole of the heat sensor for a pO₂ probe.
- Connecting a smaller 5-10 litre tank for adjusting pH of the media during the fermentation process.
- Installation of a control unit in order to read the pH and turbidity.
- Adding a capsule from the top in order to facilitate the sedimentation process by addition of a sedimentation agent at the end of the fermentation process.

Comment

Although Iraq suggested that all of the modifications occurred early on, this may not have been the case. The fermentation line was already established to produce anaerobic organisms for Co-Baghdad vaccine. For anthrax production however, a pO₂ probe and air bubbling through the mixture is necessary and therefore the fermentation line would have needed some modification after Iraq switched from botulinum toxin production to anthrax. Also in 1988, Iraq was still negotiating with a foreign company for a production line that was to be dedicated to anthrax production.

The fermentation line was used at Al Hakam Factory from February 1989 to August 1990 for botulinum toxin production, and thereafter until January 1991, for the production of

¹¹⁹ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

¹²⁰ Biology TEM, Vienna, 03/1998, and Supplier information

¹²¹ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

¹²² Biological CAFCD December 2002, Chapter X, paragraph 10.7

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Bacillus anthracis. In January 1991, production of the simulant *Bacillus subtilis* took place in one 1,850 litre fermenter.¹²³

Equipment from Salman Pak

In 1985, SEPP had ordered one 150 litre pilot plant fermenter as a complete unit. This was delivered to MSE in early 1986, but apparently not operated until after September 1988, when it was installed at Salman Pak.¹²⁴ Iraq stated that the equipment was transferred in early 1990 to the Al Hakam Factory.

Equipment from Kuwait

After Iraq invaded Kuwait another 150 litre fermenter, identical to the one obtained by SEPP/MSE, was taken from Kuwait to the Al Hakam Factory. Iraq claimed it was not received by Al Hakam until 1991, but was stored in “MIC Stores” at Al Taji.¹²⁵ The fermenter was not functioning initially due to damage of the control unit during transport. It was stated that it was not used to produce any biological agents.¹²⁶ However, this unit was fully functional in late 1991.

Other Fermenters at Al Hakam

Additional 75 litre and 300 litre fermenters, as well as a 1,500 litre fermenter, were found by UNSCOM in the scrap yard at the Northern area.¹²⁷ The 1,500 litre fermenter was from Kuwait and the other two were of unknown origin.

Attempts to procure 5m³ fermenters/process lines from foreign companies

In addition to relocating fermenters and other production equipment from civilian uses to Al Hakam, fermenters were also sought from overseas in 1988. Iraq declared that members of the biology group went to Europe to get offers for production equipment in the second half of 1988, or May 1988.¹²⁸

As a result of this visit, a competitive offer for production equipment was received from a manufacturer abroad. Iraq stated that it had plans to install three 5m³ fermenters for BW agent production, but as far as the supplier was concerned, Iraq claimed that these fermenters were to be used for SCP production. Iraq has stated that Professor Hindawi, Dr. Taha and an engineer were involved in selecting equipment for Project 85 (Latifiyah), the point of delivery for the equipment¹²⁹. According to the manufacturer the equipment discussed was not suitable for pathogen production.

A quotation¹³⁰ from the manufacturer to TSMID with the date 24 June 1988 refers to a pre-seed fermenter, seed fermenter, medium preparation tank, production fermenter,

¹²³ Biological CAFCD December 2002, Chapter 10, Annexes

¹²⁴ UNSCOM 169/BW 45, 09 - 20 January 1997, and Supplier information

¹²⁵ Iraq submitted site declaration for Al Hakam. Label on fermenter cited Kuwait Research Institute

¹²⁶ UNSCOM 126/BW 28, 27 September - 11 October 1995, UNSCOM 127/BW 29, 7-14 December 1995

¹²⁷ UNSCOM 87/BW 8, 19 July-16 September 1994, UNSCOM 127/BW 29, 7 - 14 December 1995, and UNSCOM 134/BW 31, 18 May - 1 July 1996

¹²⁸ Biological CAFCD, December 2002, Chapter 5.5.4., and UNSCOM 169/BW 45, January 1997

¹²⁹ Biological Answers in Reply to UNSCOM 104, 28 November 1994. UNSCOM document no.

MD000422T

¹³⁰ No. 09-00.863/512.G1

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storage tank, permeate tank, retentate tank, control cabinet, separator, spray dryer, product storage container, steam generator, air compressor system, diesel power generator, and spare parts. The document also contained drawing of a polyvalent fermentation plant.¹³¹ Another drawing of a polyvalent fermentation plant prepared by the manufacturer for TSMID in June 1988 was obtained by a UN inspection team.¹³²

Comment

Since both drawings are dated June 1988, it is highly likely that both are part of the same document and that in mid-1988 discussions regarding the purchase of two different production lines were on-going. This view is supported by a contract¹³³, dated 28 November 1988 and referring to an earlier contract dated 19 August 1988, sent from the manufacturer to TSMID concerning purchase of two production lines, Plant 1 and Plant 2. The equipment was going to be shipped to Al Taji according to the contract. The equipment for Plant 1 had similarities to the equipment in the drawing for Al Latifiyah, except that the smaller fermenters were at different capacities and the spray dryer was missing. The equipment for Plant 2 in the contract had large similarities to the equipment in the drawing for the Polyvalent Plant, except that there was no spray dryer.

Iraq has stated that they told the manufacturer that the equipment was going to be installed at Site 85 of PC2 (Al Latifiyah), however the intentions was to move the equipment later on to Al Hakam Factory.¹³⁴ According to other information made available to UNSCOM, the decision to have the 5m³ fermenter delivered to Al Latifiyah was made as early as 19 July 1988.¹³⁵ The reason given by the Iraqis for presenting the site at Al Latifiyah as the fermenter location was that the building at Al Hakam was still under construction and would not be ready to receive the equipment according to the purchase order schedule.¹³⁶

Comment

The Latifiyah site, close to Al Hakam, was to be used as a point of initial delivery and installation so that the fermenter could be tested before being relocated to Al Hakam. The site was also a convenient cover story, part of the Petro-Chemical-2 (PC-2) complex and it was a way of keeping foreign technicians away from Al Hakam.

In 1991, Iraq supplied to UNSCOM a drawing that was made for TSMID.¹³⁷ The drawing dated June 1989 consisted of the layout for a building at the Al Latifiyah site. The drawing shows the position of several fermenters (1 x 4,500, 2 x 200 and 300 litres), tanks (1 x 1,500, 2 x 3,500 and 1 x 600 litres), a spray dryer, and possibly a water storage tank of 30,000 litres. The drawing was based upon information received at the end of May 1989. In this drawing only one 5m³ fermenter is present. Iraq has stated that the initial agreement with the company was to supply three fermenters but due to the cost,

¹³¹ Among documents of UNSCOM 142/BW34, April 1996

¹³² UNSCOM 15/BW 2, 20 September-3 October 1991

¹³³ Document no. 5/2, dated 28 November 1988. UNSCOM document no. IR000861T

¹³⁴ Biological CAFCD December 2002, Chapter 5, paragraph 5.4

¹³⁵ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

¹³⁶ Biological CAFCD December 2002, Chapter 5, paragraph 5.4

¹³⁷ UNSCOM 15/BW 2, 20 September-3 October 1991

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only one fermenter, together with a steam generator and an air compressor, could be purchased immediately.¹³⁸ Iraq has also stated that the other two 5m³ fermenters would follow under separate contacts at a later date.

A representative from the company together with Professor Hindawi, Dr. Taha and an engineer visited the facility at Al Qaa Qaa/Al Latifiyah in 1989.¹³⁹

Iraq made a substantial down payment on the equipment that was ready for delivery but was held by the manufacturer because of a pre-embargo concern on the part of the supplying government.¹⁴⁰ Since the export permit was cancelled, the manufacturing company declined to supply the equipment.¹⁴¹

Although negotiations with this manufacturer resulted in a contractual agreement to supply a 5m³ fermentation plant, simultaneous negotiations continued with another company also for the supply of fermentation equipment. These negotiations resulted in a Pro Forma Invoice¹⁴² being submitted by the company in September 1988. When interviewed, the TSMID employees denied all knowledge of this submission¹⁴³. In October 1988, TSMID apparently issued a request for offers for a 5m³ fermentation plant using a TSMID reference number 5/83/6072.

The contract¹⁴⁴, sent from the second company in September 1988, for a complete fermentation unit for production of SCP was stated to be based on technical discussions among Iraqi representatives and the company that took place between 10 and 13 June 1988.

Comment

The production line at VRL (Al Kindi) that was transferred to Al Hakam Factory had been installed for the production of the "Co-Baghdad" vaccine. This is a mixture of Clostridium species, and thus the line could readily be applied to the production of Clostridium botulinum toxin (or Clostridium perfringens spores).

There are no documents supporting when the line was first used for the production of BW agent. Iraq has stated that the transfer of equipment occurred towards the end of 1988, and that it was not functional until February 1989. However, a very large order¹⁴⁵ for consumable spare parts for the line was placed by TSMID in May 1988, and perhaps casts some doubt on the timing. UNSCOM assessed that the nature of the order demonstrated an excellent knowledge of the working condition of the fermenter, possibly

¹³⁸ Biological Answers in Reply to UNSCOM 104, 28 November 1994. UNSCOM document no. MD000422T

¹³⁹ Biological Answers in Reply to UNSCOM 104, 28 November 1994. UNSCOM document no. MD000422T

¹⁴⁰ UNSCOM 15/BW 2, 20 September-3 October 1991

¹⁴¹ CAFCD, and Biological Answers in Reply to UNSCOM 104, 28 November 1994. UNSCOM document no. MD000422T

¹⁴² A copy of this was found in Dr. Taha's office at Al Hakam Factory in May 1996.

¹⁴³ UNSCOM 169/BW 45, 9 - 20 January 1997

¹⁴⁴ UNSCOM 142/BW34, April 1996, document no. 5/13. UNSCOM document no. IR000873T

¹⁴⁵ Additional orders for spare parts including a repeat of the initial large order was placed in the ensuing mid-year months of 1988.

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indicating that engineers were already working on it prior to May 1988. This suggests that the line may have been transferred to TRC control earlier than May 1988 and could have been operational before the end of 1988, perhaps at VRL (Al Kindi). Furthermore, the supplier has estimated that it would only take about two weeks to physically make the transfer and install it at Al Hakam Factory since all units were modular and mounted on transfer skids.

Besides the attempts to acquire fermenters from the two declared manufacturers abroad, there were indications that other manufacturers were also approached. A particular concern to UN inspectors was the possible involvement of the Arabian Trading Company (a MIC owned company) in the attempt to or perhaps actual purchase of a 5m³ fermentation plant. The same reference number 5/83/6072 used by TSMID in its solicitation to companies in October 1988 was used by the Arabian Trading Company to solicit bids from several companies for a 5m³ fermentation plant at the same time. UNSCOM obtained proof that the Arabian Trading Company, and the apparent sole employee, was engaged in BW equipment purchases. All inquiries were met with denials by Iraq of any or all knowledge about the Arabian Company and the Iraqi FFCD denies any involvement of this company in BW procurement. Furthermore, in 1989 and 1990, allegedly the VRL (Al Kindi) tried to order a large complete fermentation plant through the Agriculture Supplies Company and another company abroad. The order was cancelled because of the embargo.

Spray Dryers

Iraq has declared that the production of dry agent was a strategic objective from the earliest days of the BW programme:

- Iraq declared that research for the preservation of bacteria was conducted at Al Hazen Ibn Al Haitham Institute from 1974 to 1978.¹⁴⁶ For this purpose, laboratory freeze dryers were imported.¹⁴⁷ During that time a study was conducted on “The best way to preserve cholera by freeze-drying”.¹⁴⁸
- Laboratory-scale freeze dryers were available at MSE in 1986¹⁴⁹, and were used to preserve laboratory stocks of BW agent¹⁵⁰.
- In April 1988, when Iraq was considering the large-scale production of BW agent, the need to acquire dryers for anthrax was highlighted in a memorandum from the head of the bacteria BW programme to higher authorities.¹⁵¹

Comment

It is clear that Iraq understood the importance of drying BW agents to enhance the long-term storability and to reduce their bulk. Iraq had experimented in a small scale with the dissemination of dried agent as early as 1988¹⁵². In that year, sheep and rabbits were

¹⁴⁶ Biological FFCD, September 1997, Chapter 5, paragraph 5.1.3., and Annex V.2.

¹⁴⁷ Biological CAFCD December 2002, Chapter 1, paragraph 1.3.3.

¹⁴⁸ Biological FFCD, September 1997, Chapter 5, Annex V.1.

¹⁴⁹ Biological FFCD, September 1997, Chapter 4, paragraph 4.1.2

¹⁵⁰ UNSCOM 126/BW 28, 27 September - 11 October 1995

¹⁵¹ Biological FFCD March 1996, Document No 5.

¹⁵² UNSCOM 125/BW 27, 19 August - 4 September 1995. Annex H

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exposed to a cloud of freeze-dried anthrax spores in an experiment to study the effects of inhalation.¹⁵³ Iraqi officials stated in 1996 that they had previously planned to produce anthrax spores in powder form “to keep for a long period of time”.¹⁵⁴

Transfer of spray dryer from Al Taji SCP

Iraq declared that in 1988 equipment, including a spray dryer, was transferred from Al Taji SCP and installed at Al Hakam Factory.¹⁵⁵ Iraq stated that no attempt was made to use this piece of equipment for the drying of anthrax simulant because of the unsuitable pore size of the atomizer, inefficiency of the filter bags of the dryer, and lack of experience in drying techniques.

Procurement and attempt to procure a spray dryer from foreign companies

UN inspectors received information that Iraq had obtained two capable dryers that were air-freighted into Baghdad in 1989 from a foreign company. One of these dryers located at the Al Hakam Factory in 1991, was later installed in the *Bacillus thuringiensis* (BT) production line. The second dryer was probably sent to the Baby Milk Factory in Abu Ghraib and was later moved to Al Qaa Qaa for use in the nitric acid plant.

From supplier information, UN inspectors were aware that in 1989, Iraq attempted to import a special spray dryer (“aseptic” spray dryer, identical to those earlier air-freighted to Baghdad but with additional biological containment capabilities). Iraq has declared that this was to enable anthrax spores to be safely dried. The attempt included a visit to the manufacturer by a senior Iraq BW specialist of the TRC, and the drying of a small sample of simulant for anthrax. In March 1990, 50 litres of concentrated simulant¹⁵⁶ (for anthrax) had been produced for use in a spray drying experiment.

Iraq also declared that the attempt to obtain such a dryer failed when the manufacturer could not obtain an export license for the equipment.¹⁵⁷ Thus, the appropriate drying equipment was not supplied and no spray drying was carried out, either on pathogenic or non-pathogenic bacteria, before 1991 during the BW programme.¹⁵⁸

Indigenous manufacturing of spray dryer

According to statements by Iraq and information obtained by UNMOVIC, in the beginning of the 1990s, Iraq made an unsuccessful attempt to repair a spray dryer with a defective rotating disc/nozzle. Following this failed attempt, a decision was taken to manufacture a spray dryer in Iraq (Chapter V.XII). The Iraqi Survey Group reported that, in 1989 Dr. Taha sought to have a spray dryer manufactured in Iraq for work at Al

¹⁵³ Haidar Farm Document 100099A (photos 125, 131, 219, 223-225, 303, 306)

¹⁵⁴ UNSCOM 139/BW 33, 24 February - 1 March 1996. Session 4.

¹⁵⁵ Biological FFCD, September 1997, Chapter 2, paragraph 2.1.3.3.2. and Chapter 6, paragraph 6.1.2.3.

¹⁵⁶ The anthrax simulant for drying was declared by Iraq to be *Bacillus thuringiensis*

¹⁵⁷ Supplier information, Biological FFCD September 1997, Chapter 5, paragraph 5.3. and Chapter 9, Table 9.5

¹⁵⁸ Biological FFCD September 1997, Chapter 5, paragraphs 5.2.2.4. and 5.3.

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Hakam Factory. Iraqi companies were able to fabricate the body of a dryer, but not the other components.^{159 160}

Storage tanks and mobile tanks

Iraq acknowledges the indigenous production of four 5m³ stainless steel storage tanks and thirty-nine 1m³ mobile tanks, in addition to the mobile tanks acquired when the BW programme took over the VRL (Al Kindi) production line and the Dora FMDV Facility (Al Manal).

In 1989 and 1990 the State Establishment for Heavy Engineering Equipment (SEHEE), a MIC establishment at Al Dora, was asked to produce 1m³ stainless steel tanks to be used for storage of biological agents at the Al Hakam Factory.¹⁶¹ The 1990 Annual Al Hakam Report¹⁶² cites the follow-up of the production of seventy 1m³ mobile tanks manufactured by SEHEE. The mobile tanks could serve as both transfer tanks and storage tanks, and were specifically designed for pathogen storage and sterilization.

Both Al Hakam Factory and Al Manal had good storage for biological materials. The biological agents were stored in a bunker and a warehouse, each containing two 5m³ storage tanks, at Al Hakam. In addition to the tanks, Iraq cites the use of 20 litre polyethylene storage jars.

Know-How in terms of personnel 1988-1991

According to Iraq, during the period from 1988 to 1991, the number of employees at the Al Hakam Factory increased from about 25 to almost 60 people. These numbers were estimates supplied by Iraq.¹⁶³ The number of employees at the Al Hakam Factory continued to increase even after 1991 and the obliteration of the BW programme.

The Al Hakam Factory recruited a range of personnel to perform tasks including those related to managing, technical support, administration and engineering. In order to manage the production systems for BW agents, a number of working groups were formed. The first of these was the Working Group for Botulinum toxin (WG Btx), together with a few people from the Working Group for Anthrax (WG Ba) and an Evaluation Group. The number of personnel involved in the WG Btx rapidly increased between 1988 and 1990. During the later part of the BW programme, several persons from the WG Btx were involved in the production of *Bacillus anthracis* and *Clostridium perfringens*.

¹⁵⁹ What was in question was their ability to manufacture the very precise atomizer nozzles required to produce particles in the optimum size range.

¹⁶⁰ Comprehensive Report of the Special Advisor to the DCI on Iraq's WMD with addendums, 30 September 2004. (ISG Report) Volume 3, Biological Warfare, page 9

¹⁶¹ Further Clarifications for Biological FFCD, September 1997. UNSCOM document DD000116T

¹⁶² Annual Report of Al Hakam Factory for 1990, 15 January 1991. UNSCOM document no. 700101.013

¹⁶³ Updated List of Persons Participating in Iraq's Past Programs, March 17 2003, UNMOVIC document no. DD000297T, Biological CAFCD December 2002, UNSCOM 53/BW 3, 11-15 March 1993, UNSCOM 87/BW 8, 19 July-16 September 1994, UNSCOM 105/BW 16, 1-12 December 1994

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The majority of the personnel employed at the Al Hakam Factory were transferred from the Al Salman site. Several of the Al Hakam staff obtained their scientific training at the University of Baghdad before employment at SEPP/MSE and/or Al Salman and, later on, transferred to Al Hakam Factory. The majority of the engineers recruited to Al Salman and Al Hakam Factory obtained their education and training at the University of Technology and the Institute of Technology.

The educational level of employees at the Al Hakam Factory was fairly high by local standards with more than half of the staff having education or training at a university or technical institute. Few employees holding a PhD degree were mainly engaged as managers, directors, or heads of working groups.

Training of staff at other facilities

Ten out of eleven people involved in the production of botulinum toxin at the Al Taji site in 1988 were later working at Al Hakam Factory. Most of the employees working on the Al Taji 450 litre fermenter were transferred to Al Hakam together with the equipment in late 1988.

Iraq declared that personnel were trained on the production line at VRL in the summer of 1988.^{164 165} At least eight people, four engineers and four biologists were trained on the fermenters. Of these, two were involved in the production of botulinum toxin at the Al Taji site. Seven of the eight were later working at Al Hakam Factory. Six of the eight were earlier employed at Al Salman, and of these, three had been working at Al Muthanna.

Thus, at the start of production at Al Hakam Factory at least 16 people had been earlier trained on fermentation technology, either at the Al Taji site or at VRL or at both sites.

Activities at Al Hakam Factory prior to 1991

Research and Development

Little basic scientific research appears to have been undertaken at the Al Hakam Factory since most of the R&D work was performed at SEPP/MSE and Salman Pak two years prior to the establishment of the Al Hakam Factory. Most of the activities at Al Hakam seem to have been mainly related to quality control of agents produced on an industrial scale at the site.

The Al Hakam Division Annual Confidential Report for 1990¹⁶⁶ indicated that research at the facility included the following:

- Determination of effective ways of storing and preserving botulinum toxin and anthrax spores,

¹⁶⁴ Biological FFCD, June 1996, Chapter 5, paragraph 5.1.1.3.

¹⁶⁵ UNSCOM 169/BW 45, 9 - 20 January 1997

¹⁶⁶ Annual Report of Al Hakam Factory for 1990, 15 January 1991. UNSCOM document no. 700101.013

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- Investigation of materials capable of increasing the mass of anthrax spores for drying purposes and increasing the spore density for atomisation, as well as studies on transdermal infection with spores and facilitating chemicals,
- studies on the compatibility of agents with weapons and storage materials, and
- research on *Clostridium perfringens* spores via inhalation and transdermal infection, as well as the determination of appropriate storage conditions.

Moreover, the report confirms the starting date for the research on viruses in 1990, the Foot and Mouth Disease Vaccine Plant at Dora (Al Manal) was incorporated into the Al Hakam Factory in September of 1990 and the Agriculture and Water Resources Research Centre (Al Safa'a).

Research and Development of Al Hakam Division performed at other facilities

Viruses

A Virus Section was established in July 1990. It was, after unsuccessful months at Salman Pak and Al Hakam, relocated to the FMD Vaccine Plant at Al Dora (Al Manal). For more information regarding the viral work, see Chapter V.VIII.

Genetic Engineering

A Genetic Engineering Unit was established at Al Hakam Factory in March 1990. However, the actual research on genetic engineering was undertaken by a researcher at Al Safa'a (Agriculture and Water Resources Centre at Fudaliyah) having previously considered, and rejected, laboratory accommodation at both Al Salman and Al Hakam.

For more information on this unit and other units established for genetic engineering, see Chapters V.IX and V.VI.

Brucella

According to Iraq's declarations, Dr. Taha imported isolates of *Brucella melitensis* in 1986 from a foreign culture collection. Although not presented as a part of Iraq's biological warfare programme it was used by a researcher, who undertook a study on *Brucella* as part of an MSc programme at the College of Science at the University of Baghdad from October 1989 to 1991. The researcher stated that he spent the first year on academic courses, and thereafter began his research. Based on the academic year presumably he began his research in June/July 1990. Both he and Dr. Taha have denied that the research was a planned stage of the BW programme. The researcher essentially established methods of identifying the bacterium and studied a protein which could have been involved in generating immunity against the disease. He has claimed that he had no involvement with the Al Hakam Factory during that period.¹⁶⁷

One vial of the imported freeze-dried *Brucella melitensis* had been opened, and was thus said not to have been available to be turned over to UNSCOM in 1991, while all other un-opened vials were turned over to the first biological inspection in 1991. Iraq accounted for this opened vial by asserting that it was used by the researcher mentioned

¹⁶⁷ UNSCOM 125/BW 27, 19 August - 4 September 1995

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above for his work. However, he stated that he never was able to use the strain because he “...received it before the war and then during the war there was no electricity and the strain was destroyed.”¹⁶⁸

Yersinia and Francisella

Bacterial growth media (500gm) suitable for cultivation of *Yersinia* was found at Al Hakam Factory in December 1994. Dr. Taha explained that this was material derived from the Forensic Division at Al Salman, and claimed that it was to be used for studies on *Francisella tularensis*, but that work had not been started.¹⁶⁹ This medium was part of an order placed in 1986 by Dr. Taha while at Muthanna.¹⁷⁰

Comment

UN inspectors found no evidence that agents other than those disclosed by Iraq had been part of the BW programme. There are some indications and Iraq admitted to an interest in other agents but it appears that these interests had not matured.

It is not possible to be sure of the amount of peptone and tryptone soya broth (TSB) that may be unaccounted for. TSB is particularly suitable for the growth of “fastidious organisms” (including gram negative microorganisms such as Brucella, Yersinia and Francisella). Iraq has not declared that it produced such organisms. It is curious therefore as to why Iraq obtained bulk quantities of such media.

The finding of botulinum toxin type B on a fermenter probe at Al Hakam added to the uncertainty of Iraq’s declarations, since Iraq had denied that type B was investigated or produced. There is no evidence available to UNMOVIC that Iraq imported Clostridium botulinum type B strains. Contamination from local sources is one possible explanation. Another explanation is based on the demonstration in 1994¹⁷¹ that some Clostridium botulinum type A strains carried a silent gene for the type B toxin, and thus will turn up positive in a genetic analysis for type B.

Production activities at Al Hakam Factory prior to 1991

Botulinum toxin Type A (agent A)

Iraq has declared that following the transfer of the 450 litre fermenter from Al Taji at the end of 1988, agent A production took place at the Al Hakam Factory from January to August 1989. Thirty batches of toxin were produced of which 27 batches were successful.¹⁷² A total amount of 400 litres of 20 times concentrated toxin were produced during the period using the same procedure as for production at the Al Taji site. The concentrated toxin was stored in mobile 1m³ tanks at the Al Hakam Factory.

¹⁶⁸ UNSCOM 125/BW 27, 19 August - 4 September 1995, Annex S

¹⁶⁹ UNSCOM 105/BW 16, 1-12 December 1994

¹⁷⁰ L/C 86/3/383

¹⁷¹ Franciosa et al., J Clin Microbiol vol 32, pp 1911-1917, 1994

¹⁷² Biological CAFCD December 2002, Chapter 5, paragraph 5.5.1.

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Beginning in February 1989, and continuing to August 1990, the VRL (Al Kindi) fermenter system (Table V.VII.I) was also used to produce botulinum toxin. The total volume of each batch was about 9m³, and the mean number of batches per month was between two to three.¹⁷³ About 41 batches were produced of which 30 batches were successful and 11 batches were discarded. This was based on recollection by the senior staff working on the programme and other parameters such as media consumed in production and amount of BW agent stored. Iraq stated that the reasons for the unsuccessful runs, which resulted in the contamination of batches, were because of inexperience by operators and electrical shutdowns. In addition, Iraq declared that some equipment proved unreliable. These problems lessened over time with the success rate increasing from 69 % at the beginning of the production in 1989, to 73 % towards to conclusion of the production in 1990.

In total, Iraq declared the production of about 13,600 litres of 20 times concentrated toxin, collected in 5m³ storage tanks.¹⁷⁴ Each batch was evaluated every second month for toxicity by the biology unit.¹⁷⁵ Iraq declared that according to the recollection of those involved, toxin activity started to decrease after six months because of the less than ideal storage conditions.

Bacillus anthracis (agent B)

According to Iraq, the production of agent B required more advanced control than agent A and this is reflected in the 1988 Annual Report in which the production group expressed a desire to acquire appropriate equipment. Iraq stated that the production of the agent was postponed while they waited for an appropriate response from a foreign manufacturer.

The pilot-scale production of agent B was started in March 1989 at the Al Salman site using the 150 litre fermenter. The production period ran for about 3 to 4 months.¹⁷⁶ When the production group was transferred to the Al Hakam site, the 450 litre fermenter was used to produce 150 litres of spores concentrated 10 times during the period from May 1990 until the end of June 1990.¹⁷⁷ Iraq said that the 150 and 450 litre fermenters were selected due to their suitability for aerobic cultivation conditions.

Comment

The Iraqi statement about the 150 and 450 litre fermenters are consistent with the comments above about the need and timing to change the VRL fermentation line between anaerobic and aerobic cultivation.

After August 1990, an order was issued by General Hussein Kamel to increase the production capacity for all agents. As Iraq had already declared large stocks of agent A

¹⁷³ Biological CAFCD December 2002, Chapter 5, paragraph 5.5.1.

¹⁷⁴ Biological CAFCD December 2002, Chapter 10, Annexes

¹⁷⁵ UNSCOM 126/BW 28, 27 September - 11 October 1995

¹⁷⁶ Biological CAFCD December 2002, Chapter 10, Annexes

¹⁷⁷ Iraq has stated that production of agent B in the 450 litre fermenter in 1990 was occurring from May until the end of June. This is, however, different from the 1990 Al Hakam Factory Report which states production from 1 January to 1 August. (Biological Technical Evaluation Meeting, Vienna, March 1998)

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by this time, the VRL (Al Kindi) fermenters of 1,850 litre capacity were dedicated for production of agent B from August 1990 until January 1991.¹⁷⁸

Thirty-one batches of agent B were produced at Al Hakam Factory during the period from May 1990 to January 1991. Twenty-seven batches were regarded successful depending on spore count and pathogenicity, while five batches were contaminated during the fermentation process and were discarded.¹⁷⁹

Failed production batches were usually caused by contamination. In this case Iraq stated that it was noticed early during the run, and then the process was stopped. In other cases, the sample taken from a batch and tested turned out not to be sufficiently infective enough. These batches were stored separately from the “high quality” batches.¹⁸⁰

In total, 47 batches of agent B were produced during the period from March 1989 to December 1990, an average of 4 batches monthly. The average production of concentrated product per month was 5 litres March-June 1989, 75 litres June - July 1990, and 2,069 litres per month during August-December 1990.¹⁸¹

The total production amounted to about 8,445 litres of 10 times concentrated agent B, produced at Al Salman and Al Hakam Factory.¹⁸² The concentrated spores were stored in flasks of 20 litres capacity, and mobile tanks of 1m³. Samples were taken every second month to determine spore count and pathogenicity. The biological production group observed that the number of spores and the pathogenicity decreased after 8 months, thought to be the result of unsuitable storage conditions.

¹⁷⁸ Biological CAFCD December 2002, Chapter 10, Annexes

¹⁷⁹ Biological CAFCD December 2002, Chapter 5, paragraph 5.5.2.

¹⁸⁰ UNSCOM 126/BW 28, 27 September - 11 October 1995

¹⁸¹ Biological CAFCD December 2002, Chapter 5, paragraph 5.5.2.

¹⁸² Biological CAFCD December 2002, Chapter 5, paragraph 5.5.2.

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Comment

The lack of supporting documentation makes it difficult for UNMOVIC to confirm Iraq's figures on the quantities of bacterial BW agent produced. However, some attempt was made to estimate the potential production based on fermenter capacity and/or availability and then on the amount of unaccounted bacterial growth media. However this was only a theoretical exercise to gauge possible production boundaries. Details of these estimates, the methodology and assumptions applied are available elsewhere.¹⁸³

With respect to fermenters, there are two annual reports (1988 and 1990), considered credible by UNMOVIC, that confirm Iraq's statements on the utilization of fermenters for those years. However, for 1989 and 1991, there is no such documentation, and UNMOVIC is, therefore, unable to confirm whether the fermenters were idle in those years to the extent claimed.

From Iraqi statements, there was great demand for BW agent towards the end of 1990, and January 1991 in particular. It would have been a critical time for production. UNMOVIC, therefore, questions Iraq's statement that all but one fermenter stopped production at the end of 1990. Only one fermenter, at Al Hakam, was said by Iraq to have produced anthrax simulant. Based on interview testimony of personnel involved in the past programme, both UNMOVIC (and the ISG) concluded that there is evidence which points to additional BW agent production at least in the first two weeks of 1991. Although there is interview evidence to suggest that Iraq produced more biological agent than declared there is no evidence to suggest that any of the agent produced at Al Hakam (or elsewhere) was not destroyed sometime in 1991.

Production 1989-1990

While Iraq had the possibility to produce larger volumes of agents at Al Hakam Factory during 1989 and 1990 than declared, this cannot be confirmed. It is also possible that following the conclusion of the Iran/Iraq war, and prior to the invasion of Kuwait, there was less of a sense of urgency with regard to production, and the lower estimates may well be accurate.

An assessment of production volumes based on the processes described by Iraq, and the availability of fermenters indicates a possible production of 21,105-28,020 litres of 20 times concentrated agent A (13,600 litres declared), 11,700 of 10 times concentrated agent B (8,425 litres declared), and 280-530 litres of 10 times concentrated agent G (340 litres declared).

Bacillus subtilis and Bacillus thuringiensis

Iraq declared that it produced various bacilli species as a simulant for anthrax. Several batches¹⁸⁴ were made during the preparation period for production at the Al Hakam

¹⁸³ See UNMOVIC Website Cluster document May 2003.

¹⁸⁴ production of *B. subtilis* using N broth medium

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Factory. They were considered as experimental batches in order to adjust the production parameters.¹⁸⁵

Overall, 540 or 550 litres of about 10 times concentrated *B. subtilis* and 50 litres of more than 10 times concentrated *B. thuringiensis* were produced at Al Hakam Factory using the 450 litre and the 1,850 litre line fermenters.¹⁸⁶ Production occurred between August 1989 and January 1991.

Comment

It is difficult to distinguish between the production of anthrax spores and the production of other Bacillus spp. spores since the same equipment and personnel appear to have been used for these purposes. However, it is assumed that the quantity of anthrax simulants Iraq stated it produced is valid (no apparent reason to produce any more) and that when the fermenters were not being used for simulant production the remaining production operational time was used for anthrax spore production. Iraq cited production of Bacillus subtilis spores in January 1991. It seems logical to assume that Iraq kept production going until or approaching 15 January (the time of the 1991 war) and this has been supported by interview testimony both to UN inspectors and to the ISG. Iraq cites that the evacuation to the alternate site at the Al Asma'a school did not occur until 17 or 18 January 1991.¹⁸⁷

Clostridium perfringens (agent G)

According to Iraq, research with (agent G) started in April 1988 at Al Salman.¹⁸⁸ Initial research was focused on identifying, growing, and inducing sporulation of the organism. Unsuccessful attempts were made to produce the microorganism using laboratory fermenters. Infectivity was assessed by inducing both superficial and deep wounds in mice (Chapter V.VI).

Research ceased at the end of 1989 when the group moved to Al Hakam Factory. Nevertheless, when additional biological warfare agents were required to expand the war effort after August 1990, production runs were undertaken between August and November 1990. The 150 and 340 litre fermenters (with working volumes of 100 and 200 litres, respectively) were used, producing in total 340 litres of 10 times concentrated spores.¹⁸⁹

Iraq declared that thirty-four batches of *Clostridium perfringens* spores were produced using the 150 litre fermenter, of which 30 batches were successful and four were discarded because of contamination.¹⁹⁰ This resulted in a total of 320 litres of spores in suspension. The production was a continuous process, and it took about 24 hours to

¹⁸⁵ Biological CAFCD December 2002, Chapter 5, paragraph 5.5.3.

¹⁸⁶ Biological CAFCD December 2002, Chapter 10, Annexes

¹⁸⁷ UNSCOM 174/BW 47, 25 February - 3 March 1997

¹⁸⁸ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

¹⁸⁹ Biological CAFCD December 2002, Chapter 5, paragraph 5.5.5, and Chapter 10, Annexes

¹⁹⁰ UNSCOM 126/BW 28, 27 September - 11 October 1995

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complete one cycle. Only one batch was produced using the 340 litre fermenter, (since it was used for agent B production), resulting in 20 litres of concentrated spores.¹⁹¹

Iraq stated that the reason for not starting production until the second half of 1990 despite good results in the R&D was due to a shortage of specialised media including tryptone, which was only made available later in 1990. After the short period of agent G production from August to November 1990, it was stopped due to the need for anthrax production in large quantities.¹⁹² The agent was apparently not evaluated in a weapon. It was said stored in 1m³ tanks at Al Hakam Factory for a period and was later destroyed in 1991.¹⁹³

Comment

Seed stocks

In 1991, Iraq declared that it had obtained 103 vials of bacterial isolates (reference strains) from foreign suppliers, and provided details on the individual types, source, year of importation, and quantities. The imported isolates comprised isolates to be used in the BW programme, but also isolates imported within but not used in the programme. Of the imported vials, 13 were declared to have been used, while 90 were provided with the original seal still intact, to the first UN biological inspection team in 1991. A number of vials of isolates were used by Iraq in its BW programme (Table V.II.II).

Table V.VII.II. Fate of vials of bacterial isolates used in the BW programme or handed to the UN inspectors in 1991. These isolates were acquired by Iraq from foreign suppliers¹⁹⁴

Micro-organism	Number of declared vials used	Number of sealed, unused vials given by Iraq to BW 1 in 1991
<i>B. anthracis</i>	4	16
<i>B. megaterium</i>	1	6
<i>B. subtilis</i>	1	5
<i>C. botulinum</i> type A	3	8
<i>C. perfringens</i>	3	15
Other	0	41*

* One vial was declared used by a worker for a M.Sc. course.

It has been possible to verify parts of Iraq's declaration with respect to its use and subsequent destruction of master and working seed stocks¹⁹⁵. However, it is virtually impossible to account for all seed stock obtained from opened vials.

¹⁹¹ Biological CAFCD December 2002, Chapter 5, paragraph 5.5.5

¹⁹² Biological Technical Evaluation Meeting, Vienna, March 1998

¹⁹³ Biological CAFCD December 2002, Chapter 5, paragraph 5.5.5, and Chapter 10, Annexes

¹⁹⁴ 20th Quarterly report to the Security Council, S/2005/129

¹⁹⁵ The term "seed stock" is used collectively to reference strains of microorganisms provided by culture collections (a unique library of strains), as well as to master and working seed stocks. A microorganism used as a reference strain is one which has been isolated and its characteristics have been defined. A reference strain of microorganism is cultured and used to produce vials of master seed. One vial of reference strain may produce many more vials – possibly a hundred – of master seed. Master seeds are usually maintained in order to ensure that all successive preparations of products are derived from the source to minimize the risk of mutation and/or variation of a product. Each master seed vial can be used to

Figure V.VII.IX. Declared usage of fermenters and production runs at Al Hakam Factory 1989-1991, amounts produced and ratio of failed (F) out of total batches. The 150 litre fermenter was in the beginning of 1989 used at Salman Pak. Yellow/Cp, *C. perfringens* spores, product concentrated 10x, Green/Btx, Botulinum toxin type A, product concentrated 20 x, Red/Ba, *B. anthracis* spores, product concentrated 10x, Blue/Bs, *B. subtilis* spores product concentrated 10x, and Grey/Bt, *B. thuringiensis* spores, product concentrated $\geq 10x$.

produce many working seed vials. Cultures of working seeds are then used in biological production processes.

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Comment

Production of Biological Warfare Agents

Production of botulinum toxin type A (agent A)

Iraq claimed that the records of agent production were destroyed. Consequently it based its estimate of the quantity of Agent A produced on the 1990 Al Hakam annual report, and used this to estimate quantities for other years. Without additional records, there is very little prospect of UNMOVIC confirming these figures. UNMOVIC considers that the annual report for 1990 supports Iraq's claim for Al Hakam and FMD production sites for that year.

For the period January to August 1989 (212 days) Iraq declared the production of 400 litres 20 times concentrated Agent A using the 450 litre fermenter (Figure V.VII.IX; Table V.VII.III). It would have been possible for Iraq to produce 30 or 42 batches during this period. With a 10% failure rate, as declared for this fermenter, this would have resulted in production of 405 to 570 litres 20 times concentrated toxin, in reasonable agreement with the declared amount.

Between February 1989 and August 1990 the VRL (Al Kindi) line was used for the production of agent A. Iraq has cited 30 successful batches out of a total of 41 (equivalent to a failure rate of 27%), and each batch would have generated 9,000 litres product or 450 litres of 20 times concentrated toxin. The declared failure rate seems high, and Dr Rehab Taha stated in 1995 that the failure rate was 20%. According to the procedure described it is reasonable to assume that one batch could have been produced per 6-8 days. If time for regular and major maintenance is taken into account (approx. 100 days) Iraq's total attempted batches during the period could have been 58-76. With a failure rate of 20% (more reasonable than 27%) this would have resulted in 46-61 successful batches generating 20,700-27,450 20 times concentrated toxin, a figure substantially higher than declared in Iraq.

Table V.VII.III. Declared and assessed production of Botulinum toxin Type A (agent A) at Al Hakam Factory 1989-1990.

Fermenter volume (working volume)	Date	Runs (successful/ failed)	Quantity (L - conc)	Assessment	Media used
450 L	01-08/1989	27/3	400 - 20x	405-570 – 20x	Thioglycollate broth
Fermenter 1,480 (1,000) L x 6 Fermenter 1,480 (600) L x 1	02-12/1989	18.2/7.8	5,400 – 20x	20,700-27,450 – 20x	Thioglycollate broth, CYG medium
	01-08/1990	11.1/3.9	3,340 – 20x		
Fermenter 1,850 (1,500 or 1,200) L x 2	02-12/1989	18.2/7.8	2,800 – 20x		Thioglycollate broth, CYG Medium
	01-08/1990	11.1/3.9	1,660 – 20x		
			13,600 - 20x	21,105-28,020 – 20x	

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Production of Bacillus anthracis (agent B)

Iraq's declaration on the production of agent B in 1990 is supported by the 1990 Al Hakam annual report. The annual report, which UNMOVIC regards as credible, covers not only activities at the Al Hakam plant but also at other facilities including FMD Vaccine Al Dora plant. Thus the report provides evidence of the production of 8,425 litres of agent B in 1990. However there is no information to support Iraq's declaration for other years and Iraq has acknowledged that the figure of 20 litres in 1989 was an estimate.

Iraq has given conflicting information in its CAFCD regarding the production of agent B. Forty two successful batches of Bacillus anthracis spores were declared as being produced during the period from March 1989 (at the Al Salman site) to December 1990 (at the Al Hakam site). In Chapter 5, page 92 of the CAFCD the total amount of 10 times concentrated spores produced at the Al Hakam site has been given as about 8,500 litres. The average production of concentrated product per month was stated as 75 litres for June - July 1990, and 2,069 litres for August-December 1990 which would have resulted in 10,495 litres in total. Also, the declared working volume of fermenters and number of successful runs indicate a possible production of about 11,770 litres concentrated spores (Table V.VII.IV).

Table V.VII.IV. Declared and assessed usage of fermenters and production of Agent B at the Al Hakam Factory.

Fermenter volume (working volume)	Date	Runs (successful/failed)	Quantity (L - conc)	Assessment	Media used
450 L	06-07/1990 (05-06/90 ?)	5/1	150 - 10 x	~570 – 10x (19 successful batches could have been produced 08/1989-08/1990)	Modified G medium (N Broth for subculture)
Fermenter 1,850 (1,500 or 1,200) L x 2	08-12/1990	14/2	3,390 – 10x	3,900 – 10x	Modified G medium, Nutrient Broth
Fermenter 1,480 (1,000) L x 6 Fermenter 1,480 (600) L x 1	09-12/1990	5/1	3,000 – 10x	7,300 – 10x	Modified G medium, N Broth for sub-culture
	12/1990	3/0	1,885 – 10x		
			8,425 - 10x	11,770 – 10x	

The 450 litre fermenter was used for the production of all three Bacillus species, and the accumulated number of batches indicates a frequency of one batch per week. The failure rate was on average 17%. The fermenter was not in use in the November/December 1989 period (due to the said participation in a field test, problems with drying of B. thuringiensis, and a visit to a manufacturer for spray dryers), April-May 1990 (due to maintenance, and preparation for a field test), and August-December 1990 (due to order to increase production of agent B using the VRL

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line).

Between August 1989 and March 1990, Iraq declared the production of 18 and 2 batches of B. subtilis and B. thuringiensis, respectively (Table V.VII.VI), using the 450 litre fermenter. With one batch per week this would have consumed 20 weeks (or 140 days). Thus, theoretically and not taking the down-periods of the fermenter into account, between August 1989 and August 1990, 196 days would have been free for production of Bacillus anthracis. If one were to allow 10% maintenance time and a two week shut-down for major maintenance, 162 days could have been used for production of anthrax spores, corresponding to about 23 batches. With a 17% failure rate this would give 19 successful batches, to be compared with 5 successful batches, as declared by Iraq.

The VRL (Al Kindi) line was declared as being used for the production of Bacillus anthracis spores from August to end of December 1990. During this 5 month period 9 and 16 batches were produced using the 1,480 (about 0.5 batch per week) and 1,850 (about 0.8 batch per week) litre fermenters, respectively. The failure rate was about 12% for the two types of fermenters (Figure V.VII.XI). When these fermenters were used for the production of agent A, about 0.5-0.6 batches were produced every week, according to information in the CAFCD.

It is reasonable to assume that at least one batch per week could have been produced (the residence time in the production fermenters was 36-48 hours). If one were to allow a 10% shutdown time for maintenance, 108 (1,480 litre fermenters) and 135 days (1,850 litre fermenters) could have been used for production resulting in 15 and 19 batches. With a failure rate of 12% it is possible that Iraq produced 12 and 16 successful batches using the 1,480 and 1,850 litre fermenters, respectively. This would have resulted in about 7,300 and 3,900 litres of concentrated spores (Table V.VII.V).

Production of Bacillus subtilis and Bacillus thuringiensis (simulants for agent B)

Between August and October 1989, Iraq declared the production of 10 batches of B. subtilis. In 1990, Iraq declared the production of 8 and 2 batches of B. subtilis and B. thuringiensis, respectively, using the 450 litre fermenter (Table V.VII.V). Moreover, in January 1991, one of the VRL line fermenters was used for production of one batch of B. subtilis.

Simulants for agent B had earlier been produced at Salman Pak. Some 300 litres of unconcentrated Bacillus subtilis suspension were produced for field experiments (weapons trials) using the 14 litre fermenters in 1988. In addition according to Iraq, spores were produced on solid media for trials of the Zubaidy device at Khan Bani Saad in 1989. In January and February 1989, 150 litres of ten times concentrated B. subtilis suspension were produced using the 150 litre fermenter. According to testimony given to UNSCOM, in addition, 50 litres of 10 times concentrated B. megaterium and 20 litres of 10 times concentrated B. thuringiensis were produced in 1988 using the 150 litre fermenter at Salman Pak. This, however, is not mentioned in the CAFCD, or the September 1997 FFCD.

UNMOVIC's main concern is the adequacy of Iraq's account of its production and use of BW agent simulants. Iraq used chemicals and bacteria, such as the spore-forming bacterium B. subtilis, as simulants for different BW agents to model the properties of anthrax (agent B) and Clostridium perfringens (agent G).

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Table V.VII.V. Declared production of *B. subtilis* and *thuringiensis* using the 450 litre and 1,850 litre fermenters

Fermenter volume (working volume)	Date	Runs (successful/failed)	Quantity (L - concentrated)	Media used
<i>Bacillus subtilis</i>				
450 L	08-10/1989	8/2	240-250 - 10x	Nutrient Broth
	01-02/1990	7/1	200 or 250 – 10x (?)	
Fermenter 1,850 (1,500 or 1,200) L x 1	01/1991	1/-	100 – 12x	Nutrient Broth
			540-550 - ~10x	
<i>Bacillus thuringiensis</i>				
450 L	03/1990	2/0	50 - >10x	Nutrient Broth
			50 - >10x	

Some discrepancies remain concerning the quantities and times of production of simulants, as well as the number and dates of their use as reported in Iraq's 1997 BW FFCD and the 2002 CAFCD. For example, Iraq has not provided any account for simulant production in connection with the tests it carried out with a helicopter spraying device, the testing of the 450 litre fermenter, and the training of personnel in bulk production using a 1,850 litre fermenter at Al Hakam. Also, Iraq has not adequately explained the rationale for the production of the bacteria B. megaterium at Salman Pak in 1988, the reason for acquiring strains of B. licheniformis for the BW programme in 1985, and the reason for having B. pumilus at Al Hakam in 1991. These types of bacteria have utility as BW agent simulants.

The quantity of simulant produced is a factor in the consideration of the overall material balance of bacterial BW agents. The production of simulant consumes bacterial growth media and utilizes fermenters that otherwise might have been used in the production of real BW agent. The more simulant that was produced the less agent may have been produced, and vice versa. The timing of production is also of interest since it may be a pointer to the number of and when weapons tests were conducted.

Production of Clostridium perfringens (agent G)

In total, Iraq has declared the production of 31 successful batches, 30 using the 150 litre fermenter and 1 using the 340 litre fermenter, of C. perfringens spores resulting in a total of 340 litres of concentrated product (Table V.VII.VI).

The 150 litre fermenter was used for 4 months (Aug-Nov) in 1990. Allowing for 10% shutdown time for maintenance, a batch frequency of 2-4 batches per week (cleaning/sterilization of fermenter - 1 day, checking sterility over night, fermentation 10-12 hours, and the precipitation of

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spores 6-8 hours), and a 12% failure rate, 24-48 batches could have been produced.

Table V.VII.VI. Declared and assessed production of *C. perfringens* at the Al Hakam Factory

Fermenter volume (working volume)	Date	Runs (successful/failed)	Quantity (L - concentrated)	Assessment	Media used
340 L	08/1990	1/0	20 – 10x	20 – 10x	M-medium and RCM medium
150 L	08-11/1990	30/4	320 – 10x	260-510 – 10x (24-48 batches could have been produced)	M-medium and RCM medium
			340 - 10x	280-530 – 10x	

The 340 litre fermenter was used for one month (August) in 1990, thereafter it was used for production of Bacillus anthracis.

*The reason for not starting production until the second half of 1990 has been stated as to have been due to missing media, specifically tryptone. However, it is worth noting that according to the declared studies on the medium used, the usage of tryptone instead of peptone resulted in only a 3-fold higher concentration of spores. Also, other published sporulation media for *C. perfringens* contains peptone instead of tryptone. Procurement information indicates that 1,600 kg of peptone was delivered around mid-1988. Also, there was a delivery of 500 kg tryptone in January 1988. Thus, both peptone and tryptone seems to have been available. Furthermore, another component of the medium was ordered at end of February 1989, and possibly delivered in April of that year.*

According to statement by Iraq in 2003 the reason for not starting production until the second half of 1990 was lack of sufficient equipment and staff. This is in line with 1990 Al Hakam Annual Report, which states that the agent G team was directed for the production of agent B.

No reason has been given as to why agent G was not produced in the 450 litre fermenter which was idle following the production of Bacillus anthracis in July 1990 (Figure V.VII.XI), and despite the plans to use it. In a document written by Professor Hindawi on 11 October 1989, he states regarding agent G: "...Our production is on the laboratory scale. Quantitative production will take place in the 450 litre fermenter at the Protein Project located at Jerf Al-Sakr." The Al Hakam report mentions that all other production equipment was used for agents A and B, indicating that the 450 litre fermenter was also being used for that purpose. However, this has been denied by Iraq. Iraq speculated that the 450 litre fermenter was broken. This, despite the fact, that agent B was produced in this fermenter in 6 batches; with five successful batches just 1-2 months earlier.

The 1990 Annual Report for the Al Hakam Division refers to the production of 340 litres of concentrated agent G, which supports Iraq's declaration for that year. Iraq declared that agent G was not produced in 1989 and 1991. Iraq indicated some production in its 1988 annual report

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(for the Biological Research Department), casting doubt on the 340 litre total. In addition, there is a considerable amount of peptone unaccounted for (see above) which gives cause for concern that much larger quantities of agent G had been produced than declared by Iraq.

Production in 1991

Information available to UNMOVIC from a number of sources contradicts Iraq's assertion that total production was limited to 8,425 litres of agent B. A report dated August 1991, from a Member State, gives an account of the status of aspects of Iraq's BW programme in 1991. UNMOVIC considers this report to be credible because of references to some detailed information that can be confirmed from other sources. The report describes the location of Iraqi BW bombs, warheads and 1m³ tanks filled with agents A, B, and C during the Gulf War. From the numbers of each item referred to in the report, and their known capacities, the total amount of these agents is calculated by UNMOVIC to have been about 36,000 litres. Iraq declared that a total of 29,000 litres of agents A, B and C had been produced and hence the report indicates that there was about 7,000 litres of BW agent produced in addition to that declared by Iraq. Although the report from the Member States does not give sufficient detail to enable UNMOVIC to determine whether the additional agent was A, B or C, there are several pieces of evidence as indicated below to suggest that it was probably agent B.

*Iraqi officials have indicated that agent B production had high priority after August 1990. According to Iraq, it had produced only 170 litres of agent B up to August 1990, compared with around 14,000 litres of agent A. Although Iraqi officials have stated that the BW drop tank project was for use with a range of agents, UNMOVIC assesses that the intention was for the system to be used with agent B (anthrax). Indeed, Iraq initially disclosed to UNSCOM that the system was for use with agent B. This would also be consistent with the spraying of *Bacillus subtilis* as a simulant for agent B in the declared final field test of the prototype tank. Given that the BW drop tank project was initiated at the end of November 1990, and if it had been intended for use with agent B, this would have placed great demand on production of that agent. The 12 tanks that were said to have been planned would have required up to 26,000 litres of agent B and this would therefore be expected to have been the target production figure at the end of 1990/early 1991. Even the four tanks that were said to have been completed sometime during the Gulf War would have required more agent B than was stated to have been available after the declared filling of bombs and warheads.*

From the 1990 Al Hakam Annual Report, it is evident that agent B was not produced at FMD Vaccine plant in that year and, therefore, it seems likely that production actually occurred between 1 and 15 January 1991 prior to the Gulf War. In fact, interview testimony from one senior Iraqi scientist at the plant indicates that, contrary to Iraq's declaration, the fermenters at that site did operate in the first half of January 1991, although the scientist was unable to provide information on what was being produced. However, no definitive proof has been obtained by UNMOVIC showing that agent B was indeed produced at FMD vaccine plant.

Because of the requirement for the quantity and capacity of various delivery systems envisaged for agent B, it seems likely that fermenters at Al Hakam also operated in early 1991 for this purpose. Together, the fermenters at FMD Vaccine plant and Al Hakam would have had a capacity to produce about 7,000 litres of agent B in the first two weeks of 1991. This quantity closely corresponds to the additional amount of agent indicated in the report from a Member State.

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Alternatively, taking the assessed amount of produced agent B (Table V.VII.V) into consideration, and assuming that 2 batches were produced using the 1,850 and 1,480 litre fermenters in 1991, the undeclared production of agent B would be about 5,000 litres.

The production of 7,000 litres of agent B would consume about 140 kg of the growth medium component yeast extract. This is within the margin of error of UNMOVIC's estimate of the quantity of yeast extract that is unaccounted for. It is also the amount (141 kg) of yeast extract that Iraq stated was stolen, or otherwise lost.

Even if additional bulk agent was produced in 1991, it was most likely all destroyed in the summer of 1991. Neither UN inspectors nor the ISG found evidence of any remaining bulk biological warfare agent and the destruction was confirmed by interview testimony to the ISG.

Drying of agent

Iraq was unsuccessful in the period 1989/1990 in acquiring a special spray dryer to dry safely large quantities of anthrax as confirmed by the potential supplier. There was at least one spray dryer present at Al Hakam from 1988 onwards. This dryer would have been suitable for drying BW agent if specific safety modifications had been made, but there was no evidence of such modifications and the dryer tested negative for anthrax and Clostridium botulinum DNA.

In any event, it seems likely that no bulk drying of agent took place in either 1989 or 1990. Apparently, in 1989, large-scale BW agent production was in its initial phase and Iraq was expecting to obtain from an overseas company a special dryer for its future requirements. Therefore, there seemed to be little reason, at that time, to modify existing dryers to make them safe for BW agent drying. The Al Hakam Annual Report for 1990 makes no reference to large-scale drying of BW agents, implying that no drying occurred in that year either. The annual report, which UNMOVIC considers reliable, indicates that research into the drying of anthrax continued in 1990, but even this ceased for that year when the foreign company failed to supply the special dryer. UN inspectors verified that the R-400 bombs did have a liquid fill and this is dealt with in greater detail in Chapter V.X. Since Iraq did not obtain the special dryer it had sought, it seems unlikely that in 1991 it had modified existing dryers at Al Hakam. By 1993, Iraq was successfully drying large quantities of a bacterial biopesticide using a non-pathogenic spore forming bacteria at Al Hakam. Evidently, the technology for drying bulk quantities of spore-forming bacteria had been gained at some time prior to this date.

CHAPTER V.VIII

FOOT AND MOUTH DISEASE VACCINE PLANT IN AL DORA

Overview

The Foot and Mouth Disease (FMD) Vaccine plant in Al Dora was planned and built from 1977 to 1982 as a turnkey facility by a foreign contractor. In 1983, the foreign technicians left the plant. The facility was designed to produce FMD vaccine against three viral strains endemic in Iraq. The production method was based on cell culture grown in fermenters. The facility was designed to produce 12 million doses annually, but Iraq never produced more than 900,000 doses annually after 1984.⁽¹⁾

Iraq stated that when it was first decided that the FMD vaccine facility should be transferred to the TRC in 1990, the original concept was to continue FMD vaccine production in one part of the facility, while another part was to be used for the BW programme. For this reason, some vessels were relocated within the facility, and five brick walls were built to separate BW agent production from the FMD vaccine production. Due to the difficulties associated with using the one facility for two purposes and the associated security aspects involved, vaccine production ceased temporarily in late 1990. The whole site was formally transferred to TRC and named Al Manal in 1990.

In September 1990, Iraq started to convert a section of the Al Dora facility for the production of *Clostridium botulinum* toxin as well as for viral research for the BW programme.⁽²⁾ Production of botulinum toxin at Al Manal was performed and supervised by staff from Al Hakam. According to Iraq, a total of 5,000 litres of concentrated botulinum toxin was produced in Al Dora from November 1990 to January 1991, and research on three viruses (camelpox virus, rotavirus, Enterovirus 70) as potentially incapacitating biological agents was started.

When BW agent production stopped in January 1991, the partitions including the brick walls were removed and the original design configuration was restored and some batches of FMD vaccine were produced.

In response to the requirements of Security Council resolution 687 (1991), Iraq declared the FMD vaccine plant as a vaccine facility in a letter dated 22 May 1991 to UNSCOM. Later, in July 1995, Iraq disclosed its bulk BW agent production programme. The FMD vaccine plant was declared by Iraq in August 1995 following the defection of General Hussein Kamel when Iraq also disclosed further aspects its past BW programme. The production of botulinum toxin and research on viral BW agents at Al Dora was also revealed.

¹ Biological CAFCD December 2002 Chapter 6

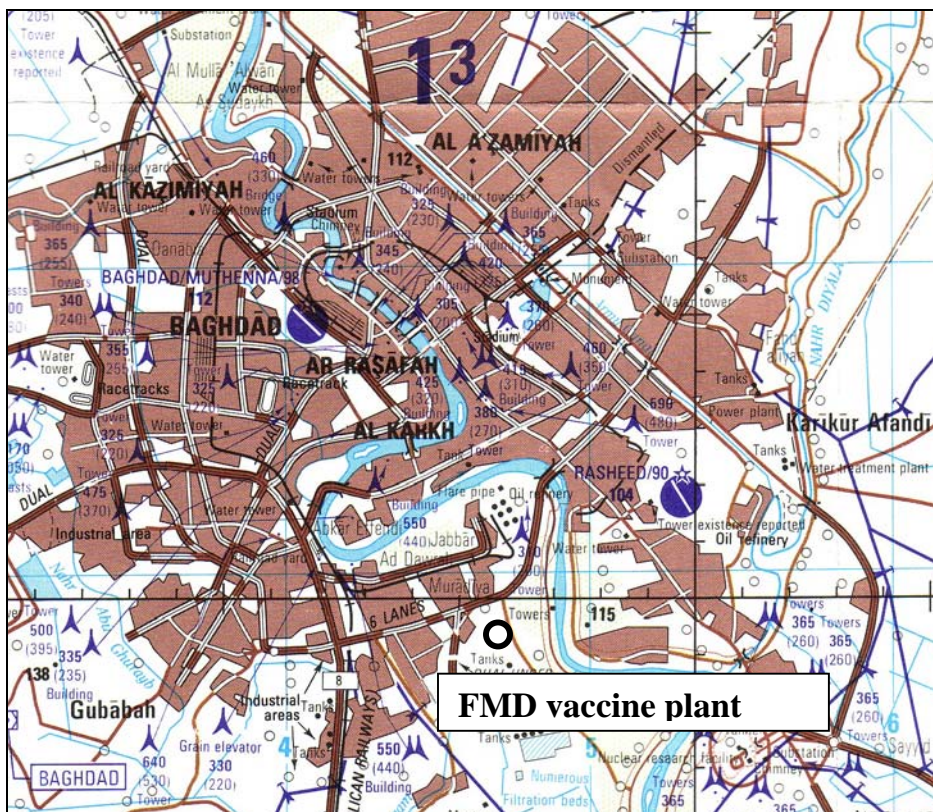
² Biological CAFCD December 2002 Chapter 6

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Location and site

The FMD vaccine plant is located in the area of Al Dora; some 10 km south of Baghdad (Map V.VIII.I).³ It was operated by the General Veterinary Body and financed by the Ministry of Agriculture from 1991 to 1998.

Map V.VIII.I. Location of Al Dora FMD vaccine plant

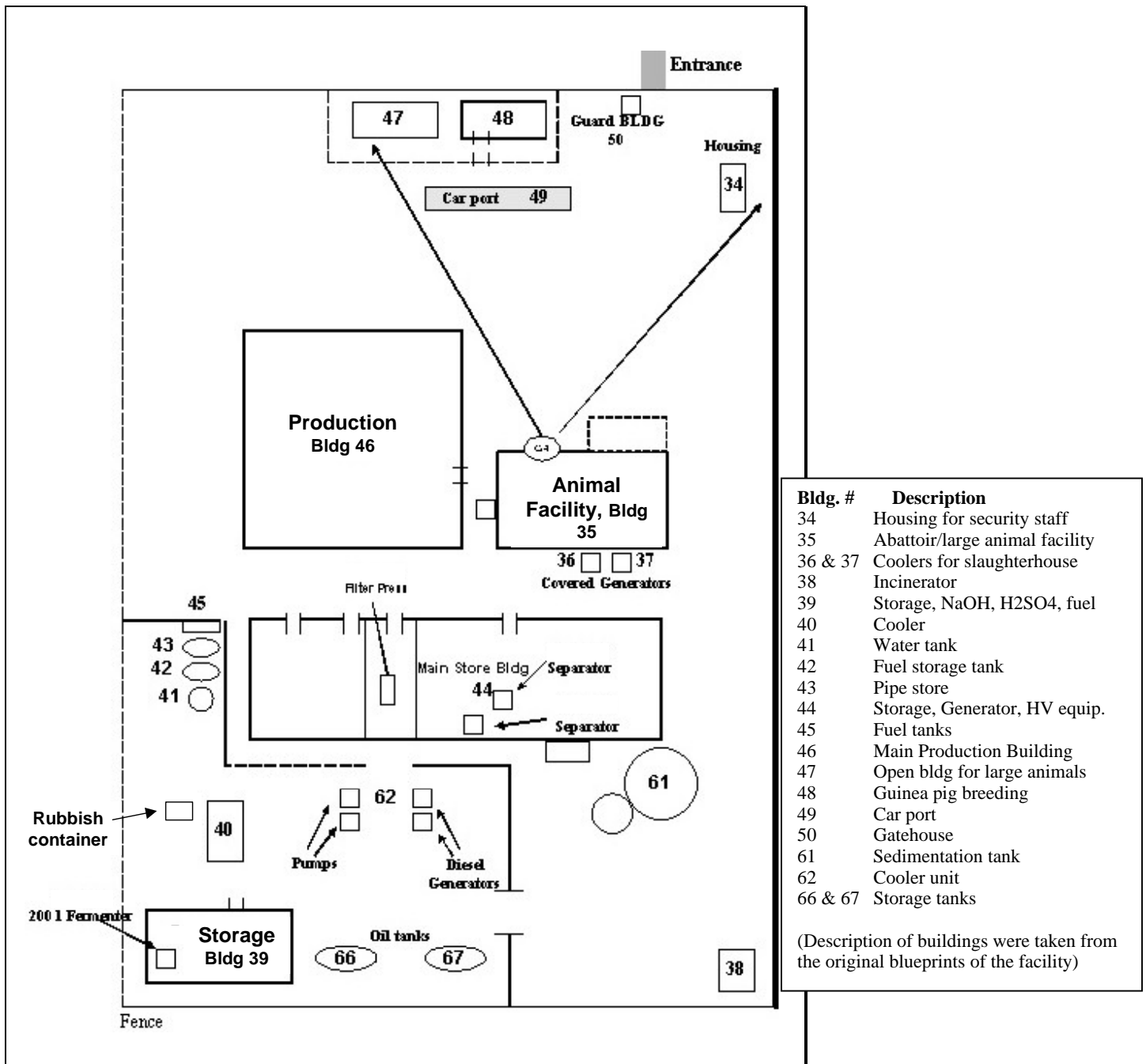


The site size is about 100m x 70m, and is adjacent to a large slaughterhouse complex. The plant includes one major production and laboratory building (No. 46), a warehouse (No. 44), an animal facility (No. 35) and some minor buildings (Figures V.VIII.I and II).

³ Address: Al-Boethay Street, Dora

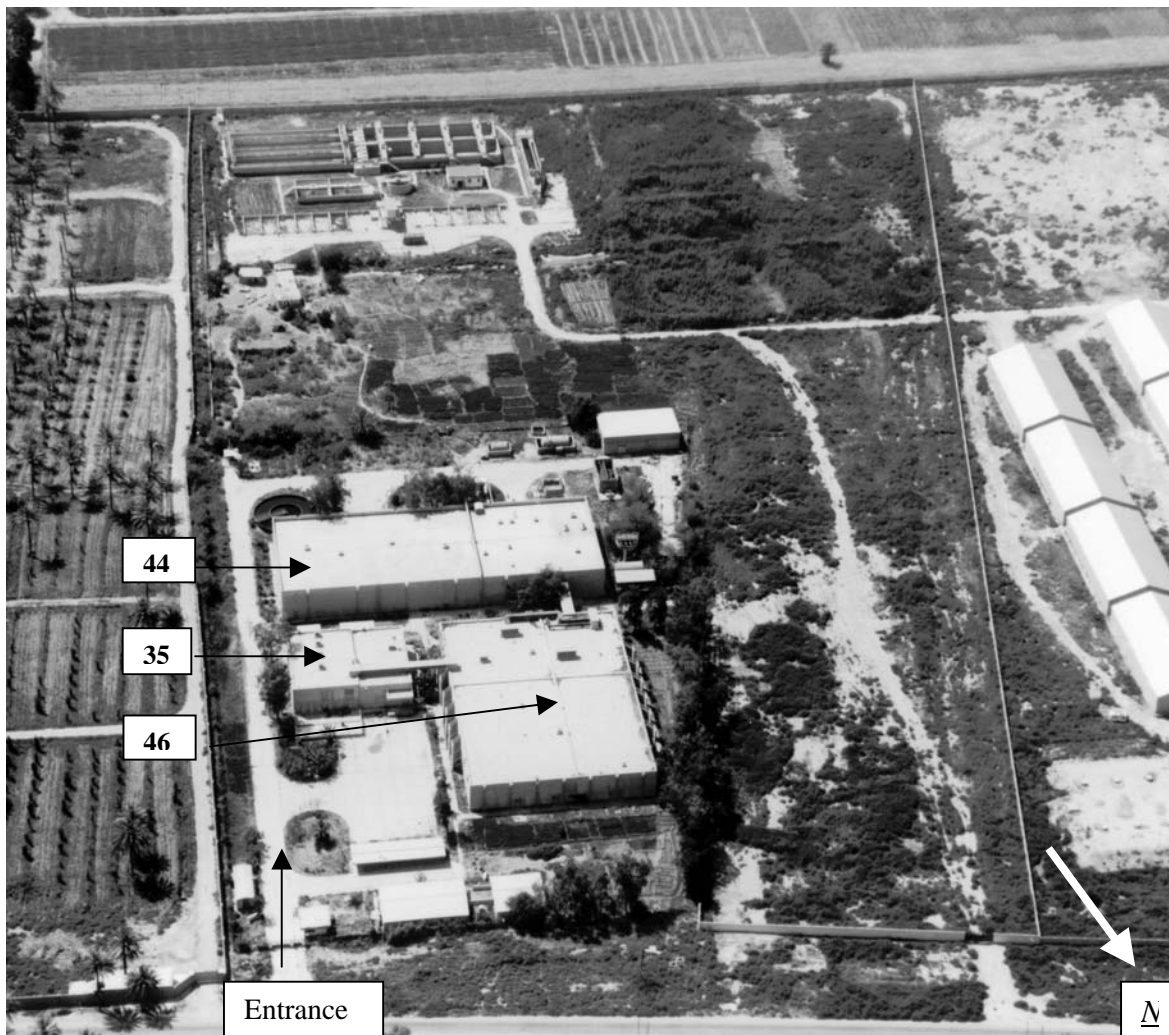
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Figure V.VIII.I. Site map of Al Dora FMD vaccine plant updated map as of August 1998, showing buildings, some major equipment and camera positions from the past monitoring.



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Figure V.VIII.II: Aerial picture of Al Dora FMD vaccine plant. The picture is turned 180° with respect to Figure V.VIII.I.

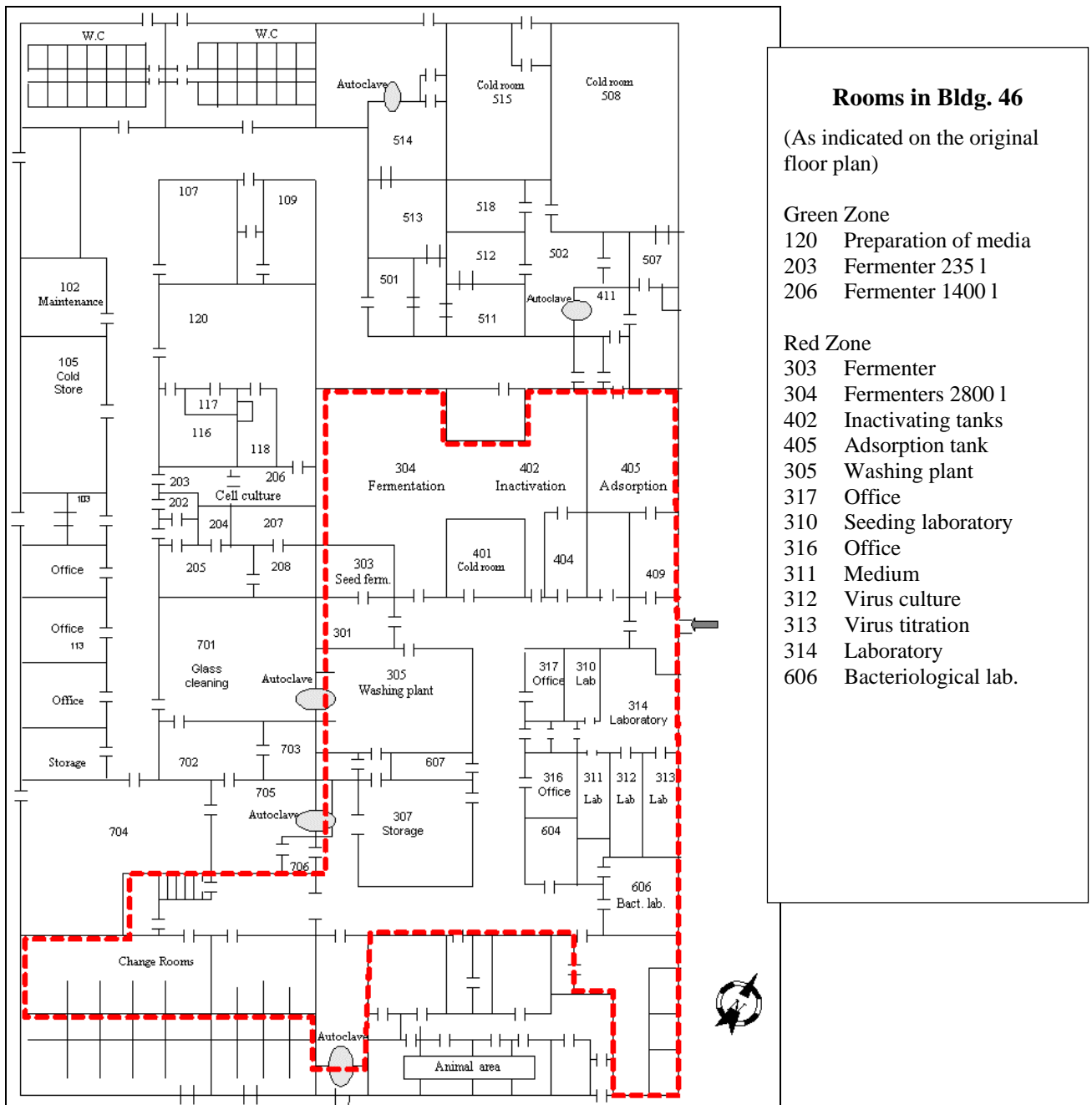


Production and research laboratory building (# 46)

According to Iraq, building # 46 housed the FMD vaccine production area as well as research/quality control laboratories. It is a two-story high building, with administration offices and technical services areas on the upper floor and the main production and laboratory area on the ground floor. The building was divided into two sections, the 'red zone', where live FMD virus was produced but not inactivated yet, and the 'green zone' where the FMD virus was inactivated to produce FMD vaccine (Figure V.VIII.III). The zones had separate air conditioning systems.

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Figure V.VIII.III. Building # 46, ground floor and original layout. The dashed line indicates the 'red zone' area where work with live FMD virus was conducted. Major fermentation equipment was located in hall 402/304. Original drawings from the contractor company indicate that these were initially planned as separate rooms, but before construction it was decided to build it as one big fermentation hall. The sketch is based on a drawing prepared by a UN biological monitoring team in August 1998, the original building plans and blue prints were provided by Iraq with photographs taken on site.



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Infrastructure and equipment

According to Iraq, the facility was designed and built for the production of FMD vaccine, with all utilities and equipment needed for that process. At Al Dora, FMD vaccine was produced using a cell culture method, which comprises several steps:

1. Media for cell culture was prepared in room 120 (see Figure V.VIII.III).
2. Cells were cultured in a 1400 litre fermenter in the green zone (room 206).
3. Cell suspension was transferred to large fermenters in the 'red zone' (room 304), where it was inoculated with live FMD virus.
4. The resulting viral suspension was concentrated using separators and transferred to inactivation tanks, where the virus was killed using chemical treatment (room 402).
5. To further concentrate the inactivated virus and to enhance antigenicity, the suspension was transferred to adsorption tanks where aluminium hydroxide was added. Viral particles adsorb the mineral particles, which eventually settle in the tank (room 405).
6. The resulting slurry of FMD vaccine was transferred to the 'green zone' where the product was further processed, including mixing of different strains to form a multivalent vaccine bottling and packaging of the final product.

The production process was supported by a variety of laboratories for quality control purposes as well as for the preparation of inoculum. Some of these were located in the 'red zone' (rooms 310-314). These laboratories were well equipped to handle the live virus.

The process required large quantities of bovine serum for the cell culture. It is likely that several thousand litres of blood had to be processed to sustain FMD vaccine production. The FMD vaccine facility was built adjacent to a slaughterhouse,⁴ from which calf blood was collected for FMD plant where serum was separated, inactivated and used for vaccine production.

All utilities needed to run the facility at bio-safety level 2 or 3 were present, including an air handling system with HEPA filters, sterile, normal and deionised water, steam, and a comprehensive effluent decontamination system, but with no negative pressure system.

For quality control purposes, a variety of laboratory animals were present at the site. A small animal area within the production/laboratory building (# 46) provided space to work with guinea pigs. Adjacent to that building, a larger animal facility to handle cattle was built (bldg. 35).

Major fermentation equipment was installed in various areas of building # 46. Some of these were originally designated as 'fermenters', others as 'tanks'. This reflected their purpose in the FMD vaccine production process, but some of the tanks were essentially

⁴ This slaughterhouse is not to be confused with the (comparatively small) abattoir built on site for quality control purposes (building 35 in figures 2 and 3). The slaughterhouse adjacent to the FMD vaccine site had the prime purpose to supply meat and was already located there prior to building the FMD vaccine production plant.

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capable of functioning as fermenters, as they were equipped with stirrers and a jacket. Below is a list all vessels (Table V.VIII.I) on site that were capable of functioning as fermenters.

Table V.VIII.I. Fermenters and tanks at Al Dora as designed for FMD vaccine production.⁵

Quantity	Volume (liters)	Working volume	Original purpose	location (room #)	Use in FMD vaccine production
Red zone					
1	141	100	Fermenter	303	Seed for virus production
2	2950	2400	Fermenters	304	Virus production
2	2100		Tanks	402	Inactivation
1	2600		Tank	405	Adsorption
1	260		Tank	405	Alum preparation
Green zone					
1	2550		Tank	Mobile	Serum mixing
1	2600		Tank	120	Media preparation
1	235	200	Fermenter	203	Seed for cell culture
1	1425	1000	Fermenter	206	Cell culture
1	3500		Tank	511	Vaccine mixing

Table V.VIII.II. Equipment at the FMD vaccine site as of 28 November 2002 ⁶ These items were, according to Iraq not involved in the BW programme and were thus not destroyed by UN inspectors in 1996. However, they were tagged and monitored, as they constitute a significant dual use capability.

Location	Equipment
Bldg 46 Rm 511	Tank, double jacketed mixing
Bldg 46 Rm 203	Fermenter, 236 L.
Bldg 44 Storage	Separator
Bldg 46 Rm 107	Filter press
Bldg 46 Rm 511	Power switch and recorder board
Bldg 46 Rm 203	Central Control Unit
Bldg 46 Rm 402	Filter Press
Bldg 46 Rm 402	Separator
Bldg 46 Rm 402	Separator
Bldg 44 Storage	Filter Press
Bldg 44 Storage	Separator
Bldg 46 Rm 118	Filter Press
Bldg 39	Fermenter

Five centrifuges/separators, four filter presses and five double-ended autoclaves (Figure V.VIII.IV for their exact location) were also declared on site.⁷

⁵ This compilation is based on the inspection reports of UNSCOM 72/BW 4, April 1994 and UNSCOM 78/BW 5, May - June 1994, the Iraqi declaration for the FMD vaccine production department, 15/7/1993 to 15/1/1994 and the Biological CAFCD December 2002. Working volumes as given by Iraq in the CAFCD

⁶ UNMOVIC inspection AIG0001

⁷ Semi-annual FMD plant site declarations from 1995, 1996

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Conversion of the facility for BW work

According to information provided by Iraq, the FMD vaccine site was chosen for BW-related activities in August 1990.⁸ This was said to be based on orders given by General Hussein Kamel in August 1990 “to increase the production capacity of biological agents”.⁹ In a parallel development, a virologist was recruited for the BW programme in July 1990, and he proposed to establish viral and other research laboratories at the FMD vaccine site after he judged Al Hakam to be unsuitable for this type of work.¹⁰

An original Iraqi document indicates that the ownership of the FMD Division was formally transferred – free of charge – from the Ministry of Agriculture to MIC-TRC on 6. September 1990.¹¹ It appears that this transfer was based on the understanding that the TRC would continue to produce FMD vaccine in Al Dora.¹² After transfer of ownership, the virologist recruited for the BW programme stated that he was placed in charge of the site.¹³

According to interview evidence, on 3 September 1990 before the formal transfer of the site, the virologist proposed detailed modifications to the FMD vaccine site that would allow the continuation of FMD vaccine production in parallel to producing BW agents. He also proposed establishing BW laboratories for fungal, bacteriological and viral and genetic engineering work. Table V.VIII.III summarizes the sequence of events and dates related to the conversion of the FMD vaccine plant for BW purposes.

To achieve the site conversion, Iraq divided the ‘red zone’ into two separate areas by building several brick walls (Figure V.VIII.IV). These partitions were later removed. After the revelation of BW agent production at the FMD vaccine site, Iraq presented the physical evidence for the removed partitions to UNSCOM in 1995 (Figure V.VIII.V).

⁸ UNSCOM notes from the high level meetings in Baghdad on 17 to 20 August 1995. During this meeting, weaponization of BW agents and the involvement of the FMD vaccine site was acknowledged for the first time by Iraq.

⁹ According to the Biological CAFCD of 2002

¹⁰ Statement from the virologist to UNSCOM 125/BW 27, August 1995

¹¹ Letter from the Head of the Presidency Bureau, to the MIC, dated 6. September 1990. This document was handed over to the Executive Chairman on 30 September 1995.

¹² This was indicated in a letter from General Hussein Kamel to the Office of the President, 21 August 1990.

¹³ Statement from the virologist to UNSCOM 125/BW 27, August 1995

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Table V.VIII.III: Timeline for the conversion of the FMD vaccine facility for BW programme.

Date	Activity	Reference
22 Oct 1988	Suggestion from scientists involved in the BW programme to establish within the BW programme expertise on viruses and genetic engineering.	Special report to TRC, dated 20 October 1988.
Jul 1990	Virologist started work at TRC	Statement from the virologist to UNSCOM 125
Jul 1990	<i>“Viral activity at TRC was started”</i>	CAFCO, p. 106
Aug 1990	General Hussein Kamel ordered increase in production capacity of BW agents	CAFCO, p. 106
20 Aug 1990	Verbal agreement between MIC and Ministry of Agriculture to transfer ownership of the FMD vaccine plant under the condition to continue vaccine production.	Letter from General Hussein Kamel to the Office of the President, 21 August 1990
21 Aug	Letter from General Hussein Kamel to the Office of the President, formally requesting transfer of ownership to TRC.	
3 Sep 1990	Virologist suggested specific modifications of the FMD vaccine site, for both viral research and the production of biological agents.	Letter from the virologist to the <i>“Director, Al-Hakam Project”</i>
6 Sep 1990	Notification to MIC of the decision to transfer ownership to TRC.	Letter from the Presidential Bureau to MIC
6 Sep 1990	Virologist from the BW programme started work at FMD vaccine	UNSCOM 126
23 Sep 1990	Name of Al Manal for the FMD vaccine site is suggested.	Letter from a senior Iraqi official to his superiors ¹⁴
End Sep 1990	One BW scientist came from Al-Hakam to oversee botulinum toxin production	UNSCOM 126
Oct 1990	Decision to produce botulinum toxin at FMD vaccine plant	Statement from the Al Dora virologist to UNSCOM 125
15 Nov. 1990	Production of botulinum toxin at FMD vaccine plant started	CAFCO, p.116
1 Dec 1990	Virus research at FMD vaccine plant started	UNSCOM 126, CAFCO p. 114
17 Jan 1991	Virus research at FMD vaccine plant ended	CAFCO p. 114
Jan 1991	Virologist left FMD vaccine plant	Statement from the virologist to UNSCOM 125 and UNMOVIC in 2003

¹⁴ UNSCOM doc. no. 133078.

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Figure V.VIII.IV: Separating FMD vaccine from BW work. The dashed line indicates the dividing line between vaccine work (left) and BW work (right). To achieve this, walls had been built at locations as indicated by the arrows and dashed lines.

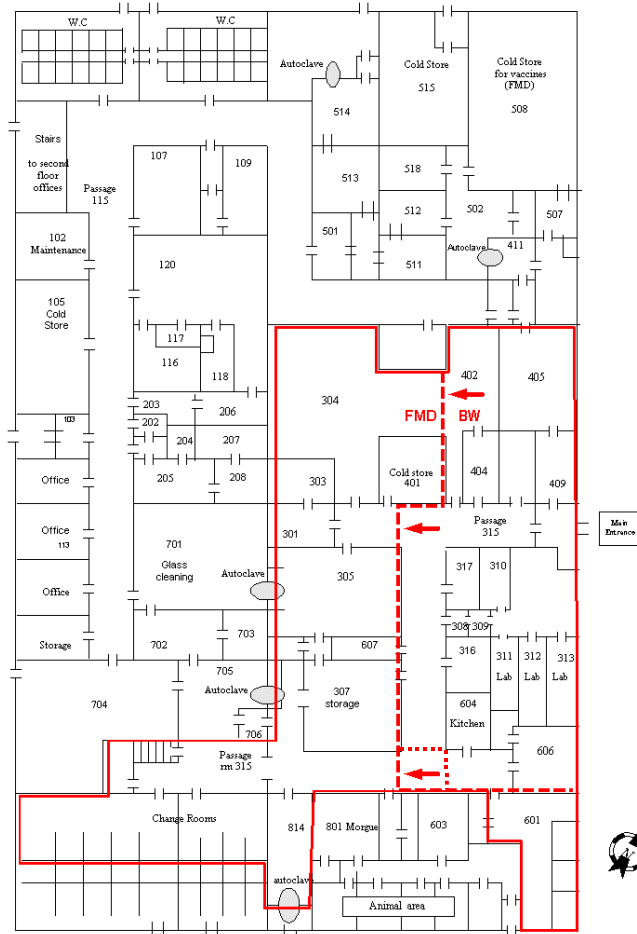


Figure V.VIII.V: Removed partitions. Evidence for removed partitions at the southern end of the hallway in the red zone is shown (see lower arrow in Figure V.VIII.IV).



According to the CAFCD, modifications were made to the equipment used for FMD vaccine production to make it more suitable to produce BW agent. The modifications included the reconfiguration of ports and probes of two fermenters.

Room number 404 was equipped for bacteriological laboratory work. An incubator, oven, spectrophotometer, balance and pH-meter were brought from Al Hakam to assist in BW agent production and were returned later.¹⁵

Five veterinarians and four technicians from the FMD vaccine staff assisted in BW related activities. The other FMD vaccine staff remained on site for about 20 days after

¹⁵ Biological CAFCD December 2002 Chapter 6.3

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TRC took over to finish up FMD vaccine production and was then sent home on full pay by TRC.¹⁶

BW activities

According to the CAFCD, two types of BW-related activities took place at the FMD vaccine plant from September 1990 to January 1991; production of botulinum toxin, and research on three viral agents.

In a proposal to his superiors, the virologist at Al Dora suggested also the establishment of laboratories for work on fungi and genetic engineering.¹⁷ According to his testimony, this part of his proposal was never followed through and no fungal, genetic engineering or bacterial work was ever performed at the FMD vaccine site [other than the production of botulinum toxin].¹⁸

Research on viral BW agents¹⁹

The 'red zone' of the FMD vaccine plant comprised several laboratories equipped for work with cell cultures. In the course of vaccine production it was needed for the preparation of seed inoculum of live Foot and Mouth Disease virus.

After the dismissal of Salman Pak and Al Hakam as suitable sites for viral BW-research, the virologist decided to establish the viral work of the Iraqi BW programme at the FMD vaccine plant. Iraq declared that viral BW work started on 1 December 1990 and was terminated on 17 January 1991 as supported by laboratory logbook handed to the Commission. The following rooms at FMD vaccine became part of the viral BW research (Figure V.VIII.VI):

Rooms 311-313	Laboratories, each with an area of about 10m ²
Room 314	Laboratory, about 30m ²
Rooms 316/317	Offices/rest rooms

The following equipment at the FMD vaccine plant was used for BW research work:

- Centrifuge w/ cooling capability
- Incubator
- Microscope
- Deep freezer
- Refrigerator
- Water bath

An unspecified number of 25 litre fermenters were received from Al Kindi, but were returned later. Attempts to acquire a freeze dryer and an egg incubator for the viral research programme were said to have failed.

¹⁶ UNSCOM 126/BW 28, September – October 1995 and UNSCOM 127/BW29, December 1995

¹⁷ Letter from the Al Dora virologist, 3 September 1990, to the "*Director, Al-Hakam Project*"

¹⁸ UNSCOM 128/EXIM 2, March 1996, interview with the virologist.

¹⁹ If not otherwise indicated, this information was submitted with the Biological CAFCD December 2002.

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Iraq declared research work with three viruses intended for use as incapacitating agents:

1. Enterovirus 70: The virus isolate was obtained from a clinical sample and propagated on two different cell cultures (Vero, HeLa). The virus' pathogenicity was (unsuccessfully) tested in small animals.

2. Rotavirus: The virus was obtained from Iraqi Health Service laboratory, propagated in cell culture and was (unsuccessfully) tested for pathogenicity in small animals.

3. Camelpox virus: Eggs were inoculated with a sample obtained from the Iraqi Veterinary Central Diagnosis Laboratory to propagate the virus. No further work was conducted on camelpox. Iraq failed in obtaining a 5,000-egg incubator intended for the production of the virus.²⁰

The virologist declared to UNSCOM 125 and later in the FFCD of 1995 that he had considered two other viral agents, yellow fever virus and Congo-Crimean hemorrhagic fever virus. Work on these agents did not progress, as insect vectors required for those viruses had not been readily available. He explicitly stated "I did not say that the reason is the lack of containment, but the lack of special means to raise the disease carrier".²¹

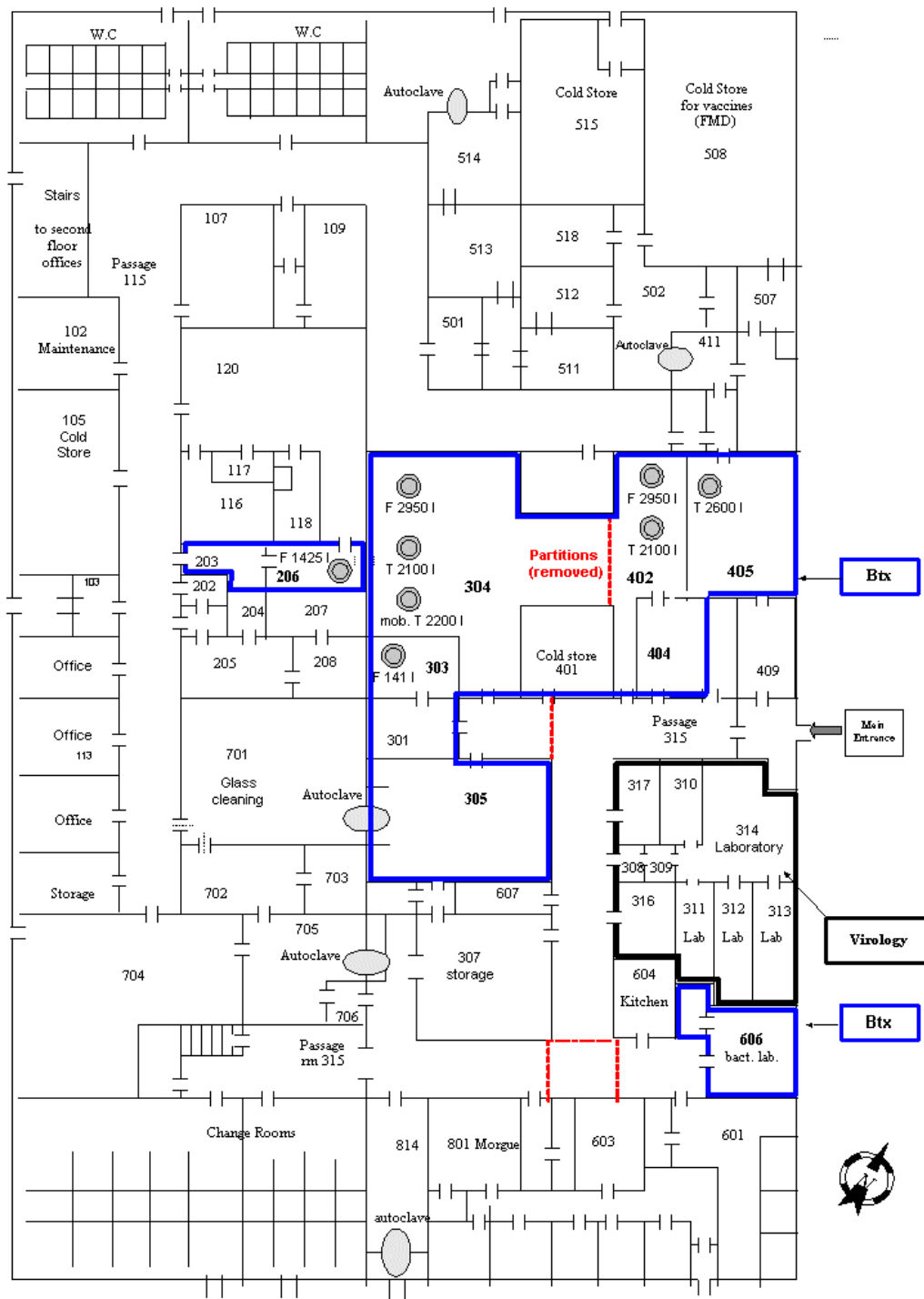
²⁰ UNSCOM 125 - BW/27, August 1995

²¹ UNSCOM 125 - BW/27, August 1995, Session 12, Annex Q

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Figure V.VIII.VI. Diagram of building # 46 Research on viral BW agents took place in laboratory area rooms 310 – 317, (black line). Production of botulinum toxin was performed in the major fermentation areas (405 and 402) as well as in two smaller fermentation rooms (203 and 206). Laboratory 606 was used for quality control. F= fermenter; T= tank.



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Production of botulinum toxin

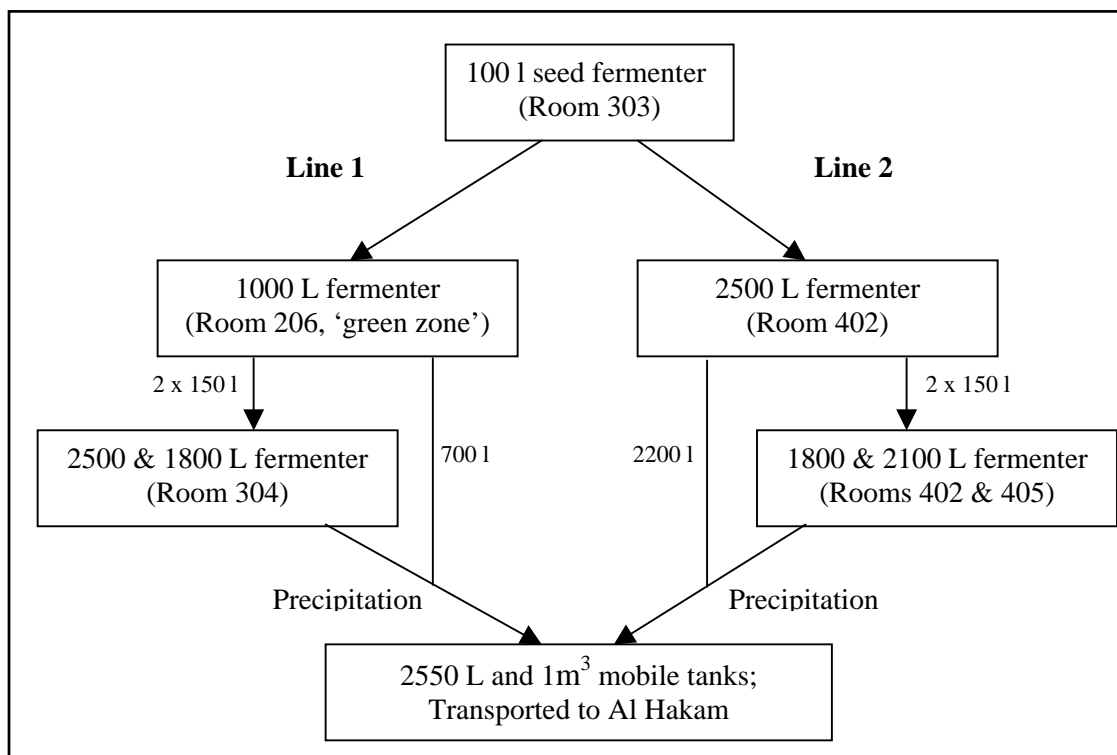
After TRC took over the FMD vaccine plant in September 1990, it was considered for the production of botulinum toxin. During 1989 and until August 1990, botulinum toxin had been produced at Al Hakam. In order to fulfill General Hussein Kamel's demand to increase production of BW agents, Al Hakam switched entirely to anthrax production and botulinum toxin production was moved to Al Dora.

Different from earlier plans to continue FMD vaccine production in one part of the 'red zone' while using the other part for the BW programme, Iraq decided to stop entirely the production of FMD vaccine and to maximize BW agent production by using nearly all fermentation capacity on site. According to Iraq, production started in November 1990, when all necessary modifications were completed.

The combined process of two simultaneous but separate production lines (Figure V.VIII.VII) was considered by Iraq to be one production 'run'. The total fermentation volume of the two lines was approximately 11,100 liters, resulting in some 0.55m³ final product (20 times concentrated) per run. The Iraqi declaration was based on an estimated total production volume of 12,000 litres per run. According to one diagram presented to UN inspectors, the inoculum volume was added to the 'working volume', that is, the final volume for each of the big fermenters was about 150 litres larger than indicated by the 'working volume'. Some of the equipment used for botulinum toxin production is in Figure V.VIII.VIII.

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Figure V.VIII.VII. Fermenters used in the production of botulinum toxin at Al Dora. ⁽²²⁾
Numbers indicate working volumes. The term ‘fermenter’ comprises both vessels that were originally intended to be fermenters and tanks with a fermentation capability.



The State Establishment for Heavy Engineering Equipment (SEHEE) produced the 1m³ stainless steel tanks that were used to transport final product to Al Hakam for Heavy Engineering Enterprises (SEHEE). A total of 7-8 of these tanks was available at Al Dora. Final product was dispatched to Al Hakam in two nighttime deliveries in December 1990.²³

²² Biological CAFCD December 2002 pages 106 – 116, UNSCOM 126/BW 28, September - October 1995

²³ UNSCOM 126/BW 28, October 1995, UNSCOM 127/BW 29, December 1995

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Figure V.VIII.VIII. Left, Mobile seed fermenter in room 303, and Right, Fermenters in room 304 of 2,950 and 2,100 liters capacity that were used for the production of botulinum toxin. In front of the fermenters to the right is a filter press and to the left a mobile tank. UN inspectors took this picture on 22 August 1994 in preparation for the ongoing monitoring and verification of the FMD vaccine site.



In addition to the fermenters and tanks declared in the CAFCD, Iraq also mentioned the presence of a 2,550 litre mobile tank in room 304 that was used for the production of botulinum toxin. This tank is of particular importance as it is the only piece of equipment in Al Dora that tested positive for virulent anthrax bacteria when sampled by UN inspectors in May 1996. The specific role of this tank in the production is not described in the CAFCD, but UNSCOM 127 reported that this tank was used “for continuation of the precipitation step.”

“The precipitate was pumped from the bottom of the tank to the mobile tank, and the tank was rolled into the cold room 401. Four - five mobile tanks were used; all but the one on site were from Al Hakam and were subsequently destroyed. After settling, more supernatant was taken off, and presumably, additional concentrate was added to the tank.” So that this mobile tank was used in the same way as the 1m³ stainless steel tanks mentioned above.

Since Iraq declared the involvement of this mobile tank in the botulinum toxin production process, it was destroyed under UN supervision in July 1996 together with all other equipment involved in BW agent production at Al Dora.

Toxicity control tests of the produced botulinum toxin were not performed at Al Dora but at Al Hakam.²⁴ Laboratory glassware for BW research was cleaned and sterilized in room

²⁴ UNSCOM 127/BW 29, December 1995

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305, using the double-ended autoclave.²⁵ Two laboratories in the 'red zone' (rooms 404 and 606) were used for tests during botulinum toxin production.

Destruction

The site air handling systems and equipment used for the BW programme were subjected to destruction or rendered harmless under UN supervision in July 1996. When UNMOVIC inspected the site in November 2002, the tagged equipment listed in Table V.VIII.II was still on site and there was no indication of any change to the building or any work being performed.

²⁵ UNSCOM 127/BW 29, December 1995

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Comment

Was Al Dora planned from the onset as a BW facility?

In analyzing the use of the FMD vaccine facility for the Iraqi BW programme, UN inspectors questioned whether this facility might have been planned as a possible BW agent production facility or general support facility for BW purposes by Iraq. Relevant to this question are both the timing of events and the size/capability of the facility.

The capacity of the site was designed for the production of 12 million doses of Foot and Mouth disease vaccine annually. This number may refer either to monovalent or to trivalent doses. It was planned to produce three different strains of the FMD virus and mix them in a final step to form a trivalent final product. If the overall capacity was 12 million monovalent doses, this would have resulted in 4 million doses of final trivalent product. It should be noted that vaccine production numbers are generally only rough estimates. FMD vaccine production is a biological process that is subject to significant fluctuations in yield. In addition, different strains can differ substantially in their efficacy to produce a vaccine response, i.e. for some strains a much higher quantity (up to 5 fold and more) of final product is needed to make one dose. However, considering that the facility in Al Dora was planned by a company with a long history of expertise in FMD vaccine production, it can be assumed that the plant was appropriately designed to produce roughly 12 million doses of the three strains selected by Iraq. UN inspectors never finally established the exact meaning of the 12 million doses. One internal Iraqi document from 1990, which was retrieved by UN inspectors, indicates that the plant was in fact suited to produce 36 million monovalent doses, equaling 12 million trivalent doses. The same paper mentions that the actual need in Iraq was not more than 2.35 million trivalent doses.²⁶

FMD vaccine may be needed for cattle, sheep, goats and camels. There are no confirmed numbers of farm animals in Iraq available and the relevant FAO database does not contain entries for Iraq. In testimony given to UN inspectors it was stated that before 1990, some 1 million cattle and 3.5 million sheep were in Iraq.²⁷ The number of vaccine shots per animal can range from 1 (in a well vaccinated animal population) to 3 per year.

Taking all these numbers together it appears that the long-term needs of Iraq for FMD vaccine is well below 12 million trivalent doses annually. If vaccinated regularly, not more than 1 shot per year/animal would have been necessary. And even if it is assumed that in addition to the 4.5 million cattle/sheep several million goats and camels were farmed in Iraq, a production capacity of 12 million trivalent doses appeared to be far beyond the domestic need. This conclusion is also supported by an internal Iraqi document (doc. no. 145035.152) cited above.

²⁶ Document No. 145035.152, titled 'Transfer of ownership/foot and mouth disease project, from 6 September 1990.

²⁷ UNSCOM 53/BW 3, March 1993, Annex D.

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However, FMD vaccine production capacity far beyond the domestic need could easily be explained by a desire to market FMD vaccine internationally. In many cases, Iraq had constructed facilities with a production capacity beyond domestic requirements with the vision of becoming a Middle East regional supplier (such as the Baby Milk Factory in Abu Ghraib) and vaccines produced at Al Kindi that was also sold outside Iraq.

An UNMOVIC expert with personal experience in building and running similar FMD vaccine facilities in various countries analyzed the layout and design of the Al Dora plant. He came to the conclusion that all of its features corresponded well with international standards of that time and that neither the overall size of the facility nor particular items such as laboratory space or animal facilities go beyond the needs of a dedicated FMD vaccine facility.

The only notable exception from this pattern, as identified by the UNMOVIC expert, is the presence of 5 double-ended autoclaves in the main production building (Figures V.VIII.IV and V.VIII.VII). In similar plants elsewhere, 2-3 autoclaves have been considered to be sufficient. All 5 autoclaves were built into the facility at the same time, as indicated by the fact that they were produced by the same manufacturer and have five consecutive serial numbers. The significance of this deviation remains unclear.

The fact that the FMD vaccine plant was built next to a huge slaughterhouse may also be conceived as an irregularity. From a bio-safety point of view it would be preferable to have no cattle in the vicinity of a facility that handles the highly contagious FMD virus, to minimize possible escape routes for the virus if it is accidentally released into the environment. On the other hand, the slaughterhouse was a temporary holding pen for cattle and was far less of a bio-safety concern than grazing cattle near the plant. It seems that Iraq choose to combine the slaughterhouse and the FMD vaccine plant in one area for reasons that may include the ease of transportation of the valuable bovine serum or a tendency to centralize sites related to the cattle industry.

Planning for the FMD vaccine plant was initiated in the mid-1970s, although the exact year could not be established. At about that time, the first Iraqi attempt to establish a BW capability at the Al Hazen Ibn Al Haitham Institute was underway. A targeted and ultimately successful BW programme did not emerge before 1986 in Iraq, and the one dedicated Iraqi BW facility we know of – Al Hakam – was planned at the earliest around that time. It is thus rather unlikely that the FMD vaccine plant was conceived from the beginning as a dedicated BW facility solely intended to produce BW agents once handed over by the Western contractor.

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UNMOVIC has no evidence to support the hypothesis that the FMD vaccine plant was part of a long-term plan to indirectly increase BW agent production capability. Considering the fact that – apart from two additional autoclaves – nothing in the facility deviates from international standards at that time, it can be concluded that it is rather unlikely that Iraq planned this facility from the onset as a direct contribution to a BW programme. It was more likely to have been only an opportunistic take over to contribute to the requirements for a surge in production capability.

The timeline for the conversion of the FMD vaccine plant for BW activities as given by Iraq is probably correct: (1) the date of the formal transfer of ownership of the site to TRC is supported by several original Iraqi documents;²⁸ and (2) the dates given for the conversion of the FMD vaccine site for BW agent production correspond with the time when the Iraqi leadership increased its emphasis on the BW programme in the summer of 1990.

Production of botulinum toxin

The question is how much more botulinum toxin Iraq could have produced if the fermenters at Al Dora were used for this purpose until 15 January 1991 and not the 31st of December 1990. The Annual Report of 1990 for the Al Hakam project, which is considered to be a reliable source, indicate that the total production volume for the 47 days from 15. November – 31 December 1990 was 5m³ of 20 times concentrated botulinum toxin. Iraq declared that this was based on “about” 9 runs of which only one partial run failed. This appears credible, as the total calculated volume produced with 9 runs would be 4.95 – 5.4m³, based on the total production volume outlined above. This indicates that the mean time per run was about 5 days, which is also consistent with the process outlined above and is considered to be a reasonable estimate by UNMOVIC.

Hence, at least another three runs could have been performed from 1 – 15 January 1991 with a maximum total production volume of about 1.65 – 1.8 m³. Considering that Iraq, after the defection of General Hussein Kamel, initially declared production runs through January 1991 and that several individuals repeated this in the years thereafter, it appears to be likely that at least some BW agent was indeed produced in addition to the 5m³ of botulinum toxin indicated in the Annual Report for 1990.

The concentration of the toxin in the final product of the Iraqi BW programme was not well defined. That an end product of a specific fermentation run was concentrated 10 times or 20 times is no indication of the concentration of the active ingredient, as fermentation runs can differ significantly in terms of yield. This fact ridicules to a certain extent a discussion about the total volume of botulinum toxin produced at Al Dora. Suspensions of undefined concentrations can easily be diluted or concentrated resulting in different volumes of suspension of equally undefined concentrations.

²⁸ See footnote 11.

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Was anthrax also produced at Al Dora?

After Iraq revealed the involvement of the FMD vaccine plant in the BW programme in 1995, UN inspectors questioned whether Al Dora might have been used not only for the production of botulinum toxin, but also for the production of anthrax spores. Iraq, however, categorically denied the production of any BW agent other than botulinum toxin at Al Dora.

The anthrax samples

UNSCOM 145 took a total of 41 samples at the FMD vaccine facility in May 1996. Of these, three samples (Table V.VIII.IV) tested positive for anthrax using a genetic test. All three samples (#223, #291, and #299) tested positive for the Lethal Factor and the Protective Antigen of Bacillus anthracis, indicating that genetic material from anthrax bacteria harboring the plasmid pX01 was present in these samples. However, only one sample (#291) also tested positive for capsule A & B genes. Anthrax strains without these genes, such as the Sterne vaccine strain, are considered to be non-virulent. No detailed genetic analysis was performed to determine the exact nature of the strain(s).

Table V.VIII.IV. Samples from the FMD vaccine facility that tested positive for anthrax. LF, Lethal Factor, PA, Protective Antigen, and CA, Capsule. It remains unclear from which vessel sample #299 was taken, as the description given by UNSCOM 145 and the equipment tag number do not correspond. The item was a 236 litre fermenter located in room 203 and not a media transfer vessel in room 120.

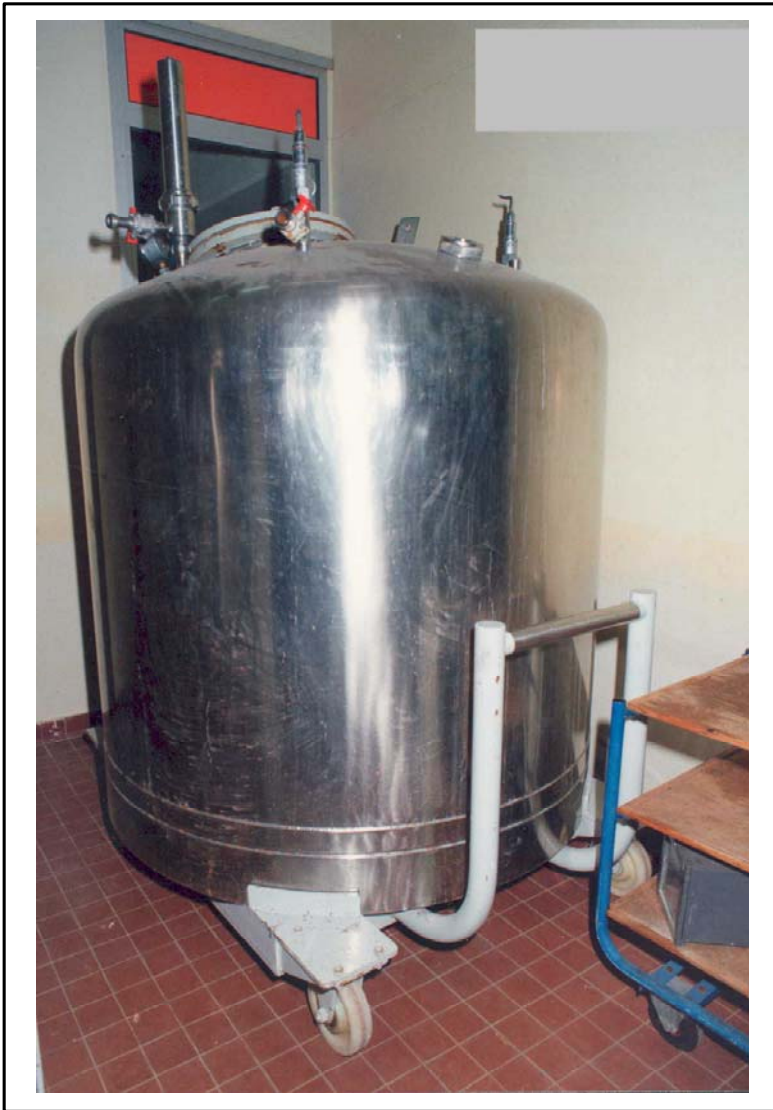
Sample #	Equipment	Room	Sample location	Sample result		
				LF	PA	CA
223	Fermenter, 2,100 litre	402	Dry swab inside	+	+	—
291	Mobile tank, 2,550 litre, serial no. 783.043.79	402	Access port Plexiglas plate & washers	+	+	+
299	“Media transfer preparation vessel with stirrer motor” ²⁹	120	Plexiglas & "O" rings around port	+	+	—

The Sample #291 was taken from one piece of equipment, a mobile tank (Figure V.VIII.IX) located at that time in room 402. In 1994, UNSCOM 72 reported that this tank was being used for serum mixing in the process of FMD vaccine production.

²⁹ Quote from original table of samples taken in UNSCOM 145/BW/35, May 1996 inspection report.

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Figure V.VIII.IX Tank that tested positive for virulent anthrax



□

In the absence of any further identification of the exact nature of the strains identified in the three pieces of equipment at Al Dora, no final conclusion can be drawn with certainty. However, the sample results should be treated with caution, as scenarios other than BW anthrax production at Al Dora can explain the presence of a positive signal for anthrax in this equipment.

One possible explanation is contamination of the calf serum with anthrax bacteria. Calf serum is a key ingredient for FMD vaccine production, and serum for the FMD vaccine plant was obtained in large quantities from a nearby slaughterhouse. Considering that anthrax is prevalent in Iraq, it is more than likely that the serum used in FMD vaccine production was regularly contaminated with anthrax bacteria or DNA.

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Particularly, the one vessel that tested positive for virulent anthrax was used during FMD vaccine production for serum mixing. As the serum was duly sterilized in the process this did not interfere with FMD vaccine production, but the sterilization process would not have removed genetic element (DNA) of these anthrax contaminants. Hence, it may well be that the positive anthrax signals in the three pieces of equipment are remnants from the legitimate FMD vaccine production process. This scenario is supported by the fact that the anthrax strains identified in the three samples differ as indicated by the absence of virulence-related genes in two of the samples. This possibility could have been further verified by an in-depth analysis of Iraqi calf serum or sample taken from the slaughterhouse and a comparison of the strains identified in calf serum and those sampled by UNSCOM 145.

There might be another explanation for the contamination of the 2,550 litre mobile tank. In December 1995, prior to sample taking at Al Dora and before the question of anthrax at Al Dora even arose, Iraq declared to UNSCOM that this particular tank was used to precipitate and store botulinum toxin. Its contents were mixed with product from the 1m³ storage vessels that were used to transport final product to Al Hakam. The possibility cannot be excluded that vessels transported back and forth from Al Hakam were a source of anthrax contamination in the 2,550 litre mobile tank.

In July 1998, Iraq presented to UN inspectors another explanation for this result. According to this account, the 2,550 litre mobile tank was once transferred to Al Hakam, was used there to store anthrax spores and was later moved back to Al Dora. This account was considered by UN inspectors to be highly unlikely, as any evidence did not support it. It also appeared to have been nearly impossible to move this particular vessel to the exact location at Al Hakam pointed out by the Iraqis. Whether or not this explanation contains some truth is an open question since no genetic analysis was performed to identify the isolate, but even if true it would not explain the presence of (non-virulent) anthrax remnants in the other two pieces of equipment at Al Dora.

UNSCOM and UNMOVIC never found any additional evidence, be it documentary or through interviews, supporting the idea of anthrax production at Al Dora.

UN Inspectors concerns:

At the end of 1990, a large amount of bulk botulinum toxin had already been produced. According to Iraq, only part of it had been weaponized and abundant bulk botulinum toxin was available. At the same time spray tanks were under development that, according to Iraq, were intended for the dissemination of anthrax spores³⁰ and would have required large amounts of anthrax spores far beyond the bulk anthrax available at that time. According to the CAFCD, the project to develop spray tanks was initiated in November 1990, and two flight tests using water as a simulat were conducted in mid and end December 1990.

³⁰ UNSCOM 125/BW 27, August 1995, UNSCOM 126/BW 28, September – October 1995

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Based on the results of these flights, one trial with a bacterial simulant was conducted on 13 January 1991. The intention was to build a total of 12 spray tanks.

The timeline, as reported by the Iraqis in the CAFCD, suggested that at the end of 1990 Iraq was confident enough with the spray tank development to engage in further testing involving bacteria. It is conceivable that this increased the pressure on the BW programme to produce in a short time anthrax to fill a number of spray tanks, each of which would have required some 1,500 – 2,000 liters of concentrated anthrax. This in turn may have triggered Iraq to switch the FMD vaccine plant from botulinum toxin to anthrax production in early January.

Considering the Iraqi experience with converting production lines from botulinum to anthrax production (as gained in Al Hakam in 1990), UN inspectors assesses that this conversion could have taken place within a couple of days. As the 1990 Al Hakam Annual Report, an original Iraqi document that is considered a reliable source, does not mention anthrax production at Al Dora, this could have started earliest on 1 January 1991 and lasted a maximum of 15 days until the outbreak of war.

*A 1999 UNSCOM assessment was inconclusive in this regard, although it quoted the analytical results of samples from the facility as being “consistent with the strain used in Iraq’s BW programme.”³¹ This expression may be misleading. The genetic analysis of the sample did not identify the particular strain of anthrax in the sample and no relationship – close or distant – to the Iraqi BW strain was established with the analysis. The analysis only revealed the presence of genetic elements of *Bacillus anthracis*, which would be consistent with many strains of anthrax.*

Also the ISG concluded that “FMD vaccine produced anthrax” based on UNSCOM’s finding of anthrax traces in FMD vaccine equipment, an unnamed “Iraqi formerly involved in biological agent research”, and on a “smell of peptone two or three times a week” that was reported to ISG by an FMD vaccine staff member.³²

Raising the possibility that anthrax may have been produced at Al Dora can also be questioned based on the following two arguments. Firstly, until August 1995, UNSCOM had no concerns about the FMD vaccine plant, and only through Iraq’s revelation of many details of its former BW programme (after the defection of General Hussein Kamel) it learned of the FMD vaccine plant’s involvement in prohibited activities. During UNSCOM inspections 125 and 126 in August-October 1995, Iraq detailed the use of the Al Dora facility for viral research and botulinum toxin production. These accounts appeared to be consistent and comprehensive.

³¹ UNSCOM document 920003 of 2 September 1999

³² ISG report, biological part, page 10 and page 61

³³ Biological CAFDC November, 2002

³⁴ Special report from Dr Taha and others to TRC, dated 20 August 1988. Document number 902027. The translation of the relevant paragraph reads: “make available Scientific Cadre to be specialised in genetic engineering, viruses, *Rickettsia*, insects and rodentia that convey the biological factors”.

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It should be emphasized that Iraq declared the involvement of most of the major equipment at the FMD vaccine plant in BW related activities. If Iraq at that time had an intention to withhold relevant information for whatever reason, for example to save some equipment from destruction, they could have easily under-declared some of the most valuable items at Al Dora given the lack of knowledge or concern on UNSCOM's side. Given the extent of Iraq's declaration at that time it would make no sense for Iraq to declare so many details but withholding information on anthrax production in early January 1991 on site, particularly as this would not have made any difference in terms of destruction or political assessment.

Secondly, from mid-December 1990, Iraq expected that the war would start around mid-January, and orders were given to all sensitive sites to prepare for a relocation of all valuable items to safe locations. While this may not have stopped Iraq from producing BW agents until only few days before the estimated start of bombardment, it is hard to conceive that Iraq would have gone through the process of reconfiguring the Al Dora site in early January to produce anthrax for a maximum of 15 days in January when they were already preparing to dismantle and salvage the programme.

In summary, there are good arguments both for and against the notion that – in addition to botulinum toxin – also anthrax spores were produced at Al Dora. Unfortunately, the anthrax samples discussed above are inconclusive absent a further analysis of the exact strains identified on the three pieces of equipment from Al Dora. Considering that the sample results indicate the presence of different strains in different pieces of equipment, it is more likely that they stem from a contamination during FMD vaccine production than from producing the, one and single, BW strain of anthrax.

Duration of BW agent production at Al Dora

The question of for how long BW agents were produced in the FMD vaccine facility is considered to be important, as a longer production time would indicate a larger volume of produced biological weapons agent. It is also of relevance to the question as to whether – in addition to botulinum toxin – also anthrax was produced at Al Dora.

The date of initiation of BW agent production at Al Dora is not disputed, as it is indicated in an original Iraqi document. The 1990 Annual Report of the Al Hakam project indicates that botulinum toxin production started at Al Dora on 15 November. Both UNSCOM and UNMOVIC consider this document and the date of initiation to be reliable. Much more difficult to determine, however, is the date of the cessation of BW agent production at Al Dora.

Iraq's declarations on the exact time of botulinum toxin production at Al Dora were inconsistent throughout UNSCOM and UNMOVIC times. Also the CAFCD is contradictory in this regard: At some places it states that production ran from November 1990 to January 1991 (e.g. pages 106, 109), while at other places it states that production period was from 15 November to 31 December 1990 (page 116)³³.

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Iraq's initial declaration directly after the defection of General Hussein Kamel, the November 1995 Draft FFCD, gave the production dates at Al Dora as 15 November 1990 to 15 January 1991 (p. 220). A similar paragraph in later FFCDs and in the CAFCD (page 116) was changed to set the end of BW agent production at Al Dora to 31 December 1990, leaving the question open on what had happened at Al Dora from 1-15 January 1991.

Throughout the UNSCOM inspection process up until 1999, Iraqi personnel interviewed by UN inspectors differed in their accounts. UNSCOM 169, for example, reported that different interviewees declared different timeframes: two individuals indicated 15 January 1991 as the end of BW agent production at Al Dora, while one interviewee insisted on late December 1990. This may be taken as an indication that no central decision was taken to set the declared date to end of December 1990 and those differences in the FFCD and individual testimonies may rather reflect varying personal recollections.

Viral research

One original document from October 1988 indicates that already at that time there was thinking within the Iraqi BW programme to establish a viral and genetic engineering expertise.³⁴ No evidence available to UNMOVIC, however, suggests that BW work on viruses started in Iraq before the virologist was recruited in July 1990. UNSCOM also accepted the timing of the establishment of the viral research programme and the commencement of BW-related work at the FMD vaccine plant, Al Dora.

UNMOVIC assesses that Iraq's declaration with regard to its viral BW research programme is credible, since it is supported by two original documents related to the viral research activities at FMD vaccine plant: The Al Hakam Annual Report for 1990 and research log-books provided by the virologist for the period 1 December 1990 to 17 January 1991. Both documents provide supporting evidence of the timing and the scope of the BW virus research programme. Given its embryonic stage, the initial research was focused on aspects of cultivation and growth of incapacitating agents at a laboratory scale with which the head virologist was familiar, which were relatively safe to produce and locally available.

According to Iraq's declarations research was performed on three viruses as incapacitating agents. UNMOVIC has found no evidence to contradict Iraq's declaration in relation to its BW viral research programme. Scientific literature describing the symptoms and infectivity of the viral agents selected by Iraq confirm that, with the exception of camelpox virus, they could theoretically be used as incapacitating agents even though these viruses are not usually considered among the most likely BW agents in the open literature. Enterovirus 70 can cause severe eye pain, blurred vision, photophobia and sub-conjunctiva hemorrhage. The symptoms appear suddenly after 24 hours and recovery can take up to 10 days. The rotavirus causes diarrhea, dehydration and cramps usually among children with generally less severe cases in adults.

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After the defection of General Hussein Kamel to Jordan, he stated to then UNSCOM Chairman Rolf Ekeus on 22 August 1995, that Ebola virus was produced at Al Dora. However, no evidence for research or production work with Ebola virus was ever identified by UNSCOM or UNMOVIC. Ebola is an unlikely candidate for the Iraqi BW programme as work with Ebola is highly dangerous and requires maximum containment, considering that it causes a deadly disease, and that neither a vaccine nor a treatment is available. It is an open question why General Hussein Kamel referred to Ebola. A possible explanation may be that in technical communications with him there was a misunderstanding, deliberately or not, and the hemorrhagic fever virus Ebola referred to by General Hussein Kamel, was likely the hemorrhagic conjunctivitis virus Enterovirus 70. No evidence available to UNMOVIC suggests that BW-related research other than the viral work declared by Iraq ever took place at Al Dora.

The only open question with regard to the viral research programme relates to the possibility that camelpox virus, considered to be ineffective as a biological warfare agent, might have been intended as a simulant for smallpox virus i.e. that Iraq ultimately aimed at developing the highly lethal and contagious smallpox virus as a biological weapon. Despite much investigation, both Commissions (UNSCOM and UNMOVIC) have found no indications to support this view. Camelpox virus could have been studied as a possible incapacitation agent and the assertions that it was actually used as a surrogate for smallpox research are based on unsupported speculations. Also the ISG reported no evidence found to support that Iraq retained any stocks of smallpox or actively conducted research into this agent for BW intentions.

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AL FUDALIYAH

Overview

The Technical Research Center (TRC), which was in charge of the BW programme, took over the Centre for Agriculture and Water Resources at Al Fudaliyah in 1990. This site was then referred to as Al Safa'a. As it was the case with the Foot and Mouth Disease Vaccine Plant in Al Dora, it was acquired by the TRC to expand production of BW agents in the run-up to the Gulf War in 1991.

According to Iraq, a total of 2,200 litres of aflatoxin-solution were produced in the course of the former BW programme. Of these, 1,800 litres were produced at Al Fudaliyah in late 1990 and the first two weeks of 1991, using a labor-intensive manual production process using glass flasks. Most of the agent was shipped to Al Muthanna in late 1990 for weaponization, and a smaller quantity was transferred after the outbreak of war in January 1991, to Al Hakam, where it was later unilaterally destroyed by Iraq.

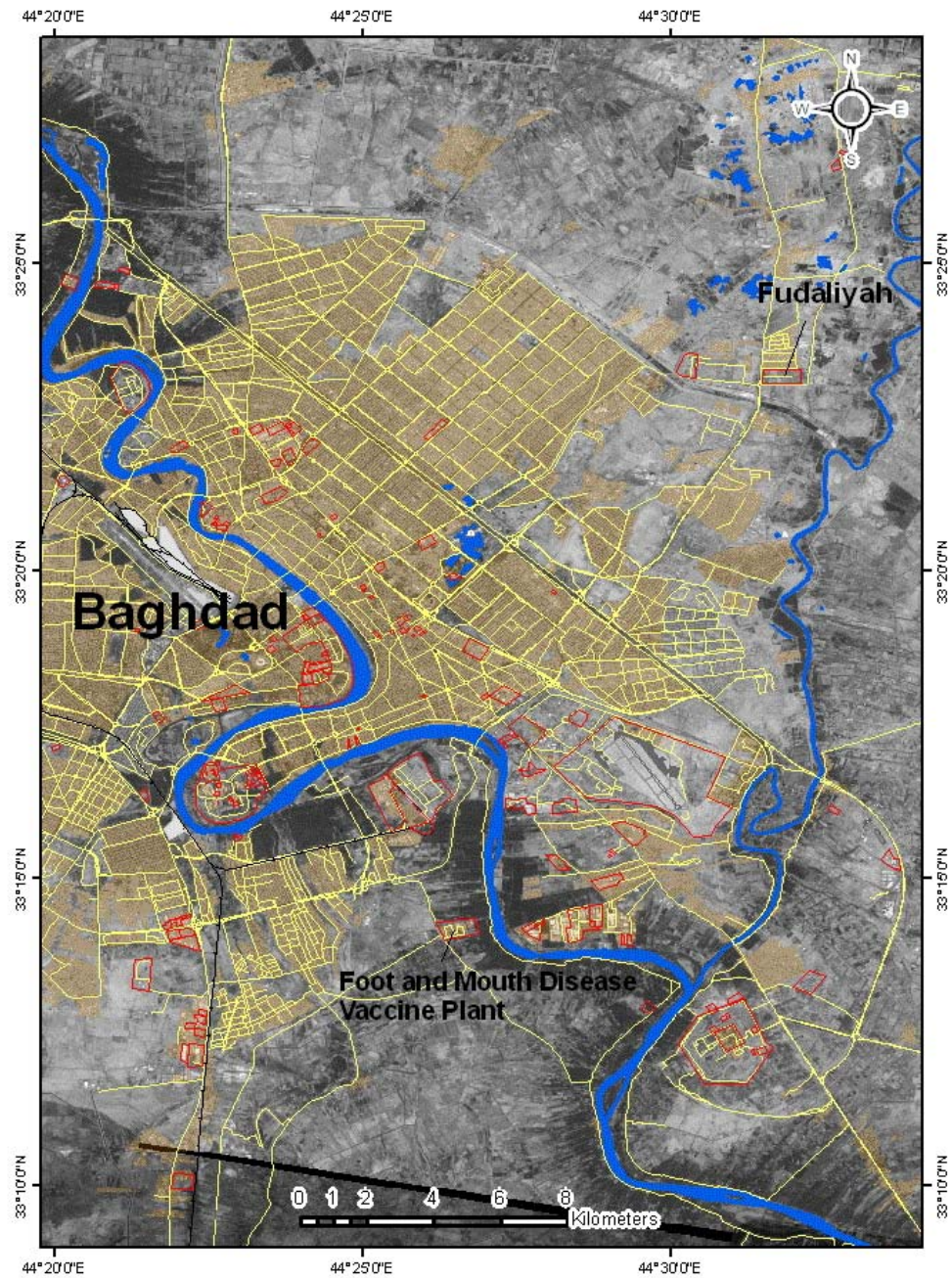
For several weeks in late 1990, a BW scientist tasked with establishing genetic engineering work, was also located at Al Fudaliyah, albeit without going beyond preparatory work.

Location and history

Al Fudaliyah was established in 1980 as the Centre for Agriculture and Water Resources under the Scientific Research Council (SRC). The site, which was 14km northeast of the centre of Baghdad, (Map V.IX.I) consisted of a rectangular plot of horticultural land 500m x 300m. It contained a number of buildings clustered in the centre of the site with several open vegetable growing areas (cloches) and greenhouses (Figures V.IX.I and II).

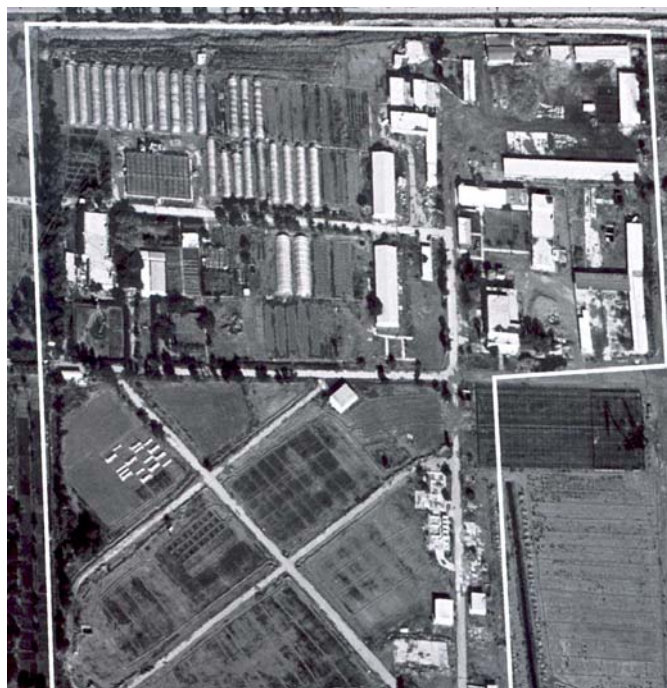
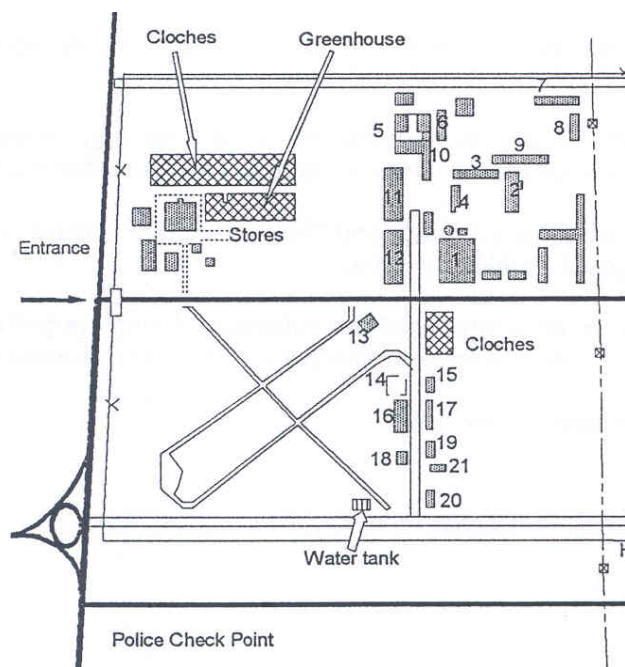
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Map V.IX.I Location of Fudaliyah Facility



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Figures V.IX.I and II: Site diagram and aerial picture of Al Fudaliyah



The site diagram and building designations were from UNSCOM 87 (1994), the aerial picture was taken in 1998.

- | | |
|---|---|
| 1 Three story concrete building; formerly yeast fermentation, distillation plant associated laboratories, they are used as a fertilizer store in 2003 | 10 Storage and small animal breeding facility according to UNSCOM 15 |
| 2 Administration | 11 Disused laboratory block, store |
| 3 Metal partitioned hut used for storage of hay sacks, and a small laboratory | 12 Disused laboratory block, store |
| 4 Store for used plastic polythene sheet | 13 Empty building, containing biosafety cabinet, formerly seed laboratory |
| 5 Laboratory building, two stores and small animal facility | 14 Demolished, formerly Dept. of Water Resources. |
| 6 Animal pens | 15 Cloches |
| 7 Animal pens | 16 Empty store |
| 8 Animal pens and storage | 17 Car port |
| 9 Animal pens and feed block manufacture | 18 Empty concrete building |
| | 19 Power distribution building with three seed dryers |
| | 20 Store |
| | 21 derelict hut |

According to Iraq, the site was comprised of personnel from the Department of Water Resources and the Department of Palm and Dates. The latter produced sugar, citric acid, and yeast from date juice and molasses. This facility contained a pilot plant for date sugar processing and included fermentation and storage vessels imported in 1979 and 1980. When the site was inspected for the first time by UNSCOM in 1991, four large animal pens as well as a small animal breeding facility were identified. In addition, other equipment was found such as: two fermenters (75 litre and 300 litre), evaporators, bio-safety cabinets, spray dryers, four large walk-in cooling units along with other laboratory

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equipment such as desiccators, a centrifuge, liquid nitrogen storage, several freezers, autoclave, oven and pH meters.

According to testimony given by the former Director of the Centre to UN inspectors in 1995, the Centre was dissolved in November 1989, and he left the site at the end of December 1989. He described four lines of research that were conducted throughout the 1980s, including palm horticulture, mechanization, sugar processing from dates and fermentation. The site was built in 1980 by a foreign contractor and the equipment was imported. No significant changes to the original design were made. According to the Director, when the Centre closed in late 1989, the 75 litre fermenter was in good condition and working, while the 300 litre fermenter was in disrepair due to a variety of technical problems and a lack of spare parts.

Aflatoxin production

In Chapter V.VI of this compendium, Iraq worked on mycotoxins at Salman Pak in May 1988, when a PhD mycologist (fungal expert) was recruited by TRC. The studies centered on trichothecene mycotoxins but later were directed toward aflatoxin. In 1990, Al Fudaliyah was affiliated to the TRC and subsequently used for the production of aflatoxin. There are differing Iraqi accounts of the exact timing when Al Fudaliyah was taken over by TRC. According to testimony given to UN inspectors in 1995, this happened in April 1990. Other UN inspection teams heard two different timelines from two former BW scientists, and the CAFCD states that the transfer happened in September 1990, after General Hussein Kamel gave orders in August 1990 to increase production of BW agents.¹ According to an internal secret Iraqi document from 27 September 1990, which was provided to the UN by Iraq, the transfer of Al Fudaliyah from the Ministry of Agriculture to the TRC was requested by the Presidential Office on 13 September 1990.² Al Fudaliyah was given the name of Al Safa'a by the Director of TRC. This development occurred at the same time as the change in affiliation and renaming of the FMDV plant in Dora (Chapter V.VIII).

According to the senior mycologist in the Iraqi BW programme, he visited several facilities in 1990 to find a suitable site for aflatoxin production. He stated that Al Fudaliyah was in very poor condition, and was chosen because there was no activity in the laboratory building, but it contained a lot of equipment and glassware. After the site was transferred from the Ministry of Agriculture to the TRC in September 1990 the fungal group repaired the cold rooms and used them as incubators. They failed however to get the 300 litre fermenter at Al Fudaliyah operational which confirmed the testimony given by the former director. Some of the utilities, such as water distillation units, were repaired while others including the steam generator, were beyond repair. The group decided to use glass flasks for the large-scale production of aflatoxin, as it was done at Salman Pak and described in a scientific publication.³

¹ Biological CAFCD, December, 2002 Chapter 7.1

² UNMOVIC doc. no. 700101.012

³ Interview conducted by UNSCOM 125/BW 27, August 1995

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Production process

Aflatoxin is also referred to as agent C by Iraq. After initial research on aflatoxin (production, extraction, toxicity evaluation and storage conditions), production started in 1989 at Salman Pak. Then production was continued on a larger scale at Al Fudaliyah in 1990.

Aflatoxin was produced using the growth of toxin-producing fungi on damp rice in individual 0.5-5 litre glass flasks, followed by organic extraction and filtration.

Iraq stated that, in order to maximize production, it established separate production-extraction-filling lines with the capacity to produce and extract aflatoxin simultaneously on a continuous 24-hour basis. The fungal group at Al Fudaliyah used a sequential system of overlapping batches in which some 900 glass flasks were equally divided into six different batches, which were prepared one after the other. When the first one went into the incubator, the next one would be prepared, and so on. Four rotary evaporators of 250 or 500ml capacity were operated to concentrate aflatoxin. This way, maximum use was made of staff and key equipment on site, such as the evaporators. Iraq stated that a total volume of 2,200 litres of aflatoxin-solution (10 mg/ml) was produced using this procedure. The final product was stored in 40 litre glass containers.⁴

The toxicity of each aflatoxin batch was evaluated on small animals and was considered by Iraq to be good. Animal testing was performed either on site, at Salman, Muthanna or Al Hakam. According to Iraq, thin layer chromatography was used to get an indication of the presence of the toxin in each batch upon which all batches were adjusted to a final toxin concentration of 10mg/ml.

The following buildings at Al Fudaliyah were involved in the production and testing of aflatoxin:⁵

- Building No. 1 was used for the preparation of medium, extraction/rotary evaporation of solvent and determination of toxin concentration.
- Building No. 4: Toxin collection. It contained four large incubators and an autoclave.
- Building 10 and one adjacent building: used to test the quality of each production run on small animals.

⁴Biological CAFCD December, 2002 Chapter 7.4 According to testimony given to UNSCOM 126/BW 28, October 1995

⁵ In this chapter only UNSCOM building designators are used.

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Figures V.IX.III and IV: Aflatoxin laboratory in building No. 10 and fume hoods in building 1⁶



According to the 2002 CAFCD, the following equipment was used for aflatoxin production at Al Fudaliyah:⁷

- 8 incubators
- 3 electric balances
- 2 stirrers
- 2 UV-cabinets
- 2 microscopes
- 3 autoclaves
- 4 refrigerators
- 4 ovens
- 3 large incubators
- 1 modified oven as incubator
- 5 rotary vacuum evaporators
- 3 water distillers
- 5 hoods
- 1 cold room
- 2 mixers
- 10 filtration funnels
- some 900 conical flasks with at total capacity of about 2000 litres.

Most of the equipment was transferred by Iraq from this site to Al Hakam in late 1991 and 1992, after the first UN inspection at Al Fudaliyah.⁸ All equipment from Al Fudaliyah that was used in the production of aflatoxin was destroyed at Al Hakam in June 1996, under UN supervision.

⁶ UNSCOM 125/BW 27, August 1995

⁷ Biological CAFCD December, 2002, Chapter 7.4

⁸ UNSCOM 15/BW 2, September – October 1991

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Amount and fate of aflatoxin produced

According to the CAFCD, a total of 1,800 litres of aflatoxin (at 10mg/ml) were produced at Al Fudaliyah in 1990 and in the first two weeks of 1991. In addition, some 400 litres were produced at Salman Pak, from January 1989 to July 1990.⁹

An internal Iraqi document, the 1990 Annual Report of the BW division, which is considered by UNMOVIC to be a reliable source, states that 2,200 litres of aflatoxin were produced in 1990, without giving the location of this production or the concentration of the product.

Iraq stated that no production records exist for Salman Pak, but that the production of aflatoxin at Salman Pak solely aimed at providing material for the weapons tests¹⁰ and thus was likely to be below 400 litres.

A small amount of aflatoxin solution was used for weapons test in November 1989 and May 1990 (see Chapter V.X for details on biological weaponization and weapons tests). For a static test using 122mm rockets in November 1989, about 40 litres of aflatoxin were used. Some 100 small animals, confined in cages hanging about 1m above the ground, were placed in circles around the rockets to determine the effectiveness of the toxin.¹¹

For dynamic tests in May 1990, a larger amount of aflatoxin was needed: this was produced at Salman Pak. According to Iraq, thirty 122mm rockets filled with aflatoxin were fired into a test grid in which some 300 small animals were placed.¹² As one 122mm rocket holds some 7-8 litre agent it can be estimated that a total of 200-250 litres of aflatoxin solution were used in the dynamic tests.

The results of these tests were considered by Iraq to be satisfactory. There is contradictory information provided by Iraq as to whether aflatoxin was also tested with R-400A bombs. While this was mentioned to UNSCOM 125 and 126, it was not included in the CAFCD.

Some 1300 litres of aflatoxin produced at Al Fudaliyah were transported in late November/early December 1990 to Muthanna for weaponisation.¹³ According to the CAFCD, seven R-400A aerial bombs and four Al Hussein warheads were filled with

⁹ Biological CAFCD December, 2002, Chapter 7.4 It should be noted here that the amounts of agent produced differ in different sections of the CAFCD. The amount of 1,800 litres of aflatoxin is given in the general description of the activities at Al Fudaliyah (Biological CAFCD December, 2002 Chapter 7). Chapter 10 of the Biological CAFCD December, 2002, however, contains contradictory information on aflatoxin production. In Table 18, the final quantity produced at Al Fudaliyah is given as 1901 litres aflatoxin, while in the Timeframe Table, it is stated that 2,160 litres were produced at Al Fudaliyah.

¹⁰ Biological CAFCD December, 2002 Chapter 3.3.6

¹¹ UNSCOM 126/BW 28, October 1995

¹² UNSCOM 126/BW 28, October 1995

¹³ UNSCOM doc. no. 125043 "Summary concerning the fate of 480 litres of agent C (aflatoxin)" prepared by Iraq and handed over to UNSCOM 125/BW 27, August 1995

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aflatoxin.¹⁴ A leftover of some 40 litres was destroyed at the filling site by pouring it on the ground and burning it, according to testimony given to UNSCOM 125.

A second batch of about 480 litres of aflatoxin was transferred to Al Hakam on 19 January,¹⁵ after the beginning of the 1991 Gulf War. At that time, the director of TRC ordered the transfer of all remaining aflatoxin to Al Hakam, where it was stored for several months. In June 1991, the remaining aflatoxin was destroyed by adding bleach and subsequent burning in a pit by using diesel oil.¹⁶

According to internal Iraqi documents, Iraq also conducted some laboratory experiments and animal tests with mixtures of aflatoxin and CS or CN tear gas, and mixtures of aflatoxin with wheat cover smut spores, which were considered as a matrix to spread aflatoxin.¹⁷ There is also one Iraqi report which mentions an experiment with aflatoxin mixed with mustard.¹⁸

Other BW-related activities at Al Fudaliyah

Genetic engineering

A biologist, recruited in March 1990 by TRC and tasked with genetic engineering development, was transferred from Salman Pak to Al Hakam and finally, in November 1990, to Al Fudaliyah. At none of the sites did the researcher find appropriate equipment and thus work was at a preparatory phase when the war started in January 1991. After the war, the researcher was transferred to the University of Baghdad.¹⁹

Wheat cover smut destruction

Al Fudaliyah was also used as a BW destruction site for the wheat cover smut that was produced as a biological agent in the early to mid 1980s. Five tonnes of smut-infected wheat spikes were produced in 1988 at an agricultural site owned by TRC near Mosul. The infected wheat was transported to Salman, and transferred later to Al Fudaliyah. In July 1991,²⁰ the smut-infected wheat spikes, which were stored in cardboard boxes, were placed in a trench (Figure V.IX.V) near the storage area and burned.

¹⁴ Biological CAFCD December, 2002 Chapter Ten Time Frame Table Note that the original account given to UNSCOM 125 differed in that Iraq declared at that time the filling of 16 R-400A bombs and did not mention warheads.

¹⁵ UNSCOM 126/BW 28, October 1995

¹⁶ UNSCOM doc. no. 125043 "Summary concerning the fate of 480 litres of agent C (aflatoxin)", prepared by Iraq and handed over to UNSCOM 125/BW 27, August 1995.

¹⁷ Annual Confidential Report for 1990 of the TRC/Al Hakam Division: This document was handed over to UNSCOM 125/BW 27, August 1995

¹⁸ Iraqi report number 915003 – internal document

¹⁹ UNSCOM 125/BW 27, August 1995

²⁰ Biological CAFCD December, 2002 Chapter Ten Time Frame Table

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Figure V.IX.V: Pit at Al Fudaliyah where wheat cover smut was burned in 1991.²¹



Comment

During initial investigations in 1991, UN inspectors found no evidence that Al Fudaliyah site participated in BW-related activities.

Production of aflatoxin (agent C)

The procedures for aflatoxin production, extraction, concentration, detection by thin-layer chromatography and the selection of the fermentation media as described in Iraq's declaration are consistent with open source literature. UNMOVIC also assesses that the number of personnel involved in the production of aflatoxin as declared by Iraq may have been sufficient to carry out the research and production activity as described.

Iraq declared that it did not practice proper quality control procedures during the production of aflatoxin and only used qualitative analysis by thin layer chromatography. Iraq asserted that, as a result, the amount of toxin produced could not be determined. Given Iraq's declared production methods, it is likely that agent C contained mainly organic solvents (chloroform, dichloroethane and triethylamine) with low concentrations of aflatoxin. This would explain the declared quantities produced. Indeed, the 1990 annual report for the Al Hakam division states that 2,200 litres of agent C was produced in that year and this supports Iraq's declaration that in total 2,200 to 2,390 litres were produced.

Iraq declared that the entire amount of agent was destroyed. UNMOVIC has seen no evidence to contradict this statement but remnants of destroyed containers were present at the declared destruction site outside Al Hakam.

It remains an open question whether Al Fudaliyah was as declared by Iraq, or whether it was already planned in the early 1980s to contribute to a future BW programme. UNSCOM and UNMOVIC did not investigate this question in any detail, but the account

²¹ Picture taken by UNSCOM 126/BW 28, September – October 1995

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given by Iraq on facilities at Al Fudaliyah prior to its takeover by the BW programme appears to make sense. No sampling was ever performed at Al Fudaliyah by UN inspectors.

However, a few oddities about the sites have been observed, such as the bio-safety cabinets or bacterial growth media identified by UNSCOM in 1991. It is also not entirely clear what type of research, development or production was conducted with the fermenters on site, and what purpose was served by the animal facilities at Al Fudaliyah.

The Iraqi Centre for Agricultural Research (IPA), which took over the site after January 1991, reported directly to the Council of Ministers and not to the Ministry of Agriculture.

These oddities may point toward more planning behind Al Fudaliyah's participation in the BW programme, but in the absence of any detailed information on these subjects, it remains mere speculation, as other explanations are also plausible.

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FIELD TESTING AND WEAPONIZATION OF BW AGENTS

Introduction

To weaponize biological warfare agents, Iraq did not develop specific biological weapons systems, but rather used chemical munitions with no or only slight modifications. Iraq declared that it tested a variety of munitions, including aerial bombs, 122mm rockets and 155mm projectiles to determine parameters of agent dispersion and viability. In addition, Iraq showed throughout the existence of its biological warfare programme a strong interest in spray devices to disseminate agents from aircraft. An initial development in 1988 ended unsuccessfully, and another project involving a modified aircraft fuel drop tank did not go beyond initial flight tests in early 1991, prior to the Gulf War.

In mid 1990, Iraq declared that it deployed R-400A aerial bombs and Al Hussein missile warheads filled with anthrax, botulinum toxin and aflatoxin despite very limited testing of these systems. Both weapons systems are not very efficient for the dissemination of biological agents. It appears that the major criterion for selecting these systems was not optimal dissemination, but rather orders from the hierarchy with regard to strategic systems and considerations of their safe use by the military commands.

According to Iraq, a total of 157 aerial bombs and 25 warheads were filled with biological agents in December 1990 and early January 1991 and were subsequently deployed to a variety of sites in Iraq. In the summer of 1991, all biological munitions were unilaterally destroyed by Iraq.

Despite extensive inspection activity, interviews and sampling analysis, neither UNSCOM nor UNMOVIC have found any evidence inconsistent with the Iraqi declaration of BW weaponization. All data supplied by Iraq or collected by UN inspectors supports Iraq's declarations that *B. anthracis* and botulinum toxin, both in liquid form, were weaponized. UNMOVIC accepts that Iraq also weaponized aflatoxin in both R-400 bombs and Al Hussein missile warheads.

A variety of original Iraqi documents supplied to UNMOVIC support Iraq's declaration with regard to the total number of bombs and warheads which were to be filled with biological agent. Some of the circumstantial evidence, such as excavated parts of bombs and warheads and analysis of samples taken from several bombs (two intact R400A bombs in 2003, three bombs in 1997) also support Iraq's declaration on the destruction of these weapons. Some uncertainties remain regarding the distribution numbers of bombs and warheads among the three declared agents.

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Research and Development Tests

Agent compatibility with munitions material

According to Iraq's declaration, a variety of laboratory experiments conducted to investigate the effect of metal or other munitions material on the viability and pathogenicity of its biological warfare agents. Experiments with botulinum toxin lasted from two weeks to one year, and none of the munition materials tested showed a negative impact on the agent. Anthrax spores, however, were negatively affected by exposure to metal from weapons, but not from specifically designed plastic or aluminum containers, or by epoxy-coated metal.

The Iraqi also determined that aflatoxin was not adversely affected through the contact with the metal of the bomb or missile casings. There was no epoxy resin in the carbon steel of R-400 bombs filled with aflatoxin and no special measures were taken for the Al Hussein warheads insert container.

Thickness of munitions

Many of Iraq's munition casings are either 3mm or 12mm thick. The first munitions test at Nihrawan was one to determine the effect on the survivability, viability and distribution pattern of *Bacillus subtilis* spores by exploding 50 litre metal cylinders of 3mm and 12mm thicknesses. Iraq concluded from the tests that the dissemination and viability of the spores was not affected by the thickness of the metal. The success of this test meant that Iraq was not constrained in the types of munitions it could fill with biological agent based on thickness of shell casing alone.

Field Tests

Timeline of biological weapons tests

In response to orders issued in February 1988 from MIC to use real munitions and animals for testing, Iraq declared that some senior persons producing the biological agents in the TRC were directed to visit munitions facilities. These personnel looked at and evaluated the suitability of some munitions for testing (or possible filling). The group's visit included Badr Munitions plant, MSE and Al Qaa Qaa.

The field testing of weapons filled with biological agents came at specific times and in batches. As shown in Table V.X.I, the first period of activity started in early 1988. At this time, Iraq had not gone into bulk agent production and batches in small quantities of agent were produced for the specific purpose of weapons testing. After a first period of testing in spring/summer 1988, biological weapons testing stopped for more than a year, according to Iraq. This gap in the reported tests led UN inspectors to question whether additional, but undeclared, tests were conducted. This possibility is discussed later in this chapter.

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Table V.X.I: Timeline, location and type of biological weapons tests declared by Iraq

Year	Month	Test	Location
1988	February	Static test of 50L containers with <i>B subtilis</i> to determine the influence of munitions thickness	Al Nihrawan
	March	LD-250 static tests with <i>Bacillus subtilis</i> and botulinum toxin (2 each)	Al Muhammadiyat
	April	LD-250 static tests with <i>Bacillus subtilis</i> and botulinum toxin (2 each) Static trials with Andersen samplers	Al Muhammadiyat
	June	Trials with Zubaidy device mounted on aircraft, using <i>Bacillus subtilis</i>	Khan Bani Saad
1989			
	November	Static test with 122mm rockets: burster size tests, tests with simulant for anthrax and tests with BW agents (botulinum toxin, aflatoxin, wheat cover smut)	Al Muhammadiyat
1990			
	May	Dynamic test of 122mm rockets with botulinum toxin, <i>Bacillus subtilis</i> and aflatoxin	Al Muhammadiyat
	August	Static test with two R-400 aerial bombs, one with full and one with half burster tube, with <i>Bacillus subtilis</i> .	Near Al Hakam
	November	Four 155mm artillery shell static test with ricin.	Jerf Al-Sakhar
1991	December	Spray tank experiments, using modified drop tank, with simulants including water, glycerin, and KMnO ₄ (potassium permanganate).	
	January	Spray tank experiment with <i>Bacillus subtilis</i>	Abu Obeydi Airfield

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Details of individual tests

In the following, individual munitions tests, their rationale and their results as described in Iraq's CAFCD, are summarized.

Static tests to determine dissemination patterns

According to Iraq, the first tests using munitions were performed in March and April 1988, using LD-250 aerial bombs which can hold up to 60 litres of agent. The tests were designed to determine distribution patterns of both, *Bacillus subtilis* as a simulant for *Bacillus anthracis* and botulinum toxin. Two bombs for each agent were mounted on a 3 meter high stand and a variety of large and small animals and Petri dishes were placed in concentric arcs downwind from the bomb. The objective of the experiment was to provide some data on the distribution patterns, pathogenicity and survivability of the agents.

The next static munitions test in November 1989 was much more comprehensive. Four different agents (botulinum toxin, *Bacillus subtilis*, aflatoxin and wheat cover smut) were tested in 122mm warheads, which can hold about 7 litres of agent. Again, the objective was to gather information on distribution patterns and survivability.

A third round of static munitions tests to determine distribution pattern was performed in November 1990. It involved ricin, which was filled into 4 155mm artillery shells.¹ The test used guinea pigs and rabbits placed in concentric circles around the artillery shells. According to Iraq, this was the only explosive test using ricin.

¹ UNSCOM 125/BW 27, August 1995

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A picture, (Figure V.X.I) found with the Haidar farm documents, shows the results from weapons testing. The Petri dishes were probably placed in the field during the weapons test, collected, incubated for further examination and photographed.

Figure V.X.I: Petri dishes used in a weapons test



Static tests to determine burster tube size

One of the over-riding concerns of the biologists in the programme was the effect of heat and pressure of an explosion on the viability, survivability and particle size distribution of biological agent. In November 1989, during initial experiments with 122mm rocket warheads filled with botulinum toxin and *Bacillus subtilis*, a range of burster tubes from half to full were used to identify the optimum warhead rupture and distribution patterns of agent.

A similar experiment was conducted using two R-400 bombs filled with *Bacillus subtilis* in August 1990. One bomb had a half burster tube, the other had a full burster tube. Iraq concluded that spore viability was not affected by the burster size and that use of a full burster resulted in a dissemination area twice as large as half burster.

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Dynamic Tests with 122mm rockets

Based on the results from the static tests, a series of dynamic tests occurred in May 1990 using the 122mm Saqr-18 warhead (Figure V.X.II) filled with botulinum toxin, aflatoxin and *Bacillus subtilis* as a simulant for anthrax. In a 1997 declaration Iraq states that “Three multi-barrel 122mm rocket launchers participated in the tests in which 3 x (30-40) warheads filled with A, B *subtilis* and C agents respectively were tested to a range of 12kms using live animals and nutrients in Petri dishes. The results were measurably less than those of the static tests due to the deviation of the warheads from the target area”²

Figure V.X.II: 122mm rocket similar to those used for the test of biological agent. Photograph taken by UNMOVIC in January 2003.



² Biological FFCD September 1997 chapter 7.4.3

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Testing the Zubaidy spray device

From 1987 until August 1988, Iraq conducted research, development and tests on devices for the dissemination of biological agents by aerosol.

Figure V.X. III the Zubaidy Device



Outdoor experiments included tests with a modified crop duster spray device, dubbed the Zubaidy device by Iraq, (Figure V.X.III) mounted at different heights (1 to 3 metres) and filled with suspensions of *Bacillus subtilis*. Experiments also occurred with the modified spray devices mounted on crop dusting aircraft at Khan Bani Saad. Petri dishes and Anderson samplers were used to study dissemination of the bacteria using the Zubaidy device.

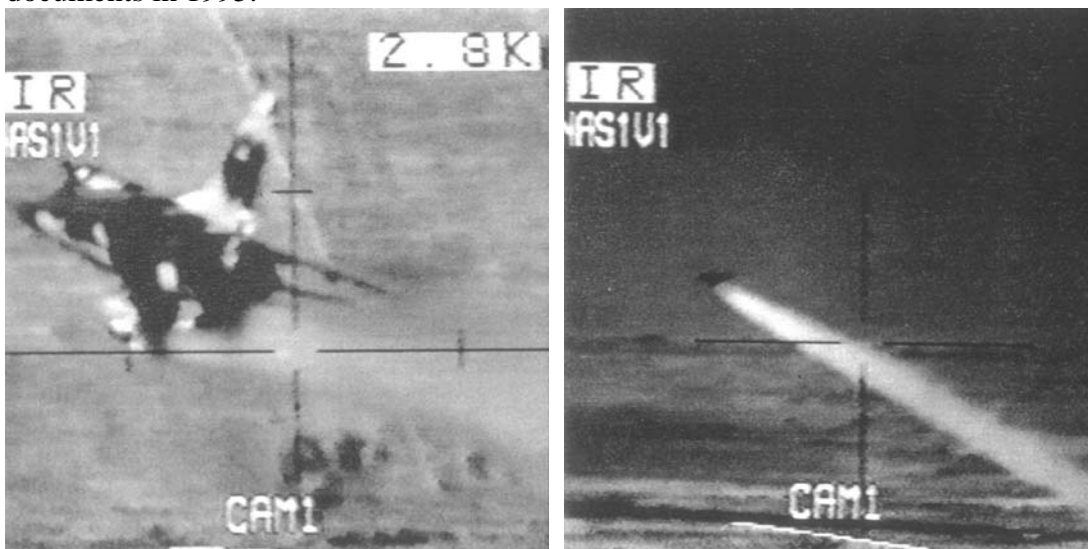
Aircraft drop tanks as spraying devices

Iraq declared that in November 1990, it decided to explore the possibility of using aircraft external fuel tanks or drop tanks to spray biological agent. The concept involved modifying the drop tank type RPL-210 of a Mirage F-1 fighter by equipping it with a spraying device. Iraq declared that “a drop tank from Abu Obeydi air base was provided to the team for modification at MSE workshop at the beginning of December 1990. The modification idea was to make a centre opening in the tank and install a venturi device on the opening”.³ In December 1990, a drop tank was modified and tested in a low flight experiment using water. After additional modifications to reduce the spraying time, a second flight experiment with coloured water was conducted end of December 1990 (Figure V.X.IV). Other tests followed in January 1991. Additional details of the modification are contained in chapter V.XI.

³ Biological FFCD September 1997 section 7.7

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Figure V.X.IV Mirage F-1 in 1991 equipped with a modified drop tank used for BW simulation test. Photograph taken from a video supplied by Iraq with the Haidar Farm documents in 1995.



The last declared test used a suspension containing *Bacillus subtilis* as a simulant for anthrax in a flight test on 13 January 1991, using a line of Petri dishes to determine the success of the spray flight. Further development of the drop tank was stopped due to the onset of the Gulf War in 1991. Iraq declared that subsequently one modified prototype drop tank attached to a Mirage F-1 at Abu Obeydi airfield was destroyed during an air raid, and three other drop tanks were unilaterally destroyed in summer 1991⁴.

Comment

The spray/drop-tank project appeared to have been pursued with the utmost vigour by Iraq and it seemed to have been the only BW weapons system that continued to be developed after the start of the 1991 Gulf War⁵.

Possible involvement of remotely piloted vehicles in the BW programme

Iraq developed and tested throughout the 1980s and 1990s a variety of remotely piloted and unmanned aerial vehicles (RPV/UAV). Details of these programmes are given in Chapter IV of this Compendium. UNSCOM and UNMOVIC did not find evidence that any of the RPV/UAV programmes were directly aimed at disseminating biological agents and Iraq declared, “no efforts were made to utilize the RPV concept for BW purposes”.⁶

Conceptually, the most efficient methods to disseminate biological warfare agents are by spraying from aircraft, whether remotely piloted or not. Consequently, a senior scientist

⁴ This issue has been covered more extensively in the Clusters Document available on the UNMOVIC web site: <http://www.unmovic.org/>

⁵ UN doc. no. S/1999/94 p. 122

⁶ Biological CAFCD, December 2002 Chapter 10.6

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of the Iraqi BW programme contacted as early as 1988 the head of the RPV/UAV group at the Technical Research Centre (TRC) in Salman Pak to discuss possible applications of RPV/UAV for the biological programme. Iraq, however, declared that the vehicles that were at that time under development at TRC were too small and unreliable for that purpose.⁷

Comment

The fact that both, the biological and the RPV/UAV programme, were located at the same site – Salman Pak – and were managed by the same entity – the TRC – is not necessarily an indication for a close link between the programmes. The TRC was at that time responsible for a number of projects related to intelligence and special weapons development that were not necessarily interlinked. Iraq declared that the smaller RPVs of the late 1980s developed by the T-2 division of the TRC were intended for air defence training and battlefield surveillance. There is no evidence that would suggest that any of these RPVs were actually used or intended to be configured for the dispersal of chemical and biological warfare agent. There was no test flight data observed or obtained by UN inspectors to indicate that these early and smaller RPVs or drones were modified in any way for the dispersal of chemical or biological agent.

According to Iraq, in November 1990 an obsolete MiG-21 was selected for further RPV/UAV developments. The concept was to use remote control for this aircraft to take off and reach altitude before control would be switched to a chase plane. The chase plane would control the MiG-21 until the autopilot took over at a designated distance before the target. One flight test was conducted with the remotely piloted MiG-21, but with a back-up pilot on board. But this test, performed in January 1991, was considered not fully successful by Iraq. According to Iraq, no further tests took place because of the start of the Gulf War.

Comment

While UN inspectors did not find evidence that the dissemination of chemical or biological agents was the primary intent of the MiG 21 development, the original account of an Iraqi officer in 1995 backs the notion that this was indeed intended, and it was later declared by Iraq that the spray tank was to disseminate chemical and biological agents.

Although the Iraqi Air Force had a large number of retired MiG-21 aircraft, the choice to use this as an RPV to effectively disperse biological agent did not offer high chances of success. The aircraft is optimized for high speed maneuvers and is not easily able to fly low and slow without substantial pilot control. The one test-flight may have provided some promise as further tests were planned, but it clearly was not entirely successful. Nevertheless the fact that Iraq had not mastered the technologies required for efficient BW agent dispersion by other munitions and platforms did not deter them from trying a new approach.

⁷ Biological CAFCD, December 2002 Chapter 10.6

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The ultimate goal of the development of an unmanned aircraft remains unclear. In 1995, directly after significant disclosures of the BW programme to the UN, an Iraqi officer involved in this effort was interviewed by UNSCOM and testified that BW agent was intended to be used with a drop tank: “The idea was that the plane would take off from an aerodrome, accompanied by another aeroplane and it would guide it to a specific place, remotely, and give an order for a specific machine to start working, which I discovered later it was about a drop tank”.⁸ Later, Iraq maintained that the project was just about developing a RPV/UAV platform, which might have been used for a variety of purposes, if successful. Once developed, a MiG-sized RPV/UAV could be equipped with any type of equipment or weapon, be it surveillance gear, high explosive bombs, or spray tanks to disseminate chemical or biological warfare agent.

Comment

Iraq conducted a series of weapons and weapon-related tests for its BW programme over the period from 1988 to 1991. The tests were for a country starting its programme without any previous experience in developing biological weapons and without input from foreign countries that had already developed such a weapons programme. The Iraqi programme of BW field-testing started in early 1988 with a series of experiments to determine the effect on the agent of contact with the metals and plastic surface of a series of munitions. At this early stage it was not necessary for the biologists involved to know what final weapons may have been or were to be selected for filling, only that the material of that weapon type had already been evaluated. Iraq conducted a number of other tests which evaluated dispersal patterns, density and concentration of agent, particle size, and survivability and viability rates for various types of munitions both explosive types and spray devices.

It is a misnomer to categorize all weapons used in the field trials as biological weapons. For the most part they were types of munitions that the Muthanna State Establishment (MSE) had available and had used for testing chemical agents. Other countries, which in the past developed a biological warfare programme, have used a similar transition in weapon testing, using available chemical munitions first. Only at a later stage could it be expected that specialized weapons purpose-designed and built for biological agents would have been constructed, tested and deployed.

The testing programme does not seem to have been haphazard or ill conceived, although many tests – as documented on Iraqi videos from the Haidar Farm – do not seem to have been conducted in a rigorous scientific manner. Both static and dynamic field testing of munitions occurred for 122mm rockets and spray devices and static tests were also completed for half and full burster sizes for two types of aerial bombs. Table V.X.I gives an overview of all biological weapons test as declared by Iraq.

During interviews with UN inspectors, some Iraqis connected with the past BW programme suggested that there was a change in the concept for use of biological warfare agents from their employment in tactical weapons to a use in strategic weapons

⁸ UNSCOM 125/BW 27, August 1995

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systems. From February 1988 until May 1990, the weapons systems used for field-testing were all typical of tactical systems: LD-250 aerial bombs, 122mm rockets and the Zubaidy spraying device. The LD-250s and 122mm rockets had been tested extensively with chemical agents, while the Zubaidy device was an attempt to modify an aerosol dissemination device for use with biological warfare agents. The choice of the tested munitions does not necessarily indicate the final weapons choice for those agents. These field tests were designed to test viability and dispersion. The criteria to judge the success of the test were death or injury to the animals in the test grid or the growth of bacterial colonies on Petri dishes. The only specific biological-related tests of strategic systems were the field test on the full and half burster tubes for the R-400 aerial bomb and the Mirage drop tank tests. The BRIP-400 bomb, on which design the R-400A was based, was tested extensively by the Iraqi Air Force as was the R-400 chemical bombs. There was no specific BW-related test of the Al Hussein missile warhead apart from laboratory experiments to test compatibility of the agent and container and the test which involved mating the warhead to the missile.

The final selection of the R-400 bomb as a weapon of choice for biological agents seemed to result from the recommendations of the Iraqi Air Force. The practical concerns for pilot safety and protection of the aircraft were paramount and much more of a concern than the efficiency with which a munition delivered its payload. Even if of low efficiency, the R-400 was more suited to the Iraqi Air Force's requirements (thickness of bomb minimized damage from accidents and accidental leaking). The thinner, smaller LD-250 had a more effective agent to burster ratio and some results of field-testing with this bomb were known. However, the LD-250's thin skin also resulted in leakages of (chemical) agent and these bombs suffered damage while in storage. In contrast, both the R-400 bomb and the Al Hussein warhead had less efficient agent to burster ratios, which would have resulted in very small amounts of agent being delivered at the correct respiratory size and low viability but this appears to have been very much a secondary consideration to safety.

The same issue of safety seems to apply to the Mirage spray device. Concerns during the testing phase were more focused on pilot and aircraft safety than on the distribution of agent. The large Mirage drop tank once converted to a spray tank was modified again to reduce time over target from 12 to 4 minutes – there was no discussion about agent cloud patterns or concentration rates although implicitly these would have been affected.

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Aerial bombs (R 400A)

Aircraft bombs used to disperse chemical or biological agents can either be designed specifically for that purpose or they may be modifications of conventional bombs. For example, white phosphorus (smoke) bombs with little modification, are adequate for use for chemical agents such as mustard. Alternatively, a bomb intended for use with bulk high explosive must be modified by the addition of a burster tube in order for it to be useable with either chemical or biological agents (see Figure V.X.V).

Figure V.X.V: Aerial bomb R400 for dispersal of chemical or biological agents. Note the burster tube in the center of the bomb body.



Iraq declared that, in early 1988, all types of munitions produced or imported by Iraq had been reviewed for their suitability for BW weapons tests.⁹ Iraq also stated that it relied heavily on the experience gained from weaponization of chemical agent.¹⁰ In May 1990, a 400 kg aerial bomb was certified, after flight trials, by the Iraqi Air Force command to be suitable.¹¹ Iraq stated that the reasons for selecting the bomb type, which was later named R-400, were that it could be dropped from a low altitude, it had a good capacity (80-85 liters) for agent, it could fit Iraq's military aircraft, and it had a thick casing which could protect its contents in the event of an accidental drop or a crash.¹²

Comment

UNMOVIC assesses that, while the R-400 bomb may be suitable for low altitude release from an aircraft, the R-400 type bomb is technically much less efficient in the dissemination of biological warfare agents than for some chemical warfare agents. The droplet sizes created by the detonation of such a bomb are far from optimal for the inhalation of the agent. It appears that the major criteria for selecting this bomb type

⁹ Biological CAFCD December, 2002 Chapter 8.1

¹⁰ Biological CAFCD December, 2002 Chapter 8.3

¹¹ Biological CAFCD December, 2002 Chapter 8.7

¹² Biological CAFCD December, 2002 Chapter 8.7

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focused on operational requirements for the delivery system and less on an optimum dispersion of the biological agent. However, despite its limited effectiveness, any use of biological aerial bombs by Iraq would have entailed significant political and psychological repercussions and would have forced an opponent to take protective measures.

According to Iraq, MIC initially requested Al Nasr State Establishment (NSE) to manufacture 1000 bodies of the R-400 bombs for chemical purposes. Production started on 5 June 1990, and was completed by 14 August 1990. Bomb bodies were pressure tested and the rejected bodies were repaired and stored at the NSE warehouse as surplus production.¹³ Iraq declared that, after additional production orders (including 200 for biological agent), the total number of R-400 bodies produced by NSE was approximately 1359.¹⁴ Of these, 1224 had been ordered by MSE, 10 additional bodies were dispatched to MSE to replace damaged ones, and eight bodies were sent out for training purposes. The remaining 117 bodies (1359 – [1224+10+8]) were stored at NSE until after the war, when they were destroyed unilaterally, according to Iraq's declarations.¹⁵

In August 1990, 200 R-400 bodies – part of the total of 1224 ordered as mentioned above – were requested by the Muthanna State Establishment with specifications for an internal coating with epoxy paint for BW purposes.¹⁶ The internal coating was required to prevent an adverse reaction between the agent (B) and the metal of the bomb. Two black lines were painted on the outer body to differentiate the new batch from the previous order and the bombs were designated R-400A (Figure V.X.VI). According to Iraq, the internal coating was stopped after a few weeks at the request of MSE, so that finally 175 bombs were internally epoxy coated and 25 biological bombs were uncoated.¹⁷ Iraq declared that the uncoated bombs were intended for use with aflatoxin for there was no adverse reaction detected between the aflatoxin solution and the internal walls of the carbon steel bomb, but rather the aflatoxin organic solvent reacted with the epoxy coating.

Iraq stated that, shortly after ordering the 200 bombs from NSE, static tests near Al Hakam were performed during the second week of August 1990 using two R-400 bombs to determine optimal burster size and the dissemination of BW simulant.¹⁸

¹³ Biological CAFCD December, 2002 Chapter 8.7

¹⁴ Biological CAFCD December, 2002 Chapter 8.7

¹⁵ Biological CAFCD December, 2002 Chapter 8.7

¹⁶ Biological CAFCD December, 2002 Chapter 8.7

¹⁷ Biological FFCD September 1997 Chapter 7.5

¹⁸ Biological CAFCD December 2002 Chapter 8.8

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Figure V.X.VI R-400A bomb and, on the right, a stencil with the Arabic letter A.
The black longitudinal stripe indicates that this is a biological R-400A bomb (and not a chemical R-400 bomb). A white Arab letter A was used by Iraq to mark bombs intended for botulinum toxin, which was designated 'Agent A'.



According to Iraq, the R-400A bombs were transferred from mid-September to early October 1990 to Al Hakam, where they were marked with Arabic letters equivalent to A, B and C: 100 for botulinum toxin (designated by Iraq 'agent A'), 75 for anthrax (agent B) and 25 for aflatoxin (agent C) (Figure V.X.VI).¹⁹

While Iraq initially planned to fill the R-400A bombs (and warheads) at Al Hakam, these munitions were eventually transferred to Al Muthanna for filling during the last week of December 1990²⁰. According to testimony given by Iraqi scientists to UN inspectors, this was largely due to the fact that the filling stations were already set up at Al Muthanna, and based on orders given by General Hussein Kamel, the weapons were transferred from Al Hakam and filled at MSE and were handed over to the military unit at MSE that was responsible for special weapons.

The number of bombs filled with the three agents, however, differed from the original plan. According to Iraq, a total of 157 bombs were filled with biological agents: 100 with botulinum toxin, 50 with anthrax and 7 with aflatoxin. Iraq stated that the reason for not filling the remaining bombs was that Al Hussein warheads transferred to Al Muthanna were given priority and interrupted the filling of the R-400A bombs. There was then insufficient agent at Al Muthanna to complete the filling of the bombs and with war imminent, there was not adequate time to bring additional agent from Al Hakam. This explains the presence of empty R-400A bombs in 1991 when the Chemical Destruction Group destroyed 37 of them assuming that they were empty chemical munitions.

Iraq declared that once filled, the R-400 biological bombs were equally divided and sent to two sites for storage. The sites were Al Azziziyah Firing Range and Air Strip 37. Iraq further declared that the bombs remained at these locations until the first week of July

¹⁹ Biological CAFCD December 2002 Chapter 8.10

²⁰ Biological CAFCD December 2002 Chapter 8.11

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1991, when bombs at Air Strip 37 were collected and transported to Al Azziziyah Firing range for destruction.²¹

Documentation on the R-400 and R-400A bombs, particularly in relation to their production, is more extensive than that associated with any other aspect of Iraq's BW programme. Documents in the possession of UNMOVIC include orders for the production and numbering of R-400 and R-400A bombs, reports by the Iraqi Air Force of the results of R-400 weapon trials, acceptance reports from the quality control unit, and gate receipts and passes for R-400 components that left the Nasr State Establishment.

Comment

The UN commission recorded over 60 serial numbers from R-400 and R-400A bombs²². All numbers were consistent with the numbering system declared by Iraq. The recorded serial numbers are consistent with a production of a total of 1359 bombs and support Iraq's declaration in that respect. The serial numbers are in four groups and if production in each group was completed it would imply that a maximum of 1374 bombs were manufactured although the actual number may be less than this. One conclusion that may be drawn from the serial number analysis is that Iraq's statement that the 117 bombs (the third group) produced in excess of requirements were undelivered and remained at NSE²³ is incorrect. A total of 15 such bombs were seen at Al Walid Airbase, Al Muthanna and, after recovery from the Euphrates River, near Al Hakam²⁴. UNMOVIC therefore concludes that all R-400 bombs produced were probably also transferred, although not necessarily filled with agents.

Iraq has stated that, of the four groups of bombs produced, the last group in the series (the R-400A bombs) had been intended to be filled with botulinum toxin and anthrax, and 25 of the third group (R-400 bombs without any internal coating) were said by Iraq to have been intended for aflatoxin filling²⁵. However, at least one R-400 bomb (no black stripe or internal coating) was marked with Arabic A (implying the intended fill was botulinum toxin). Another R-400 bomb recovered from a destruction pit at Al Azziziyah, and analyzed under UNSCOM auspices, had also been possibly filled with botulinum toxin. These findings suggest that some R-400 "chemical" bombs were used for BW purposes and, indeed, Iraq acknowledged that during filling, the BW team may have been short of R-400A bombs and used some R-400 bombs for BW purposes²⁶.

Considering that there were 175 pre-marked bombs and only 157 that were, according to Iraq, filled with BW agent, it is an open question why some non-marked, chemical bombs were filled with biological agents while others marked for BW were found empty and destroyed in 1992 by the CW team at Muthanna. One reason pointed out by Iraqi scientists to UN inspectors might have been that in the final days before the 1991 Gulf

²¹ Biological CAFCD December, 2002 Chapter 8.13

²² UNSCOM 125/BW 27, August 1995

²³ Biological CAFCD December, 2002 Chapter 8.7

²⁴ UNSCOM 125/BW 27, August 1995

²⁵ UNSCOM 133/BW 30, January 1996

²⁶ UNSCOM 133/BW 30, January 1996

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War started, there was a rush to get as many aerial bombs filled, and during this intense effort the filling probably did not go as orderly as usually, leading to some mix-up of aerial bomb types. It can also be speculated that more than 100 bombs may have been filled with botulinum toxin. As there were only 100 bombs pre-marked for botulinum, Iraq had to use unmarked 'chemical' R400 bombs to fill them with botulinum toxin and later added the Arabic A marking.

The monthly acceptance records from the quality control unit indicate that 1359 R-400 bombs had been produced and certified from June to September 1990. Although this is 117 bombs in excess of the number ordered, it is what might be expected to meet an order of 1224 bombs plus spares.

Al Hussein warheads

The second biological weapons system deployed by Iraq was the Al Hussein missile warhead. Iraq built special warheads that can be filled with a liquid for chemical and biological agents by modifying high explosive SCUD warheads. Special warheads were also manufactured in Iraq using some imported components, for example structural rings, which it purchased from a foreign supplier.

The special warhead design could accommodate a canister made of either aluminum or stainless steel with a capacity of around 150 litres of a liquid agent (Figure V.X.VII). According to Iraq, aluminum canisters were only used for chemical agents and because of a shortage of aluminium sheets at Al Taji, stainless steel canisters were used for biological weapons.

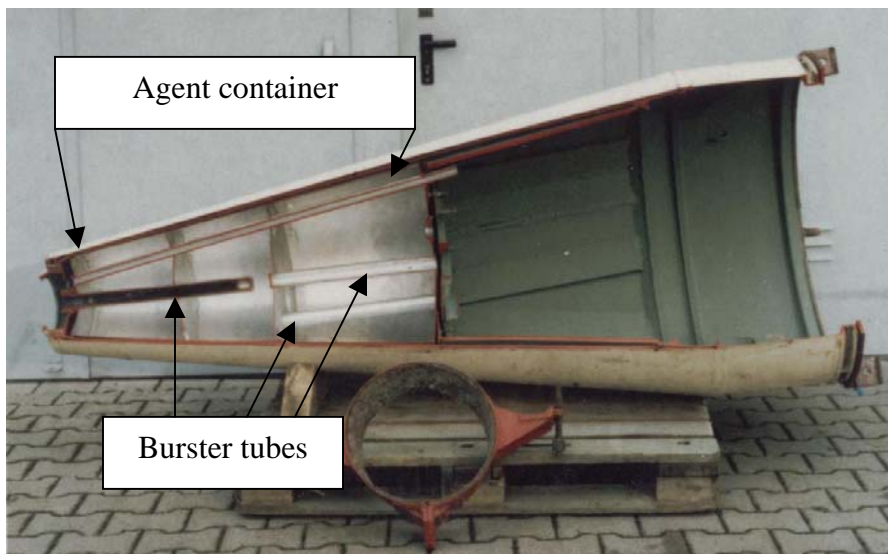
Comment

The Al Hussein warhead as configured, if equipped with an impact fuse is a very ineffective way of dispersing biological agents. Iraq only had impact fuses for its warheads and therefore agent would not have been dispersed prior to impact. This would limit the size and reach of any cloud of agent dispersed by the warheads and made them even less effective. In addition, according to Iraq, the warhead was never tested. Iraq had concerns about agent survivability during flight and at impact.

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Figure V.X.VII: Special Al Hussein warhead for chemical and biological agents.

A container to hold up to 152 litre of agent was mounted into the front part of the warhead. This container has three burster tubes, one in the front and two in the rear, to disperse liquid agent.



According to Iraqi declarations, on 2 August 1990 (the invasion of Kuwait) General Hussein Kamel ordered that biological agents were to be filled into aerial bombs and Al Hussein warheads²⁷. Iraq further stated that it did not have the time to field-test the biological Al Hussein warheads²⁸ and that it considered them as a psychological weapon or a deterrent against possible nuclear attack²⁹.

Following General Hussein Kamel's instruction, 25 special warheads for biological purposes were ordered from Al Taji. Fifty warheads for chemical warfare agents had already been ordered in April 1990. Apart from the container material (aluminum or stainless steel), warheads intended for biological agents were not different from the chemical warheads.

Iraq states that these 25 warheads were delivered to the Muthanna State Establishment (MSE) and filled with biological agents between late December 1990 and 11 January 1991³⁰: sixteen were filled with botulinum toxin, five with anthrax and four with aflatoxin³¹.

In preparation for the war, these warheads were moved to remote locations on 13 January 1991. Ten warheads filled with botulinum toxin went to a railway tunnel at Al Mansuriyah, and the remaining 15 warheads (six with botulinum toxin, five with anthrax,

²⁷ Biological CAFCD December, 2002 Chapter 8.11

²⁸ Biological FFCD, September Chapter 1.8.10.2

²⁹ Biological FFCD, September Chapter 1.8.8

³⁰ Biological FFCD, September 1997 Chapter 1.2.2

³¹ Biological FFCD, September 1997 Chapter 7.6.8

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and four with aflatoxin) were moved to a site adjacent to the Tigris Canal³². According to Iraq, the biological warheads were unilaterally destroyed in July 1991. After chemical deactivation of the BW agent, the warheads were moved to Al Nibai³³ and destroyed on 9 and 10 July 1991 in several pits using explosives followed by burning. CW warheads were also destroyed in this area. Fragments of the destroyed warheads were collected and buried in the demolition pits or in pits close to them. Conventional bombs were then exploded over the burial area to obscure any remaining signs³⁴. The destruction of the BW munitions is covered in greater detail in the following chapter (V. XI).

Comment

There is some evidence that 25 Al Hussein warheads had been filled with BW agents. A document signed by Iraq's missile specialists and a member of its biological team refers to the inspection of 25 special warheads³⁵. There are other documents³⁶ that also refer to a group of 25 special warheads. While none of these documents provides definitive evidence for 25 BW warheads, together they are persuasive. No conclusion can be reached on the number of warheads filled with each type of agent. Much of the evidence is conflicting and Iraq's account on this matter has changed several times.

The number of filled BW Al Hussein warheads destroyed cannot be determined with any great confidence. UNSCOM concluded through the analysis of warhead fragments at the destruction site that probably at least 75 special warheads were destroyed³⁷, but it is not possible to determine whether all of these warheads were filled with agent prior to destruction, and how many of these were biological and chemical in nature (see chapter V.XI for more details regarding destruction).

³² Biological FFCD, September 1997 Chapter 7.6.11

³³ Biological FFCD, September 1997 Chapter 7.6.12.1

³⁴ Letter from Lt Gen Amer Rashid to Executive Chairman UNSCOM 21/7/98.

³⁵ Biological FFCD, September 1997, accompanying document 66

³⁶ Biological FFCD, September 1997, accompanying documents 67 –70

³⁷ UNSCOM 252 BM/69 July 1998, Annex E

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Comment

Did Iraq do more testing of biological munitions than declared?

There might have been a variety of reasons for the limited number of tests and the gap in the testing period. For example, the same staff at MSE was responsible for both, biological and chemical weapons trials using the same testing facilities. An additional factor is the ceasefire in the Iran/Iraq war in August 1988 which may have reduced the impetus to do more testing.

In order to shed more light on this question and with the hindsight of all UN findings, Iraqi declarations and the ISG report, UNMOVIC looked again at the nature of the biological tests that were declared and compared them to chemical weapons tests. The objective of this comparison was to determine if a similar gap exists in the testing of chemical weapons and if individual chemical weapons were tested in a manner similar to individual biological munitions.

The CAFCD disclosed that a significant number of tests of chemical weapons, principally involving binary munitions, were carried out during 1988 and 1989. It appears that no similar gap as in biological weapons testing exists for chemical weapons. Therefore we can conclude that Iraq was not generally trying to hide the fact that it conducted weapons tests during the period in question.

As to the question of the similarity in testing, Iraq conducted a variety of types of tests with chemical bombs including burster size determinations, area coverage, evaporation rate of the disseminated agent, accuracy of delivery and mechanical reliability. Biological munitions tests were narrower in scope and included agent survival following dissemination, burster size determination, and area coverage. There was no apparent need to duplicate tests for mechanical reliability and accuracy for munitions that were tested with chemical agents.

The lack of sophisticated planning and weapons testing by Iraq seems to be more a reflection of the pressure to deploy under wartime conditions, their own methods of deployment and their inexperience in developing and proving a munition system rather than a concealment of the tests themselves. As mentioned above, the biological weapons were largely derived from chemical weapons with minor modifications. The chemical weapons were in turn derived from conventional munitions with small modifications. Most of the conventional weapons had already been tested many times for mechanical and accuracy tests and therefore Iraq already had confidence in the deployed conventional system. As Iraq did not manufacture new BW weapons systems, but merely modified existing systems, this would have reduced the requirement to do exhaustive testing.

An example is the R-400A biological bomb. This bomb was derived from the chemical R-400 bomb. The R-400 bomb was in turn derived from the imported conventional BRIP-400 bomb. This conventional bomb was tested many times by the Iraqi Air Force, with

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different aircraft, different configurations, different fuses, different parachutes, was dropped at different heights and at varying speeds and so when deemed acceptable, the Air Force already had confidence in its use. It may therefore have appeared unnecessary to conduct many more extensive tests when filled with chemical or biological agent.

In contrast, when Iraq modified the Mirage drop tank as a spray device for biological agent, at least four tests were conducted. It is not certain if more may have been scheduled but were interrupted by the start of the 1991 Gulf War.

The pattern of BW weapons testing may have resulted from the pressure on the on-going war with Iran (until August 1988) and the soon to be invasion of Kuwait (August 1990). The urgency to test biological weapons may have waned between late 1988 and mid-1989. While BW agent production continued at a steady rate and then accelerated after 1989, it was not matched by weapons tests.

Extensive weapons testing are neither a pre-requisite nor necessarily a good indicator for deployed systems. The long held concerns of undeclared weapons tests (in part fuelled by contradictory and ambiguous Iraqi statements) may have been without foundation and nothing found either by UN inspectors or the ISG has suggested otherwise. Also a valuable lesson is that BW weapons systems can be and were deployed without any specific BW testing at all. The circumstances surrounding the Iraqi case is unique, a country under pressure of imminent war may be expected to take extreme measures for reasons of deterrence or deployment.

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RPV/UAV after 1991

The RPV programme after 1991 are dealt with in more depth in Chapter IV, the missile section of this Compendium. This section seeks only to highlight some aspects which relate to the possible RPV developments linked to the spraying of biological agent. Iraq declared that in 1995, it embarked on a project to develop an RPV using its retired L-29 trainer aircraft. Although Iraq declared that this project commenced in 1995, it is curious that the Air Force refurbished a number of obsolete L-29 training aircraft between 1993 and 1995 in this aircraft type had been phased out of operations since the late 1980's. Being a more stable and forgiving aircraft particularly at low speeds, the L-29 project could have been a follow-on project to the MiG-21 RPV.

Original Iraqi documents state the reason for the project was to develop a full-dimension air target for air defence training. The concept was to use the L-29 for target acquisition and tracking, not to shoot it down: according to Iraqi statements, the L-29 would be more representative of a real target than a smaller RPV. However, if target acquisition and tracking was the goal, then other aircraft in the Iraqi inventory (with a pilot) would seem to have been more useful and would have more closely resembled the flight profile of coalition aircraft. In addition, Iraq continued to develop the smaller RPVs for air defence training.

Iraq also developed and tested beyond 1991 some smaller RPV/UAV (Chapter IV.X) There is no evidence available to UNMOVIC, that any of these were connected to the delivery of CBW agent. However, the Ibn Fernas Company, which took part in the development and testing of RPVs, was also involved in some projects related to aircraft spraying, such as a cloud seeding project and experiments with agricultural spraying techniques at Khan Bani Saad.

UN inspectors were concerned that the development of the RPV platform and the spraying device may have been deliberately done separately until both were proven individually, and only then married together. Although UN weapons inspectors found evidence of RPVs and separately spray devices, there was insufficient evidence to link the two.

UNSCOM did discover two L-29 drop tanks being used on a helicopter at Khan Bani Saad airfield in May 1994: these tanks were subsequently tagged (Figure V.X.VIII). During inspections of Khan Bani Saad airfield in 2003, UNMOVIC accounted for the tagged tanks to follow up on this issue. Iraq declared that the helicopter was supplied by the Army Aviation and the modified L-29 tanks, and the associated cradle came from the Ibn Fernas State Company³⁸. Iraq declared that only a small number of tests were carried out over a short period, using two alternatives to herbicide - diluted sulphuric acid and diesel. These statements seemed inconsistent with the project but it was not possible,

³⁸ UNMOVIC Inspection Report R2003-X110-1013 of 13 February, 2003.

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before UNMOVIC was withdrawn from Iraq, to determine whether such modifications to the drop tanks made them suitable for dispersing chemical or biological agents.

Given the cloud seeding project and the herbicide project involving L-29 drop tanks, as well as other work on a range of conventional munitions, the Ibn Farnas Company had expertise in both RPV technology and spray systems.

Figure V.X.VIII: L-29 drop tanks at Khan Bani Saad.



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DESTRUCTION OF BIOLOGICAL AGENTS AND WEAPONS

Destruction of Bulk Agent

In July 1995, Iraq declared that “In July 1991, the order was issued from HK (General Hussein Kamel) to destroy the stockpile of biological agent: the stored quantity of botulinum toxin type A ¹ was about 7.5m³, *Bacillus anthracis* was about 3.4m³, and aflatoxin was about 0.34m³. The process of destruction started following an order by General Hussein Kamel and continued for about one month”. ² The order issued was supported by General Hussein Kamel himself during an interview with UN inspectors in Amman, Jordan following his defection. ³

Iraq declared that it used a three-step approach for the destruction of the bulk agent botulinum toxin that was stored in 5m³ storage tanks at Al Hakam. First, the toxin was chemically inactivated by bubbling through the tanks a 2% concentration of liquid formalin. Secondly, Iraq declared that the formalin-toxin mixture was heat treated at 121 degrees centigrade for 2 hours and samples taken and injected into mice. The final step was described as follows “the destroyed agent was transferred to PVC tank (2m³) and potassium permanganate was added in order to give final concentration of 0.1%. The mixture was left for 24 hours and after the toxicity result was determined nil [and] the mixture was drained”. ⁴

Iraq described the destruction of the bulk agent anthrax as follows: “The stockpile was transferred under pressure from the mobile tank to the tanks of 1480 L capacity, sterilized at 121 degrees centigrade 1.5 bar for 1.5 hours to achieve complete destruction of the spores. Formalin was added to the tanks with final concentration of 2% with stirring and left for 48 hours. The destroyed spores were transferred to PVC tanks of 2m³ capacity; KMnO₄ (potassium permanganate) with final concentration of 4% was added and left for another 48 hours. Samples were taken for viable count and pathogenicitythe results of the viable count were zero and pathogenicity test nil, so the destroyed spores were discarded to the sewer”. ⁵

Iraq further described the destruction of aflatoxin by adding and mixing bleach and described the destruction of bulk *Clostridium perfringens* by steps similar to botulinum toxin and anthrax that is, by adding formalin then potassium permanganate followed by autoclaving at 121 degrees centigrade.

Bacterial isolates were declared to be autoclaved at 121 degrees centigrade, at 1.5 bar for 1.5 hours then discarded. Sealed ampoules of lyophilized bacterial isolates not used in

¹ Agent A was Botulinum toxin type A; Agent B was *Bacillus anthracis* and Agent C was aflatoxin

² Biological FFCD September 1997 Chapter 6.5.8

³ UNSCOM (<http://www.un.org/Depts/unscom/>) and UNMOVIC (<http://www.unmovic.org/>) Homepages for details of the transcript/summary of interviews.

⁴ Biological FFCD September 1997 Chapter 6.5.4

⁵ Biological FFCD September 1997 Chapter 6.5.5

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research or production were transferred to the Sera and Vaccines Institute at Ameriyah in January 1991, and returned to Al Hakam in April of that year. These unopened ampoules were handed to the first biological inspection team in August 1991.

Iraq stated that it fumigated the production and storage areas for a week using concentrated formalin. All instruments, glassware, clothes and drainage pipes were similarly treated with formalin. The sewage tanks were emptied and the waste dumped in an area outside the perimeter fence of Al Hakam which was then sprayed with diesel fuel burnt twice and covered with soil. The sewerage tanks themselves were fumigated with formalin and burnt with alcohol. In other measures, Iraq declared that walls were washed with antiseptic; floors were washed with sulphuric acid solution to remove the potassium permanganate stains and the fermenters were steam sterilized. Where the brown permanganate stain could not be removed, equipment was burnt (PVC tanks); removed and mechanically cut into pieces (1m³ stainless steel mobile tanks) or broken into pieces and moved outside the site (glassware). Other measures such as removing and replacing filters, painting equipment and stands and removing of culture media also occurred.

Similar measures were taken to remove all evidence of BW-related activity at other sites including Salman Pak, Al Manal (Dora) and Fudaliyah. This clean-up of the BW agent production facilities was completed before the arrival of the first UN biological inspection team in August 1991. The clean-up efforts at the FMDV plant at Al Dora and Fudaliyah are covered in earlier chapters (Chapters V. VIII and V.IX).

Comment

The quantity, timing and disposal locations for bulk agent have changed during Iraq's declarations and during interviews with UN inspectors. However neither UN inspectors nor the ISG have found information inconsistent with the general statements that the remaining bulk biological agent held by Iraq after the first Gulf War was destroyed sometime in the summer or autumn of 1991. The order by General Hussein Kamel to destroy all BW weapons and bulk agent as declared by Iraq was not only supported by interviews he gave to UN inspectors following his defection, but also from information obtained through the interviews conducted by UNMOVIC and the ISG.

Some bulk agent was disposed of in the waste pits outside the Al Hakam perimeter fence and this was confirmed through UN sampling and analysis in 1996 and 2003. Information provided by a Member State, suggested that bulk agent was removed from Al Hakam prior to the Gulf War and sent to a military related facility near the Iranian border. This source was assessed by the UNMOVIC to be very credible as other information which was provided, proved accurate. The ISG found, through interviews conducted with those involved in the past BW program, that a quantity of bulk agent was inactivated and dumped close to a Presidential Palace near Radwaniyah. However, the ISG did not report a verification of the Radwaniyah site.

From other interview information obtained by either UN inspectors or the ISG, there are

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unconfirmed reports of bulk agent being dumped in an area near Nibai and bulk agent being stored at Airfield 37 and at Al Azziziyah outstation of Abu Obeydi airfield⁶ prior to the Gulf War in 1991. Pieces from two or possibly three 1m³ stainless steel storage tanks were recovered at Al Azziziyah outstation of Abu Obeydi airfield and these tanks had the Arabic letter B written on them possibly indicating agent B (anthrax). Abu Obeydi airfield was where the Mirage F-1 spray tank was located prior to the Gulf War of 1991.

UN inspectors in 2003 verified qualitatively, the destruction of bulk agent, specifically Bacillus anthracis at the dumpsite and in R-400 bombs. Genotyping results showed the isolate at the dump site was identical to the isolate from the R-400 bombs and this was identical to the isolate that Iraq declared it used for bulk agent production. UN inspectors also verified that botulinum toxin was weaponised in R-400 bombs, but at that time there was no reliable method to verify markers or degradation products of aflatoxin destruction.

R-400 Aerial Bombs

As stated in chapter V.X, Iraq declared that in mid-January 1991, biological filled R-400 bombs were equally divided and sent to Airstrip 37 and Al Azziziyah firing range, and stored there until July 1991⁷. During the first week of July 1991, bombs stored at Airstrip 37 were transferred to Al Azziziyah firing range for destruction. Once transferred, the bomb contents were subjected to chemical deactivation⁸. After completion of the chemical deactivation, the 157 bombs at Al Azziziyah were placed in pits, dosed with diesel fuel and destroyed by explosives⁹.

Iraq claims that only 157 bombs were filled with biological agent and that these were all destroyed in the manner described above. As evidence of the number of bombs destroyed, Iraq provided a diary of an officer who was in charge of the destruction team that allegedly included others from Al Hakam as supervisors.¹⁰ The diary relating to this issue appeared somewhat ambiguous. As further evidence that the bombs were biological (and not for example chemical) the officer in charge of destruction stated that there were no chemical bombs at this site, the smell of the bombs according to the officer was "like dead bodies" suggesting the smell of the formalin used in the deactivation process and that he also recalled that some bombs had black stripes.

Comment

The diary suggests that 157 bombs were destroyed in July 1991 although UN inspectors and subsequent interviews by the ISG have cast doubts on the validity of the diary (on numbers of bombs destroyed and methods of destruction, not that R-400s were not destroyed). Other evidence available to the UN suggests that Iraq dispersed (and

⁶ UNSCOM 173/BW 46, January 1997

⁷ Biological FFCD September 1997 Chapter 1.2.3, Chapter 1.2.4; Chapter 1.8.9; Chapter 3.3

⁸ Biological FFCD September 1997 Chapter 1.2.4

⁹ Biological FFCD September 1997 Chapter 7.5.11.2, supported by doc. no. 15

¹⁰ Biological FFCD September 1997 Doc. no. 15 translated comments from a diary of an Engineering Corps officer

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possibly destroyed) 132 R-400 biological agent filled bombs. Other empty R-400A bombs were noticed at Al Walid Air Base in 1991: these bombs were subsequently taken to Muthanna for destruction.

In addition to the 157 bombs destroyed at Al Azziziyah, Iraq claims that a total of 36 or 37 empty bombs comprising 25 or 26 R-400A (Figure V.XI.I) and about 11 R-400 bombs marked with Arabic "C", were destroyed at Al Muthanna under UN supervision in September 1991 (Figure V.XI.II). At that time, UN inspectors were not aware that these particular bombs were designed for biological agent fill. A video of the UN supervised destruction process was provided by Iraq as evidence.

UN inspection records do not detail the breakdown of the bombs into types or serial numbers. From the Iraqi video and photographs available to UN inspectors it appeared that 25 or 26 bombs may have been of the R-400A type but the number of bombs with "C" markings was not possible to determine from the video.

Figure V.X.I: Destruction of empty biological R-400A bombs under UN supervision at MSE in September 1991. The black stripes and stenciled circle indicate the bomb was designed for a biological agent.



Iraq also declared that of the other bombs destroyed, one R-400 bomb was used for an epoxy test, one bomb was for a simulant test at Jerf Al Sakr, two bombs for a test of the burster tube at Al Hakam, and that two bombs were removed from MSE by UN inspectors in 1991.

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After the ceasefire in 1991, the rejected R-400 bombs that were left at Al Hakam were buried in a pit with other munitions. These R-400 bombs were unearthed in the summer of 1991 and thrown into the Euphrates River¹¹. In the period of 3-11 December 1995, and in the presence of the biological monitoring team, four complete R-400 bombs, two bodies of R-400, five complete tail assembly and two main tail parts were extracted from the Euphrates river¹². In the presence of the UNSCOM biological monitoring group¹³ 6 bombs were verified to be R-400, and were within the serial numbering designed for BW fill 1500-2990 and with no traces of an internal epoxy coating. The total quantity of R-400 biological bombs filled or unfilled destroyed was about 200.

Figure V.X.II: Empty biological R-400 bombs with white stenciled circles and the Arabic “C” inside. These bombs were at MSE in September 1991 awaiting UN supervised destruction.



Al Muthanna (MSE) was declared as the site of destruction under UN supervision for almost all of the unfilled R-400 biological bombs. Al Azziziyah firing range was declared as the destruction area for all of the filled biological R-400 bombs and was excavated under the supervision of UN inspectors in 1997.

¹¹ Biological FFCD September 1997 Chapter 1.2.5

¹² BG-3 Reports of 2 – 11 December, 1995

¹³ BG-3 Report of 9 December, 1995

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UN inspectors identified three intact bombs and fragments of about another 20 R-400 bombs. Excavation was stopped because of the risk of unexploded ordnance in the area. The recovered bombs were found to contain liquid that was sampled (Figure V.XI.III). The results of the analysis of these bombs revealed signatures of botulinum toxin type A.

Figure V.X.III: Sampling of a recovered biological R-400 bomb at Al Azziziyah in 1997.



Verification of the Destruction of R-400 bombs

From 24 February to 16 March 2003, UNMOVIC biological team carried out a series of inspections at Al Azziziyah firing range located approximately 100 km southeast of Baghdad. These inspections were to observe Iraqi efforts to recover R-400 bombs and bomb pieces that Iraq claimed that they had filled with biological agents and subsequently unilaterally destroyed in 1991.

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Iraq made efforts to recover and account for the 157 R-400 bombs that it claimed were filled with biological agent and destroyed at Al Azziziyah firing range. Iraq began the excavation and recovery of R-400 bombs and pieces on 19 February; informed UNMOVIC on 22 February 2003, by letter, of initial findings; and supplied copies of videotapes taken during the period when inspectors were not present at the site.

Iraq provided a progress report on the excavation by a letter dated 25 February 2003. UNMOVIC personnel observed all excavation activity from 24 February until 16 March 2003. The level of corrosion and surface contamination of the fragments and the bombs indicated that those pieces were buried for a considerable time period and suggested that Iraq's claim was credible (Figure V.XI.IV).

Figure V.XI.IV Nose Cones of recovered R-400s at Al Azziziyah in 2003



The recovered pieces were examined for identification markings. Where present, the bomb marking was in agreement with the information provided by Iraq, that is, bilateral black paint stripes on nose cones, black paint stripes on body sections,

black stenciled lettering "R-400" on a body section, large white circle with an Arabic letter in the centre. However, due to the burial conditions, in some cases the markings were either very faint or could not be distinguished. Some further work was suggested to distinguish the excavated R-400 bombs from similar conventional bombs, but that work could not be carried out before inspections were suspended.

Figure V.XI.V Recovered R-400 Bomb Fragments in 2003 with markings such as the bomb type (left) and the black stripe (right).



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Because of the level of surface corrosion it was not always possible to confirm the presence or absence of a black stripe on the bomb casings or the fragments there which were excavated. The counting of base plates appeared to provide the best way to clarify the number of bombs (Figures V.XI.VI and VII). Base plates were not always intact and there was no way of knowing whether the base plate belonged to an R-400 bomb destined for the biological programme or a chemical R-400 bomb. It was not possible either to say whether the base plates may have come from a conventional BRIP-400 bomb. However, given the circumstances, the base plate analysis coupled with the other evidence of bomb case markings was the best criteria available.

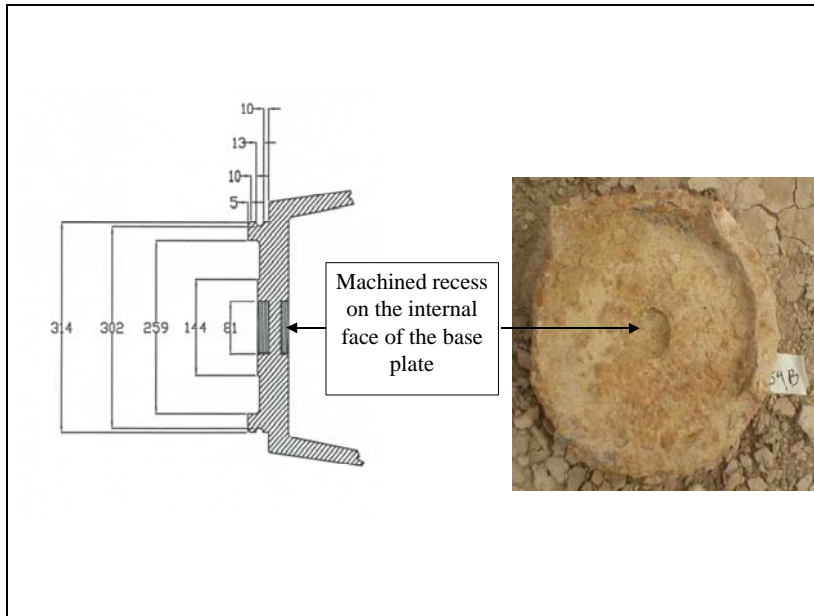
Figure V.XI.VI Bomb fragments and base plates were examined in 2003



The excavations made from 19 February to 16 March 2003 unearthed the following items: eight complete bomb bodies of which three were intact, 96 base plates, 60 nose cones and many fragments of nose cones, tails and bomb bodies, accounting for a total of 104 R-400 bombs, in addition to about 24 R-400 type bombs excavated by the UN in 1997. The total number of R-400 bombs accounted for at Al Azziziyah is about 128 (out of 157 declared destroyed).

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Figure V.XI.VII Base Plate of R-400 Bomb. Left, drawing of R400 and R400A bomb base plate, and Right, Photo of base plate found and examined at Al Azzizziyah by UNMOVIC



Samples were taken from base plates, from nosepieces with intact burster tube fittings and from intact but breached bombs. In addition, and in order to verify Iraq's declaration that the excavated bombs were indeed of the biological type, an UNMOVIC team drilled and sampled the liquid contents of three intact bombs excavated at Al Azzizziyah in February 2003 (Figure V.XI.VIII). Two of the bombs contained liquid and showed no signs of environmental contamination, while the third contained a clay-like material, probably due to the presence of an undetected breach in the casing.

Figure V.XI.VIII One of eight intact R-400 bombs at the Al Azzizziyah Firing Range examined by UNMOVIC in 2003



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Analysis of these samples indicated the presence of high levels of manganese and formaldehyde/water adducts, confirming the Iraqi declaration that biological bombs were chemically inactivated using two disinfectants, potassium permanganate and formaldehyde. However, the initial screening techniques for chemical or biological warfare agents at BOMVIC gave negative results for all tested material. The biological tests were performed on the samples directly without pre-cleaning or concentration. Since the biological laboratory at BOMVIC did not have the nucleic acids or sample cleaning kits to clean the samples from the quenched DNA by potassium permanganate and/or formic acid, the samples from the two R-400 bombs filled with liquid agent were tested in outside laboratories.

The results of that analysis indicated that both bombs contained DNA fragments of virulent *Bacillus anthracis*. No evidence of chemical agents, their precursors or degradation products was found, nor was any evidence found of *Clostridium botulinum* DNA or toxin. Additional tests were conducted to perform single nucleotide polymorphisms (high resolution genotyping) to compare the type of *Bacillus anthracis* found in bombs to the type declared and weaponized by Iraq; the results confirmed that the strain of anthrax as declared by Iraq. This unequivocally confirmed Iraq's declaration that at least the two bombs sampled by UNMOVIC were indeed biological R-400A bombs.

Regarding the munitions and fragments recovered at Al Azziziyah, all fragments excavated under UNMOVIC supervision supported Iraq's declaration about the destruction site and methods of destruction. It gave further credence that bombs were filled with liquid agent were destroyed as declared.

The mechanical features of the eight intact bombs confirm that they are indeed R-400 type bombs and the presence of fragments of DNA of *Bacillus anthracis* strongly suggests that at least two of them were R-400A bombs. The presence of "R-400A" stenciled on a few of the fragments; the black stripes observable on other fragments and white circles on yet additional fragments all suggest that additional R-400A bombs were present. However, the total number of fragments with these and other markings is only a few dozen.

Comment

Ninety-six base plates were excavated and collected at Al Azziziyah. These base plates appear to be similar to one another in design and similar to the pattern of base plate used with the R-400A bomb (Figure V.XI.VII). Therefore it can be inferred that they represent 96 destroyed R-400A bombs. However, this is not a valid assumption unless the base plates from R-400, R-400A and BRIP-400 bombs can be clearly distinguished from one another. Given that R-400A bombs were manufactured to the same specifications (other than an internal epoxy coating) as the R-400 bombs there is no reason to believe that the base plates from these bombs can be distinguished from one another based on physical features. Further, the specific features of the base plate of the BRIP-400 bomb

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are unknown to UNMOVIC and therefore any anomalous feature that would distinguish base plates from that bomb from either the R-400 or R-400A is also unknown.

All base plates excavated at Al Azziziyah are most likely to be R-400 bombs. This evidence includes the total number of fragments recovered, the fact that all of the fragments appeared in similar condition (no evidence of the site being seeded) and that some distinguishing features pointed unambiguously to some R-400 biological bombs, it is not unreasonable to conclude that all of these base plates were from R-400 biological bombs.

Al Hussein Warheads

Iraq declared that it produced 75 “special” warheads of which 50 were designated for fill with chemical warfare agents and 25 designated for fill with biological agent. Of the 50 special warheads for CW use, 30 were destroyed under UN supervision while the remaining 20 CW warheads and all 25 BW warheads were declared as unilaterally destroyed by Iraq in 1991. Details of the CW warhead destruction are contained in Chapter III of the Compendium.

Iraq declared that, about a week before the outbreak of the Gulf War (which occurred on 16 January 1991), the Military Industrialization Commission (MIC) ordered the dispersal of all munitions at MSE to safe locations. The Al Hussein BW warheads were dispersed on 13 January 1991: 15 to a site adjacent to the Tigris Canal (six filled with botulinum toxin, five with anthrax and four with aflatoxin) and 10 to a railway tunnel at Al-Mansuriyah (filled with botulinum)¹⁴ see Figure V.XI.IX. Iraq stated that the special (BW) warheads remained at their original storage sites after the cease-fire and the adoption of resolution 687 (1991).¹⁵

Figure V.XI.IX. Mansuriyah Tunnel and warheads ready for destruction



¹⁴ Biological FFCD September 1997 Chapter 7.6.11

¹⁵ Letter from Lt. General Amer Rashid to the Executive Chairman of UNSCOM 10 March 1998

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In July 1991 General Hussein Kamel ordered the destruction of all BW agent and weapons. The BW warheads were chemically deactivated and the warheads moved to pits at Al Nibai for destruction¹⁶. Iraq stated that the destruction of the BW warheads took place on 9 and 10 July 1991 in several pits using explosives followed by burning. CW warheads were also destroyed in the same area. Fragments of the destroyed warheads were collected and buried in the demolition pits or in pits close to them. Conventional bombs were then exploded over the burial area to obscure any remaining signs¹⁷.

The details on the BW warheads given in Iraq's declarations relied heavily on the recollection of personnel involved in the production and destruction of the warheads and that it had little documentation regarding production or destruction (see Chapter IV Missiles for further details).

Comment

UN inspectors tried to verify the accounts of the destruction of the BW warheads at Al Nibai by counting unique fragments of warheads and taking samples of excavated remnants of warheads. The accounting of warheads was made more difficult by the fact that Iraq had destroyed and buried fragments of a number of conventional warheads in the same pits as those for the special chemical warheads. There were some differences between the two types of warheads that allowed UN inspectors to identify conventional from special warheads but many fragments could not be uniquely categorized.

In addition, there was a mixture of stainless steel and aluminium warhead containers buried in the pits with only the stainless steel being declared as used for BW. The pits also contained a mixture of modified foreign and indigenously produced warheads. To add further confusion in the accounting for all special warheads (CW and BW), the numbering system on the warheads and its shipping container was not always the same and Iraq admitted much internal confusion with regard to its numbering system. Iraq stated in interviews with UN inspectors that no one present at the site of unilateral destruction recorded the warhead numbers destroyed even though they observed the destruction process.¹⁸ UN inspectors tried to unravel the markings and numbering sequences on both the missile warheads and the transport containers although a totally clear picture failed to emerge.

*Iraq provided conflicting accounts of the distribution of biological agent's fill within the 25 warheads.¹⁹ However, through documentation, UN inspectors found sufficient evidence that 25 warheads were filled with BW agents. There is no evidence that suggested that these warheads had not been destroyed. UN inspectors conducted detailed sampling and analysis of warhead fragments recovered from the Al Nibai destruction pits and sample results revealed that the biological agent *Bacillus anthracis* was present in at least seven fragments from individual warheads.*

¹⁶ Biological FFCD September 1997 Chapter 7.6.12

¹⁷ Letter from Lt Gen Amer Rashid to Executive Chairman UNSCOM 21/7/1998

¹⁸ UNSCOM 211/CBW-BM1 October 1997

¹⁹ UN Doc. no. S/1999/94 29 January 1999 pages 113 to 117

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This sampling and analysis did not fully resolve the issue of the three BW agents distribution among the warheads. Additional details regarding the destruction of Al Hussein warheads are contained in Chapter III of the Compendium.

External Fuel (Drop) Tanks

Iraq declared that although it had planned to modify a total of 12 drop tanks, because of the lack of electric fuel valves²⁰ it was only able to modify three tanks in addition to the prototype tank referred to in Chapter V.X. The modification of the three additional tanks was carried out during the Gulf War in January 1991 and completed by March 1991²¹.

Iraq further stated in its September 1997 FFCD that it had unilaterally destroyed the three drop-tanks in the summer of 1991. The prototype drop-tank and the Mirage F1 had been destroyed in a hangar at the Abu Obeydi Airbase during aerial bombardment in 1991²². It was also stated that this prototype was supposed to have undergone additional testing²³.

Iraq provided several documents relating to the issuance, transfer and subsequent destruction of the three fuel tanks during the period January to August 1991. A document dated April 1991 referred to a cash award to the personnel involved in the modified drop tank project. Another document dated 20 August 1991 referred to a request by the Department of Aeronautical Engineering for the return of fuel valves it had made available to Al Muthanna for the project.

In January 2003, UN inspectors visited the Technical Military Depot for the Air Force at Al Taji to conduct a detailed examination of the remains of several external fuel tanks for jet aircraft that were presented by Iraq during a previous inspection of the site.

The first phase of the examination involved a determination of how many tanks were present. To accomplish this, the remains were shuffled until it was possible to mate the various remaining sections. Most of the components of two of the tanks were accounted for along with two small, but important, sections of a third tank. Three separate tanks were definitely present.

As a result of a side-by-side comparison with a complete tank and the remains of the other tanks (Figure V.XI.X) the inspectors were confident that the remains were definitely from 2200 litre fuel tanks for the Mirage F-1.

Iraqi officials had previously stated that these remains were fuel tanks that had been modified for use as biological spray tanks. To validate these declarations the inspectors physically inspected the remains to identify the nature of the modifications claimed. A close comparison of the remains with the unmodified tank disclosed two points of difference. The first, and most obvious, is the presence of two plates riveted to the sides

²⁰ UNSCOM 126/BW 28, September – October 1995

²¹ Biological FFCD September 1997 Chapter 7.7

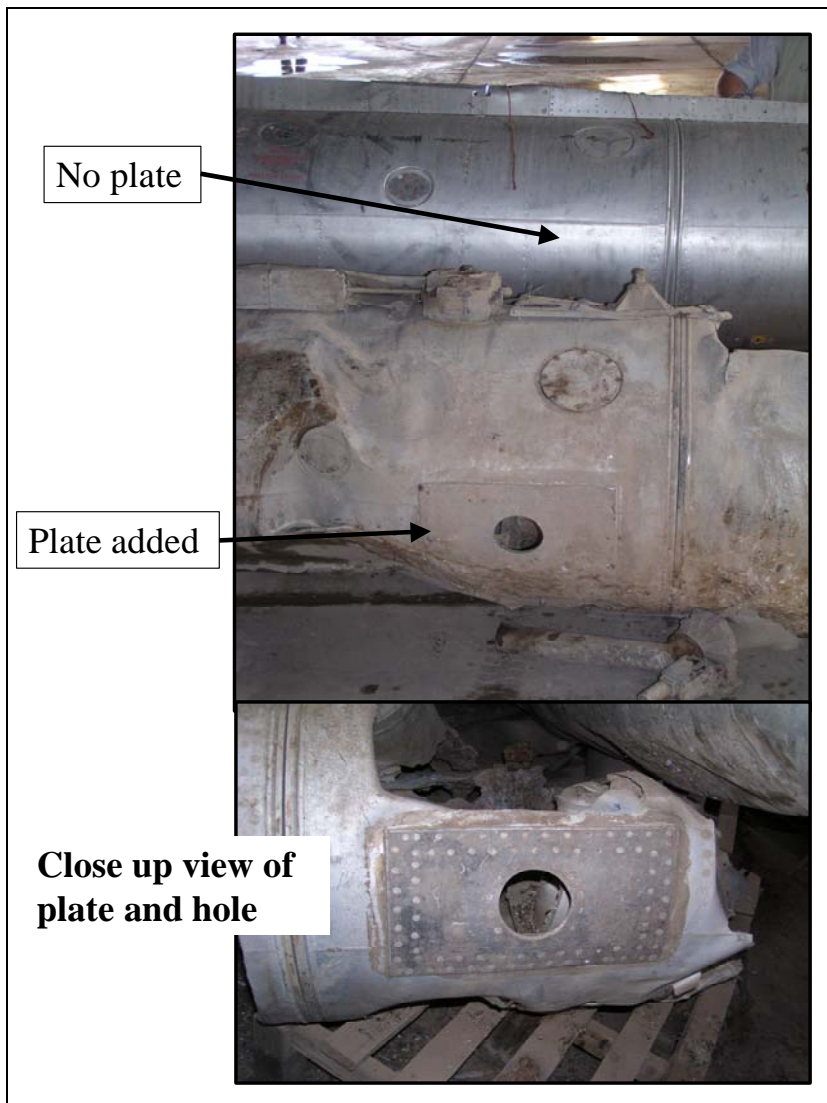
²² Biological FFCD September 1997 Chapter 7.7

²³ March 1998 Technical Evaluation Meeting transcript

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of the tanks (Figure V.XI.X, bottom). These plates are 180 degrees apart and lay along the mid-line axis of the tanks. There are corresponding but dissimilar plates both inside and outside the tanks. The two external plates are rectangular and approximately 257mm wide, 419mm long and 12mm thick. The plates are arranged with their long axis in line with the long axis of the tank. Each plate has a 105 mm diameter hole centered at a point 286mm from its forward edge. The hole is roughly centered on the plate in the vertical axis. The internal plates that were observable were clearly both different from the external plates and different from one another. They appeared to serve as backing plates to add strength. No obvious purpose for the plates/threaded holes was apparent nor were the Iraqi's present aware of their purpose. Nothing was attached to the plates and nothing was obviously missing from the inside of the tanks.

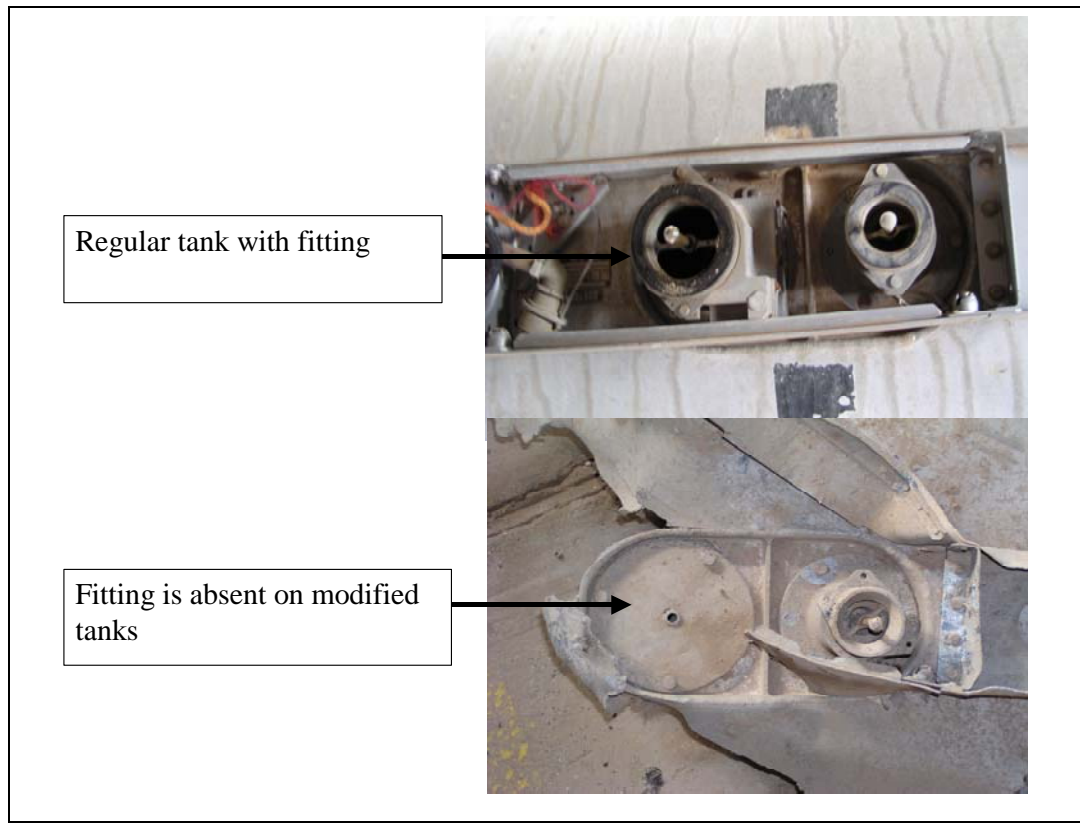
Figure V.XI.X Side by Side drop tanks comparison of regular (Top) and modified (Bottom), with added plate



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The second point of difference was in the equipage on the top centerline of the tank. At a point approximately 2/3 of the length of the tank from the nose there was a fitting present on the new tank that was clearly absent from each of the three modified tanks (Figures V.XI.XI and XII). The purpose of this fitting is unknown.

Figure V.XI.XI Drop Tank Fittings. Top, regular tank, and Bottom, modified drop tank

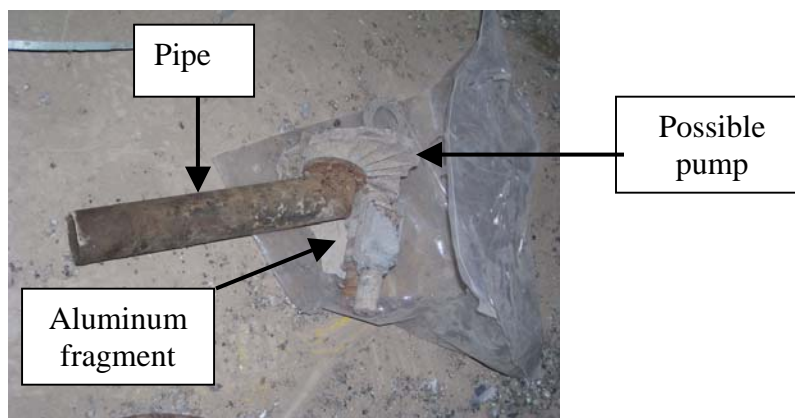


The inspectors conducted a seam-by-seam and object-by-object comparison of all of the remains with the unmodified tank and could discern no other points of difference.

The remains included a section of pipe attached to what might be a pump (Figure V.XI.XII). This assembly is, in turn, attached to a fragment of aluminum. An examination of the fragment of aluminum disclosed that it was similar to a “baffle” found in both the forward and in the rear sections of the modified tanks. No similar assembly was present in any of the modified tanks and there was no indication that this device was previously part of the modified tanks. However, the relevant sections of the three tanks are not all present and therefore UNMOVIC could not conclusively determine that the device was not previously a part of one of the tanks. Its exact function and purpose are unknown.

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Figure V.XI.XII Possible Pump attached to an aluminum fragment in the modified drop tank



Comment

UN inspectors examined and verified the remains of the three spray/drop tanks unilaterally destroyed by Iraq²⁴. The venturi dissemination devices had been removed and could not be found in the scrap-yard where the remains of the modified spray/drop tanks were located. One such device, which was claimed to have been recovered from the scrap yard, was presented by Iraq to UNSCOM in April 1998²⁵. In 1998, an inspection to the airbase where the prototype spray/drop tank was alleged to have been destroyed failed to yield evidence of either the modified spray/drop-tank or the associated Mirage F-1²⁶.

UNMOVIC also inspected remnants of the modified fuel drop tanks presented by Iraq. These remnants did show some differences to a normal Mirage F-1 fuel drop tank and a side by side comparison was made. Because only remnants of the tanks remained, it was not possible to determine conclusively whether these were the modified tanks as declared by Iraq.

Samples were taken from the tanks and were analyzed for chemical agent degradation products and for signatures of biological warfare agents. Tests results were negative for both.

MiG-21 RPV/UAV Project

Iraq stated that the MiG-21 RPV/UAV project was abandoned in 1991. During an inspection in 1998²⁷, UN inspectors were told by an Iraqi representative that the MiG-21 RPV was located somewhere at the Al Rasheed airbase, although the aircraft, or remains

²⁴ UNSCOM 126/BW 28, September – October 1995
and UNSCOM 250/BW 69, July 1998

²⁵ UNSCOM 238/CW 46, April 1998

²⁶ UNSCOM 126/BW 28, September – October 1995

²⁷ UNSCOM 232/BM62, July 1998

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of such, were not observed by the inspectors. Iraq provided a letter dated 19 March 2003, containing additional information on the specifications of all types of unmanned aerial vehicles in its inventory, lists of personnel involved in the development of remotely piloted vehicles/unmanned aerial vehicles, flight test data and information related to the verification of its accounts of its MiG-21 unmanned aerial vehicles project. Although UNMOVIC did not have time to verify this declaration by Iraq, nothing was found by either UN inspectors or the ISG to suggest that the declaration is not accurate.

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Annex to Chapter V.XI

An example of UNMOVIC's verification activities, is demonstrated in a summary of the Inspection Report which focused on the excavation of R-400 BW bombs and fragments at Al Azziziyah Airfield.

Summary

From 24 February to 16 March 2003, UNMOVIC biological team carried a series of inspections at Al Azziziyah Firing Range, located approximately 100km SE of Baghdad, in order to witness Iraqi efforts to recover R-400 bombs and bomb pieces that Iraq claimed were filled with biological agent and subsequently unilaterally destroyed in 1991.

The recovered pieces were examined for identification markings and samples were taken from base plates, nosepieces having intact burster tube fittings and intact but breached bombs. In addition, three intact bombs were drilled and samples of their contents taken for analysis. Of these three, two contained liquid samples, whilst the third contained clay like material, probably due to the presence of an undetected breach in the casing.

Identification markings observed were:

- Bilateral black paint stripes on nose cones
- Black paint stripes on body sections
- Black stenciled lettering "R-400" on a body section
- Large white circle, approximately 20cm diameter
- Small white circle, approximately 8 cm diameter, with possible first letter in Arabic in the center indication agent A fill

The main body of the report is a chronology of the findings on consecutive inspections.

24 February 2003

A biological team supported by EOD and Chemical Group inspectors visited Al Azziziyah Airfield and Firing Range. This inspection was initiated following receipt of a letter from General Amer Al-Sa'adi to Dr Blix dated 22 Feb 2003, regarding Iraq's efforts to account for R-400 aerial bombs filled with biological agent and allegedly destroyed at Al Azziziyah Range.

On arrival the team was taken to a site in Area B2 (Iraqi designation) where four excavators were at work. Near to a large pit were several recognizable fragments of R-400 bombs, one intact bomb and parts of parachutes. Many pieces had black line markings, one was labeled R-400, but no other identifying markings could be discerned due to the rust and general corrosion of the surfaces. Samples were taken from several bomb fragments and semi-intact bombs and from the compacted ground inside the bomb pieces.

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The intact bomb appeared to have liquid contents evident by gentle rocking. This bomb was x-rayed. Two smaller collections of pieces were laid out on the earth nearby. These comprised similar fragments but no complete bombs.

At the second site, approximately 2 km away in Area B1 (Iraqi designation), there were three large holes each four to five meters deep with water in the bottom. Next to one hole there was a collection of seven complete bombs, five of which had holes in them and one, which appeared intact but dented and one intact bomb containing liquid. Further samples were taken from inside the bombs and from earth compacted into one fragment. The intact bomb was x-rayed.

In a fenced area approximately 200m away from the holes a collection of pieces and fragments was neatly laid out on the ground. Black lines could be seen on many of the pieces and one bore a faint white circle approximately 12cm diameter. The Iraqi liaison officer stated that the bombs and fragments had been removed from two of the holes whilst the third hole contained rocket pieces that had been explosively destroyed. This area has been used for the destruction of a variety of conventional munitions.

The team was taken to an area near a fence and earth bank which had previously been visited by UNSCOM. There were a number of R-400 pieces mixed with a variety of other munitions including practice bombs and cluster bomb fragments. The Iraqi liaison officer was asked to extract these pieces to an area about 10m from the bank for further inspection at a later date. No samples were taken in this area. A method of assessing the numbers of bombs that the nosepiece fragments represented was proposed. This was based on estimating the percentage of a whole nosepiece represented by the larger fragments. From these, it was suggested, the total number of nosepieces and hence bombs could be extrapolated.

25 February 2003

On arrival the team drove to the site near the fence and earth bank where two excavators were working dragging bombs and bomb pieces away from the base of the bank for inspection. Any R-400 pieces were removed to a pegged out area and lined up in two rows with tail sections and base plates in one row and bomb nosepieces in the other. The Iraqis explained that the tail sections, largely intact, were part of a testing programme when the bombs were filled with water and dropped on the range. It was explained that they had not been filled with biological agent and did not form part of the 157 bombs that they were seeking to account for. The tail sections had been cleared from the range to this area.

It was noted that these tail sections were largely intact with no obvious signs of explosive damage as compared with the tail sections at Area B1, which were much more deformed. The EOD confirmed that this was consistent with explosive destruction. The nosepieces, some with black stripe markings, were brought to this area from the nearby destruction site. It was noticed that two of the nosepieces with complete burster tube mounting rings included parts of detonation fuses. When asked about this feature, Iraq conceded that

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only practice bombs filled with water had been fitted with fuses, therefore these could not be counted as part of the 157 bombs.

The team also observed further digging activity at Area B2, where only 8 small metal fragments claimed to be from the R-400s were found during the day. The largest being roughly the same area as a piece of A-4 paper. All these pieces were heavily corroded. The Iraqi liaison arrived during the inspection and expressed a wish to complete and agree on the counting of the bombs as soon as possible, preferably that day. The team confirmed that the task would be completed as quickly as possible but would not be rushed and the counting would require agreement on which pieces would be sufficient to identify individual bombs. It was suggested that the fuse attachment holes or the base plates were the most suitable unique identifiers and advice would be sought from NY.

26 February 2003

The team discussed with the Iraqi liaison officer how the bombs and various fragments could be counted in order to assess the overall total number of bombs. After much debate it was agreed that the base plates where the parachute is attached and the complete fuse attachment point at the nose tip would be counted. These are considered to be unique items representing one bomb each. The highest number of either base plates or nosepieces would represent the number of bombs found. Iraq was unhappy that the many fragments of nosepiece would not be counted and it was suggested that these be weighed in order to make an assessment of the number of bombs they represent. Each base plate was given a number followed by a letter B and each nosepiece a number and letter N. All numbered items were photographed.

At the end of the day's activities the numbers of bombs and pieces were as follows: Complete bombs (8), Base plates (77), Nose pieces (53) and Nose Fragments (240). This represent a total of 85 bombs accounted for. Two sections of bomb body were identified with the outline of a white painted circle and a faint Arabic "Alef". Internal surfaces were examined for the presence of blue epoxy paint and small traces were identified on some pieces. However, most pieces are heavily corroded with no trace of paint.

27 February 2003

The Iraqi personnel, under the supervision of the site liaison officer and observed by UNMOVIC personnel, weighed all of the R-400 nose piece fragments from the three locations, Area B2, Area B1 and near the fence. They were weighed using a conventional industrial beam balance, which had been brought from the town of Azziziyah. Also, two intact nose cones were weighed to provide a reference weight.

These confirmed the weight of an intact cone as about 90kg. At the end of the weighing the total weight of the fragments was agreed as 3109.5kg. It was not possible to extrapolate from this figure the number of bombs that it represents as many of the fragments were likely to have come from the nose pieces with complete burster fittings but not complete cones that were previously counted as representing individual bombs. It

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was pointed out that if weighing were to provide reliable information, then all nosepieces either complete or in fragments should be weighed.

Whilst weighing was carried out, the excavators continued working in Area B2. They uncovered several fragments and one more base plate. Site personnel involved in the retrieval process reported finding further items approximately 500m east of the pit at B1. These were inspected and four base plates and one nose were identified. The liaison officer stated that they intended to dig in this new area designated B3 on Friday 28 February.

At the end of the day's activities the numbers of bombs and pieces are as follows: Complete bombs (8), Base plates (82), Nose pieces (54) and Nose Fragments (262). This represents a total of 90 bombs accounted for (complete and base plates).

28 February 2003

Digging continued at site B1 next to the pit. A further 3 base plates and 2 nosepieces were located and identified as being from R-400 bombs. Several nosepiece fragments were also found in this area. Another nose cone (in two matching pieces) was found in an open area approximately 800m to the east of the pit at B1.

This brings the total of R-400 related items to:

Complete bombs (8), Base plates (85), Nose pieces (57) and Nose Fragments (262).

The Iraqi Liaison revisited the issue of how to count the fragments. His proposals introduced a subjective approach that was not acceptable to a process of verification. It was agreed to count the items on the existing system of base plates and nosepieces with intact burster tube fitting and to arrange a meeting at the National Monitoring Directorate to discuss the matter further. The total bombs accounted for (complete and base plates) $8+85=93$.

1 March 2003

A biological team from UNMOVIC returned to Al Azziziyah Airfield and Firing Range for a sixth day. The purpose was to observe further digging in search of R-400 bombs and to take samples from base plates and nose pieces.

Scrape samples were taken from the base plates and nose pieces which had soil and rust adhering to the inner surfaces. Several items, which appear to have remained on the surface, did not have soil or heavily corrosion on their surfaces. Swab samples were taken from these pieces. Since the previous days inspection, the Iraqi site personnel located one more base plate in the area of the pit at B1 and during the course of today's inspection, two more base plates and one nose piece. One of the base pieces was found during the digging at the pit, area B1 and the second was found on the surface along with a nosepiece approximately 600m due south of the pit at B1.

This brings the total of R-400 related items to:

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Complete bombs (8), Base plates (88), Nose pieces (58) and Nose Fragments (262). Other fragments were not counted. The total bombs accounted for (complete and base plates) were $8+88=96$

2 March 2003

A biological team from UNMOVIC accompanied by an EOD expert and a Chemical detection and decontamination team returned to Al Azziziyah Firing Range for a seventh day. The main purpose was to drill and take samples from three intact bombs. Also, to verify any additional R-400 pieces recovered by Iraq.

Further scrape and swipe samples were taken from base plates and nosepieces not previously sampled. A total of three intact bombs, one at site B2 and two at site B1 were successfully drilled using the MONICA device. All three drillings were without incident. The Chemical team confirmed the absence of chemical agent vapor by the use of CAM and AP2C equipment. Liquid samples were obtained from one bomb (labeled No.1) at site B2 and one bomb (labeled No.7) at site B1. A third intact but dented bomb (labeled No.4) at B1 was drilled and thick earth like substance was obtained. The liquid samples from Nos. 1 and 7 were dark straw coloured and slightly turbid. Samples were easy to extract and in the case of No.7, the chamber was slightly pressurized. Sample ports were left in the two liquid containing bombs to allow further sampling to be carried out, whilst the sample port was removed from No.4 to allow extraction of some of the clay like substance. It is believed that this bomb was breached during the destruction process and the location of the breach could not be seen due to the heavy surface rust.

The samples taken from the three intact bombs were collected by the chemical sampling team and were divided into three parts, one for Iraq, one for chemical analyses and one for biological analysis. Further samples were taken from bomb No.1 by the biological sampling team after first rocking the bomb in order to disturb any sediment.

At the end of today's activities a further 5 more R-400 base plates had been located and identified. This brings the total of R-400 related items to: Complete bombs (8), Base plates (93), Nose pieces (58) and Nose Fragments (262). Other fragments found today were not counted. The total bombs accounted for (complete and base plates) were $8+93=101$.

3 March 2003

The purpose of the inspection was to take additional samples from the bombs and to label and photograph any additional R-400 pieces recovered by the Iraqi personnel. Further scrape samples were taken from those pieces not previously sampled. At the end of today's activities a further one R-400 base plate had been located, identified and labeled 94B.

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This brings the total of R-400 related items to: Complete bombs (8), Base plates (94), Nose pieces (58) and Nose Fragments were no longer being counted. The total bombs accounted for (complete and base plates) were $8+94=102$.

5 March 2003

Digging continued in the area B2 and one of the excavators was seen returning to area B1. No further pieces were recovered whilst the team was on site and the totals remained the same as of 3rd March. The team checked the number of tail fins and base plates at the area near the fence that Iraqi officials had claimed belonged to test bombs filled with water and dropped at the range.

There were: Tail fins 15, Base plates 10. These tail fins and base plates were not part of the total bombs accounted for.

Photographs were taken of several stainless steel fragments near the area B1 and B2 pits. These are believed to be from the stainless steel storage tanks that Iraq claims were used to store bulk agent.

On the evening of 5 March 2003, a meeting was held at NMD to discuss issues relating to the R-400 bombs described above. The following is a summary of the discussion.

Iraq sought clarification on the issue of how many bombs they were seeking to account for. They quoted 48 bombs verified in 1997 and the 103 bombs and base plates found at Al Azziziyah giving a total of 151 against the 157 declared filled with biological agents. The UNMOVIC team explained that it was unclear at this time whether actual total to be accounted for was 157 or 200. It was agreed that the UNSCOM reports relating to the R-400 bombs would be reviewed.

Both sides discussed technical matters relating to the recovery of the R-400 bombs that were unilaterally destroyed. The UNMOVIC team explained the principles of searching for bomb fragments as used elsewhere and suggested that Iraq should adopt a more systematic approach to include the areas of excavation.

However, it was agreed that, at this stage of the process, application of a grid location system may not be possible as accurate locations for each find had not been kept. Iraq also explained that part of this area had been farmed in the period since the destruction of 1991, which farmers may have moved some of the pieces on top or shallow areas. In addition, the whole area was flooded for some time.

An Iraqi military officer explained that in May 1990, 24 practice R-400 bombs were dropped on the range using four different types of aircraft.

- Flight 1. Four different aircraft each with two bombs, which had no fuse or parachute. The bombs (8) were recovered from the range and removed to the Nasr State Company. Of the 8 bombs above, 6 were sent to Al Muthanna, one was exploded to test the burster and one was used for internal painting and then cut into pieces to see if the paint had covered all surfaces.
- The remaining 16 were dropped at the range with full explosion.

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The Air force requested a further 10 to check for accuracy. Iraq explained that it was possible to distinguish between the test bombs and the destroyed agent filled bombs by the level and type of damage, which shows internal or external explosion and the test bombs were all painted with a red stripe on the outside. [Comments: UN inspectors had seen them during mid 1990 inspections missions.] This is consistent with findings reported by UNSCOM 173 in January of 1997. It was also stated that the first eight test bombs with no fuse, had a nosepiece blanking plug in place. It was agreed that the pieces recovered to date could be removed to an area near the control tower, provided they were kept separate according to the area where they had been found. This was done under UNMOVIC supervision.

6 March 2003 to 16 March 2003

The Iraqi personnel continued their search for R-400 bombs and related items at the site and during this period a further two nosepieces and two base plates were recovered. The total number of items recovered at 16th March 2003 is as follows: Complete bombs (8), Base plates (96), and Nose pieces (60). Nose Fragments or other fragments were no longer being counted.

On 9th March, team members observed the transfer of recovered items from areas B1, B2 and B3 to an open area in front of the Control Tower. The pieces were arranged according to type and a small fence was erected around the collected pieces. Some of the items were relabeled by the team using paint to replace the original adhesive tape labels. During the transfer, the sampling port was damaged on one of the intact bombs that had been drilled for sampling purposes. The seal remained intact and the contents did not leak. The total bombs accounted for (complete and base plates) were $8+96=104$.

Summary and Conclusions

- Iraq appeared to be making genuine efforts to recover and account for the 157 R-400 bombs that it claims were filled with biological agent and unilaterally destroyed in 1991.
- Iraq began excavation and recovery of R-400 bombs and pieces on 19 February 2003 but informed UNMOVIC on 22 February. As a result, UNMOVIC personnel were not on site during the first three days of digging and not able to verify that early excavated items examined, including the intact bombs, were excavated at the site. However, the level of corrosion and surface contamination of the pieces that have clearly been buried for some time suggests that Iraq's claim is genuine. Iraq has supplied copies of videotapes taken during the period when inspectors were not present at the site. The surroundings of the excavated area on the videotape appear similar to Al Azziziyah.
- Counting of base plates appeared to provide the best measure of the number of bombs. However, because of the level of surface corrosion and the fact that in some items only the base plate rim was present, it would not be possible to confirm the presence or absence of a black stripe on all of these items.

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- If nosepiece fragments are to be taken into account, then all nosepiece fragments and intact nosepieces should be weighed before a calculation of the total number of nosepieces can be made.
- Iraq stated that the 8 test bombs dropped without fuses were fitted with an end plug in the tip of the nosepiece. Some of the nosepieces at the site have retained end plugs.
- UNMOVIC took liquid samples from two R-400 biological bombs excavated at Al Azziziyah in 2003. These liquid samples contained DNA fragments of *Bacillus anthracis*.²⁸ Molecular genotyping of the DNA fragments contained in the liquid samples was carried out by two laboratories within UNMOVIC's network of reference laboratories. The analysis confirmed that the genotype of the *Bacillus anthracis* isolate in the R-400 samples was identical to the genotyping of the *Bacillus anthracis* isolate which Iraq had declared it had selected for weaponization and filled in R-400 bombs.²⁹
- In 2003, UNMOVIC also requested two reference laboratories to do genotypic analysis of samples containing elevated levels of *Bacillus anthracis* spores taken from the Al Hakam dump site by UNSCOM in 1996. Analysis showed that isolates from the site were identical to the strain of *Bacillus anthracis* declared by Iraq as used for its agent production. Furthermore the *Bacillus anthracis* isolate in the R-400 samples was indistinguishable from the *Bacillus anthracis* isolate found at the dump site.³⁰

²⁸ UN doc. no. S/2003/844 of 30 May 2003

²⁹ UN doc. no. S/2003/1135 of 26 November 2003

³⁰ UN doc. no. S/2003/1135 of 26 November 2003

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AL HAKAM POST 1991

Introduction

Following the conclusion of the Gulf war in March 1991, Iraq's most senior decision makers opted for a policy of not declaring the past biological weapons programme. In order to fulfill this policy, Iraq embarked on the unilateral destruction of its BW agents, records and weapons and then on an elaborate system of concealment, deception and denial. Besides, the destruction of BW agents and weapons, Iraq had to prepare an elaborate cover story for the existence of facilities such as the Al Hakam factory. Iraq could not be sure how much was known to the coalition or the UN through numerous defectors, and had to account for the imported equipment which it probably assumed was well known to the UN inspectors.

Unlike MSE, Al Hakam continued to operate from 1991 and produced a variety of agricultural-related products until December 1995, when all activities were suspended based on a letter from the Executive Chairman of UNSCOM. The Al Hakam Factory was destroyed in 1996 by Iraq under UN supervision.

In April 1991, after the adoption of Security Council resolution 687 (1991), Iraq declared that it did not possess any biological weapons or related items. In May that year, Iraq identified a number of biological dual-use facilities that worked with micro-organisms or contained fermentation equipment. Al Hakam was described as a biological facility intended for the future production of vaccines or other materials produced by micro-organisms such as single cell protein (SCP). As part of the cover story, Iraq used some of the equipment present at the Al Hakam Factory for production of animal feed supplements or SCP, biofertilizers and biopesticides.

According to statements made by Dr. Rehab Taha, the estimated national need for biopesticide production was 800 tonnes per year. The total capacity of two fermenters of 5m³ would have been 1000 tonnes per year. Furthermore, Dr. Rehab Taha has stated that Iraq's demand for SCP was between 200,000 and 250,000 tonnes per year. Thus, the SCP production plant would have required a 50m³ fermenter for pilot-scale production and for large-scale production, even larger fermenters of the order of 500 m³ would have been needed. Therefore, in late 1991 or early 1992 Iraq embarked on a programme to expand the production capacity of Al Hakam Factory.

Iraq declared that the production rates of SCP, biopesticide, and biofertilizer at Al Hakam Factory were consistently low. The quantities of SCP produced were estimated to have been approximately 20 tonnes (between 1992 and 1994 using brewery waste) and 150 kg (using ethanol/methanol and in batch or continuous process). In addition Iraq stated that 40 to 50 tonnes of biopesticide products were made in each year from 1993 to 1995. Smaller amounts, about 160 litres, of biofertilizer were also produced. Products under development included beer yeast, bakers yeast, starter cultures for yoghurt, and organic solvents.

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In establishing the production processes and testing the manufactured products, the Al Hakam Factory interacted with other Iraqi facilities such as the Ministry of Agriculture, and the Agricultural and Biological Research Centre at Tuwaitha (referred to as Tuwaitha hereafter for brevity). The latter research centre provided both basic and applied research support to the Al Hakam Factory; the development of large-scale fermentation protocols, downstream processing and field application of biopesticide, isolation and development of microbes for SCP and bio-fertilizers, and quality control support for Al Hakam's biopesticide production. For the quality testing of its products, the Al Hakam Factory cooperated with facilities such as Tuwaitha (biopesticide), the Technical Institute at Al-Shatra (biofertilizer), the Musayyab Technical Institute and the College of Agriculture, University of Baghdad (SCP).

Between 1992 and 1994, the laboratory-scale research at the Al Hakam Factory was focused on four different areas: (1) SCP production by yeast from hydrocarbon sources (methanol and ethanol), (2) SCP production by yeast from carbohydrate sources (beer and whey residues, planned projects included adding molasses), (3) Agricultural projects (microbial fertilization enhancers, nitrogen-fixing bacteria), and (4) Production of *Bacillus thuringiensis* pesticides from different strains and evaluation against different targets such as mosquitoes, the wax moth, and cockroaches.

Iraq stated that the production of SCP was the single largest fermentation activity on site, and work to establish the Al Hakam Factory as an operational production site began mid-October 1991. With regard to other projects Iraq declared that, in 1992, Al Hakam began producing several strains of *Bacillus thuringiensis*, referred to as BT, for use as a bioinsecticide. The activities at Al Hakam Factory also involved investigating ways to increase soil productivity for wheat crop cultivation by using nitrogen-fixing micro-organisms as biofertilizer. Manufacture of this product via a fermentation process was also initiated in 1992.

To meet the demands of the processes developed or under development, the Al Hakam Factory acquired additional equipment during 1992 and 1993. The major part of the equipment was either transferred from other Iraqi facilities (Agricultural Research and Water Research Centre, Fudaliyah -Al Safah -, the Agricultural Ministry, Ibn Sina Company, Nineveh Alcoholics Company, Al Salaam Factory, and Tuwaitha) or through the "Local Market". Additionally, some equipment was manufactured or planned to be manufactured by Iraqi facilities.

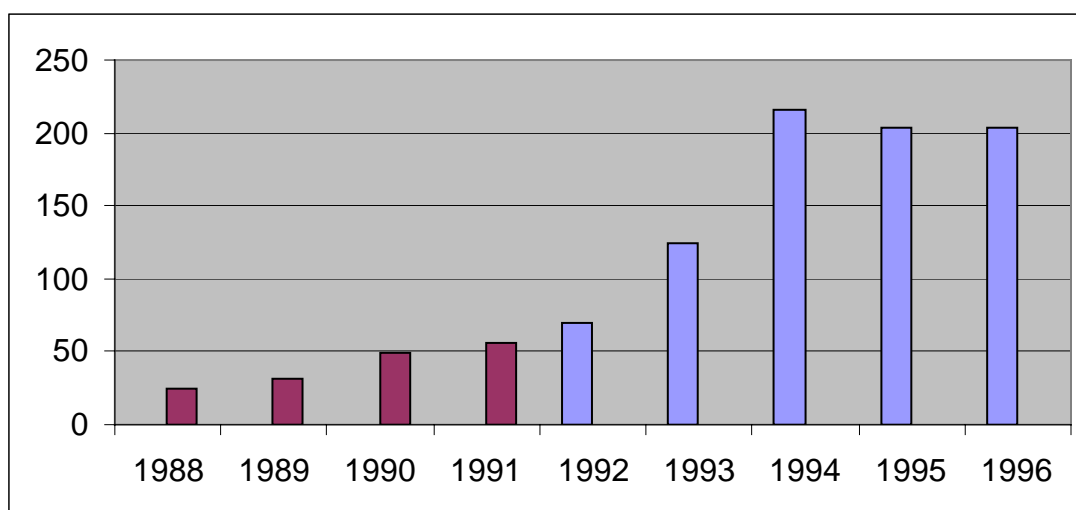
Organization and personnel

The programme to expand the production capacity of Al Hakam Factory was reflected in increased building and construction activities, acquisition of equipment and accessories, as well as an expansion in staff (Figure V.XII.I). The number of employees at the Al Hakam Factory showed a steady increase from 1988 to 1994, thereafter the number of the staff seems to have remained rather constant. Activities at the Al Hakam Factory ceased in late 1995 following the request by the Executive Chairman of UNSCOM and some

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buildings were sealed. The work force in 1996 reflects those still on the Al Hakam staff list even if they were not working at the site.

Figure V.XII.I Number of employees per year at Al Hakam Factory/Division during the period 1987 to 1996. The numbers for 1988-1991 have been estimated from the compilation of information in an Iraqi letter dated 17 March 2003, and the CAFCD of December 2002. Numbers for 1992 and 1993 are based on UNSCOM inspection reports. Numbers for 1994-1996 are as declared by Iraq. The period of employment for 13 named persons involved in the BW programme has not been declared and thus they are not included.



In 1993 the factory was organized into at least 15 different sections or offices (Table V.XII.I). At end of 1995 and beginning of 1996 there were 210 people employed at Al Hakam Factory, including 1 PhD, 1 veterinarian, 22 engineers, 132 technicians, 1 student, and 47 administrators or support personnel.¹

Table V.XII.I. Offices and sections of Al Hakam Factory in 1993

Department	Section/Approx. number of employees	Approx. Number of employees per area
Management & Administration	Office of the Director/2, Planning & Follow-up/6, Administration/5, Finance & Accounting/5	18
R & D	R & D/18	18
Production	Production A/7, Production B/9, Agriculture production/5, Evaluation & Quality control/4	25
Maintenance & Supplies	Instrumentation/3, Resident engineers/4, Maintenance/11, Warehouse/7	25
Safety	Clinic/2, Industrial safety/6	8
Other Support Staff	Guards, cleaners	31
Approx. total number of employees		125

¹ Al Hakam Factory monitoring declarations for July 1995 and January 1996

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After the dissolution of the TRC in 1991, the Al Hakam Factory was directly subordinated to MIC.²

Iraq stated that in November 1991, Professor Nasser ‘Abd Al-Hussein Al-Hindawi assumed the responsibility for the SCP project at Al Hakam.³ Later, in April 1992, he assumed the task and duties as director of the Al Hakam Factory.⁴ However, in beginning of April 1992, Dr. Rehab Taha was placed in charge of Al Hakam Factory as director, when Professor Nasser Al Hindawi announced his intention to return to the university.⁵ Dr. Taha remained as director until the destruction of the facility in June 1996.

Production of SCP at the Al Hakam Factory

Iraq stated that the Al Hakam factory was a further development following on from the R&D work at the Al Taji SCP plant under the Direction of Professor Nasser Hindawi in the early 1980's (Chapter V.V).⁶

According to Iraq's discussions with UNSCOM in April 1992, work to establish Al Hakam as an operational site for SCP began mid-October 1991.⁷ Up to April 1992, small amounts (up to 1 kg quantities) of SCP had been produced, using the 1m³ capacity fermenters in the Northern Production Area. There were samples showing at least 26 successful runs using different combinations of substrate material and/or isolates.

The initial SCP manufacturing process employed at Al Hakam Factory involved the use of brewery waste. In addition to protein extraction from industrial residues using whey as a possible carbon source, the Al Hakam project in 1992 also involved utilizing hydrocarbon sources such as methanol and ethanol as substrate for SCP production.

According to Iraq, in April 1992 the production operations were on a pilot-scale (as the largest fermenter capacity was 1m³). Iraq stated that it planned two pilot lines in the Northern production area, to be used for SCP production from carbohydrate sources. Although a primary focus of effort had been to make all of the equipment operational, the only operational pilot line was the fermenters transferred from VRL (Al Kindi) in 1989. The 450 litre fermenter transferred from the Taji SCP pilot project, needed modification and the water distillation plant was operational, but only by manual control.

² UNSCOM 35/CW 8, 15-29 April 1992, Annex H

³ Order No. 2698 memo. UNSCOM document no. 174014

⁴ Order memo. UNSCOM document no. 174015

⁵ UNSCOM 35/CW 8, 15-29 April 1992, Annex H

⁶ UNSCOM 105/BW 16, 1-12 December 1994

⁷ UNSCOM 35/CW 8, 15-29 April 1992

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The yields from the operational pilot line had been low relative to those noted in the literature and the Director felt that this was primarily attributed to the use of local isolates (*Candida melentis*, *Candida utilis* and *Saccharomyces cerevesiae*) instead of standard isolates. According to information obtained during UNSCOM inspections⁸ in March 1993, also the yeast *Kluveromyces fragilis* was grown on beer waste and whey at pilot-scale (using the 450 litre fermenter). *Candida* sp. was grown on ethanol and *Hansenula* on methanol.

In April 1992, Iraq stated to UN inspectors⁹ that the Southern Area would eventually be used for SCP production from hydrocarbon sources. The building at that time was in the process of completing civil engineering work that was halted in the summer of 1990. The equipment installed, which required a great deal of repair, only occupied one-quarter of the southern production building. The Director indicated that the remaining space would eventually be used for the scale-up fermentation equipment for full-scale production that would either be the 5m³ system, should the firm honour its contract, or a similar system. However, SCP was never produced in buildings in this area of the Al Hakam Factory.

SCP from brewer's waste

The starting material for this manufacturing process, spent fermentation lees from the brewing of beer, contains a large quantity of yeast in a crude mixture of alcohol, beer fermentation medium, and metabolic waste products. The principal breweries which supplied the Al Hakam Factory with brewery waste were Sanibel and Sheherazade (that is the National Food Industries Brewery in Baghdad)¹⁰. The waste was transported into Al Hakam via a 140,000 litre capacity tanker truck although the actual volume delivered varied considerably (Figure V.XII.II).

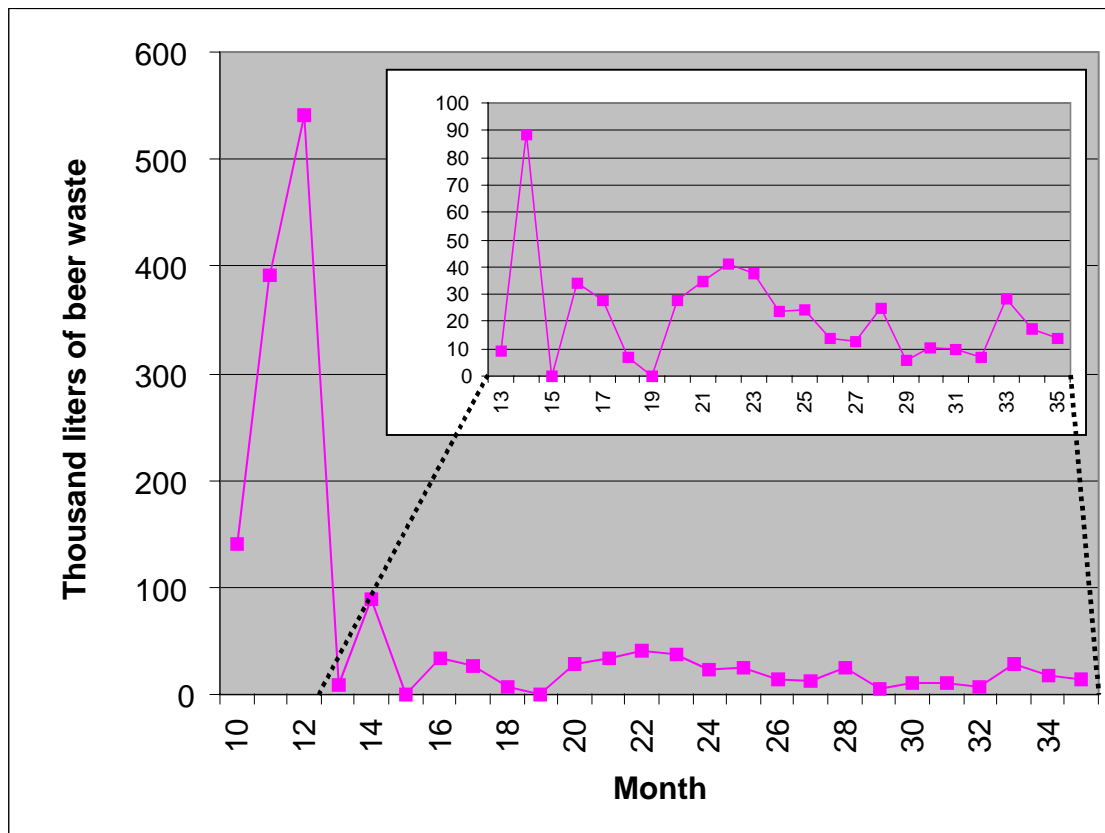
⁸ UNSCOM 53/BW 3, 11-15 March 1993

⁹ UNSCOM 35/CW 8, 15-29 April 1992

¹⁰ Prior to the utilization of this waste material by Al Hakam, Baghdad brewers disposed of it by dumping it into rivers or the sewer system, although some UN inspections revealed that some breweries had the necessary equipment to dry the lees into a useable agricultural product. According to Dr. Rehab Taha avoidance of the resultant pollution was one important reason for processing at Al Hakam Factory.

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Figure V.XII.II Supply of beer waste to the Al Hakam Factory during Oct 1992-Nov 1994.¹¹



The yeasts were recovered after pasteurization, alkali precipitation and drying and was essentially the SCP final product. The dried material contained approximately 39% to 46% protein by weight. The process was carried out in Shed A1 in the Northern Area. Once Al Hakam began utilizing brewery waste, a drum dryer from the brewery in Mosul was purchased and moved to Al Hakam for use in its SCP production operation. The drum dryer was sampled by UN inspectors and found negative for a range of BW agents (Figure V.XII.III).

Production out-puts of SCP for the years 1992, 1993, and 1994 were 4.4 (October to December), 9.8 (January to December), and 6.1 (January to November) tonnes, respectively.¹²

¹¹ UNSCOM 105/BW 16, 1-12 December 1994, Annexes X-Z

¹² UNSCOM 105/BW 16, 1-12 December 1994, Annexes X-Z

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According to Iraq, in late 1994 the limiting factor in production was the availability of beer waste.¹³ The supplying breweries had cut production to 25% of pre-sanction levels because of problems in obtaining equipment spares, and they could neither guarantee quantity nor quality. If sufficient beer waste was available, capacity would have been limited by the reliability of the drier which could not be used daily because of lack of spare parts.

Figure V.XII.III. Sampling of SCP product from brewery waste after drying in the drum dryer located in the Northern Area of Al Hakam.



SCP via batch fermentation

Subsequent to developing a process for producing SCP from brewery waste, and apparently due to the unpredictable supply of the starting material and the ease of obtaining alternative starting material from the petrochemical industry¹⁴, Al Hakam Factory developed a process for obtaining SCP by producing yeasts supplemented with either methanol or ethanol.

The process occurred in Sheds A1 (Figure V.XII.IV) and A2 (Figure V.XII.V) in the Northern Area. Although this production line was not in operation in late 1994, due to equipment problems and a shortage of spare parts, it was stated that approximately 100 kg of SCP were obtained via this process in 1994.

This SCP production process employed a batch fermentation process, that is, the fermentation was initiated and running until the cells had consumed all available nutrients and/or were not able to be provided with sufficient oxygen and would not longer reproduce. The fermentation was then terminated and the cells harvested from the whole broth. From this point forward, the production process was the same as SCP production from brewery waste.

¹³ UNSCOM 105/BW 16, 1-12 December 1994

¹⁴ Specifically from a programme called PC2 or Petro Chemical 2

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Figure V.XII.IV. Right front view of Shed A1 in the Northern Area of Al Hakam



SCP via continuous fermentation, pilot-scale

To improve on the batch manufacturing of SCP (increase product yield and make more efficient use of the equipment), a research programme was initiated in 1992 focussing on investigating the feasibility of adapting a continuous yeast fermentation process. In late 1994 UN inspectors¹⁵ were able to review a publication provided to them by Dr. Taha summarizing the research. The studies indicated that continuous fermentation of yeasts provided with a feedstock containing either n-paraffin, methanol, or ethanol was possible and that the process could achieve a higher productivity than the batch fermentation process.

Problems such as the absence in the final product of amino acids containing disulphide bonds (for example, methionine and cysteine) as well as the presence of possibly toxic materials were recorded in the publication. The absence of the amino acids was stated as not being a significant problem since these components could be added to the final product, or the SCP could be mixed at a 50:50 ratio with animal protein to make it nutritionally complete. The n-paraffin used as a substrate in the production of SCP contained impurities which may have contributed to the toxic content of the end product. Thus, the research moved into using more purified forms of alternative carbon sources, for example, methanol and ethanol.

Developmental work on the continuous fermentation was done in Shed A2 (Unit 2) in the Northern Area (Figure V.XII.V).

¹⁵ UNSCOM 105/BW 16, 1-12 December 1994

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The initial concentrations of 3 to 4 grams per litre were improved to 10-12 grams per litre, which Iraq considered satisfactory for commercial production. The pilot-scale production of SCP via continuous fermentation began in 1992, and in October 1993 Al Hakam had produced approximately 50 kg of SCP by this process.

Figure V.XII.V Left front view of Shed A2 in the Northern Area of Al Hakam.



The 450 litre fermenter (Figure V.XII.VI) was used in the production line. At the pilot-scale, no seed build-up in a fermenter was required as sufficient inoculum could be generated in shake flasks in the adjacent laboratory. During inspection of Shed A2, one 150 and one 100 litre fermenters were observed. Iraq indicated that these were not operational at the time of inspection due to lack of spare parts. The 450 litre

fermenter was in operation but Iraq stated that it was being used for BT biopesticide in support of work performed in the production building in the Southern Area.

Figure V.XII.VI The 450 litre fermenter used for production of SCP



In the continuous process, a hydrocarbon source (or substrate) with a balanced salt solution was added to the ongoing fermentation and whole broth was withdrawn at the same rate. The downstream process was the same continuous or single-batch process as described in the SCP production processes.

Results at the end of 1994¹⁶ pointed to ethanol as the preferred feedstock, although development work for the utilization of methanol continued. Iraq stated that the alcohol

¹⁶ UNSCOM 105/BW 16, 1-12 December 1994

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process could be made to work without further scale up trials in the 50m³ plant planned (see below), to be operational at end of 1995.

SCP via continuous large-scale fermentation

Anticipating success with the pilot-scale SCP process, in 1992 Iraq embarked on construction of a facility which was going to be dedicated to the production of SCP via the continuous fermentation process in a single 50m³ fermenter.

The shell of this facility was essentially complete at end of 1995 but it still lacked doors, windows, had no electricity or water supply and also lacked the necessary process equipment. The fermenters, holding tanks, and apparently the majority of the process equipment for this facility were planned to be manufactured in Iraq.

According to statements by Al Hakam workers, the seed build-up for the large fermenter would occur in three-stages, ending in a 5m³ fermenter. The contents of this fermenter were then to be transferred into the 50m³ fermenter. Apparently, Al Hakam Factory planned to perform trial runs in the 5m³ fermenter before committing resources to the large fermenter.

Since the pilot-scale continuous fermentation took place in a 450 litre fermenter, this intermediate process development stage represented an approximate 1:10 increase in scale, with the increase to the 50m³ fermenter being a subsequent ten-fold increase in scale. The large-scale SCP manufacturing process was the same as the pilot-scale continuous fermentation process.

The planned output from the 50m³ fermenter was thought to be approximately 500 tonnes of SCP per year. The unit was expected to have a multi-purpose capability with regard to feedstock. The ideal feedstock would be n-paraffin, but it needed purification by molecular sieve technology at the refinery prior to use, and this expertise could only be obtained from the overseas. Dr. Rehab Taha also stated that use of n-paraffin as feedstock in the 50m³ reactor might cause difficulties with the pumps.

Comment

The proposed building expansion may well have been part of the elaborate deception plan aimed at preserving the capabilities of the Al Hakam Factory. Expanding the capability of the Factory would have the added benefit of allowing the staff to continue work with pilot and large-scale fermentation technology, allow familiarity with drying techniques and possibly derive some income from the site even if this fell well short of being economically viable. It is possible that Iraq may have envisaged the Al Hakam Factory as producing products for civilian needs when there was no need or urgency to produce BW agents. This would have been a similar concept to MSE which was capable of producing chemical fertilizers and pesticides when not producing CW agent.

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Testing of SCP product

The SCP produced was tested at the Al Hakam Factory, and in 1994 and 1995 evaluations were made of the efficacy of SCP as animal feed. In some trials other facilities were also involved such as:

- College of Agriculture, University of Baghdad. SCP derived from ethanol was confirmed as satisfactory as a feedstuff for chickens bred for human consumption (the main outlet for SCP in Iraq). The product was mixed 50% with existing animal feedstuffs to provide the necessary sulphur containing amino acids.
- Musayyab Technical Institute. Part of the SCP product derived from methanol was used in fish feeding trials at the Institute. However, it was considered that only the product from beer waste was suitable for this outlet. The remaining product was used in trials with chicken in the animal house at Al Hakam Factory.

Production of BT biopesticide

Relationships between the Al Hakam Factory and Other Organisations

The Al Hakam Factory had a close relationship with the Ministry of Agriculture and the Biological Research Centre at Tuwaitha.¹⁷ The latter provided both basic and applied research support to Al Hakam Factory: the entomology and microbiology departments at Tuwaitha were responsible for developing all of the protocols for production, downstream processing and field testing and application of BT¹⁸, isolation and development of micro-organisms for SCP and biofertilizers and quality control support for the factory's biopesticide production. The Ministry of Agriculture was the main receiver and product distributor in the farming community.

In 1986 Tuwaitha began research on *Bacillus thuringiensis*, (BT) focussing on evaluating the best media, and factors that affect production.¹⁹ Researchers from Tuwaitha met Dr. Taha and Professor Hindawi at a meeting sponsored by the Iraqi Society of Microbiology in the mid 1980s. In 1991/1992 Al Hakam received strains from Tuwaitha. In March/April and July 1995 the Tuwaitha researcher stated to UNSCOM²⁰ that the strains being used at that time for production at Al Hakam were *Bacillus thuringiensis* strains Kurstaki and Gallerium for the control of the corn borer.

Strains of *Bacillus thuringiensis* present at the Al Hakam Factory

In 1992, Al Hakam began producing biopesticides, based on several strains of *Bacillus thuringiensis*. BT Kurstaki was acquired from Tuwaitha in 1992. There were two other sub-strains of *Bacillus thuringiensis* (Azawai and Israelensis) present at the facility.

¹⁷ UNSCOM 152/BW 38, 23 July-3 August 1996

¹⁸ Statements to UNSCOM monitoring team (BG-1) in mid 1995

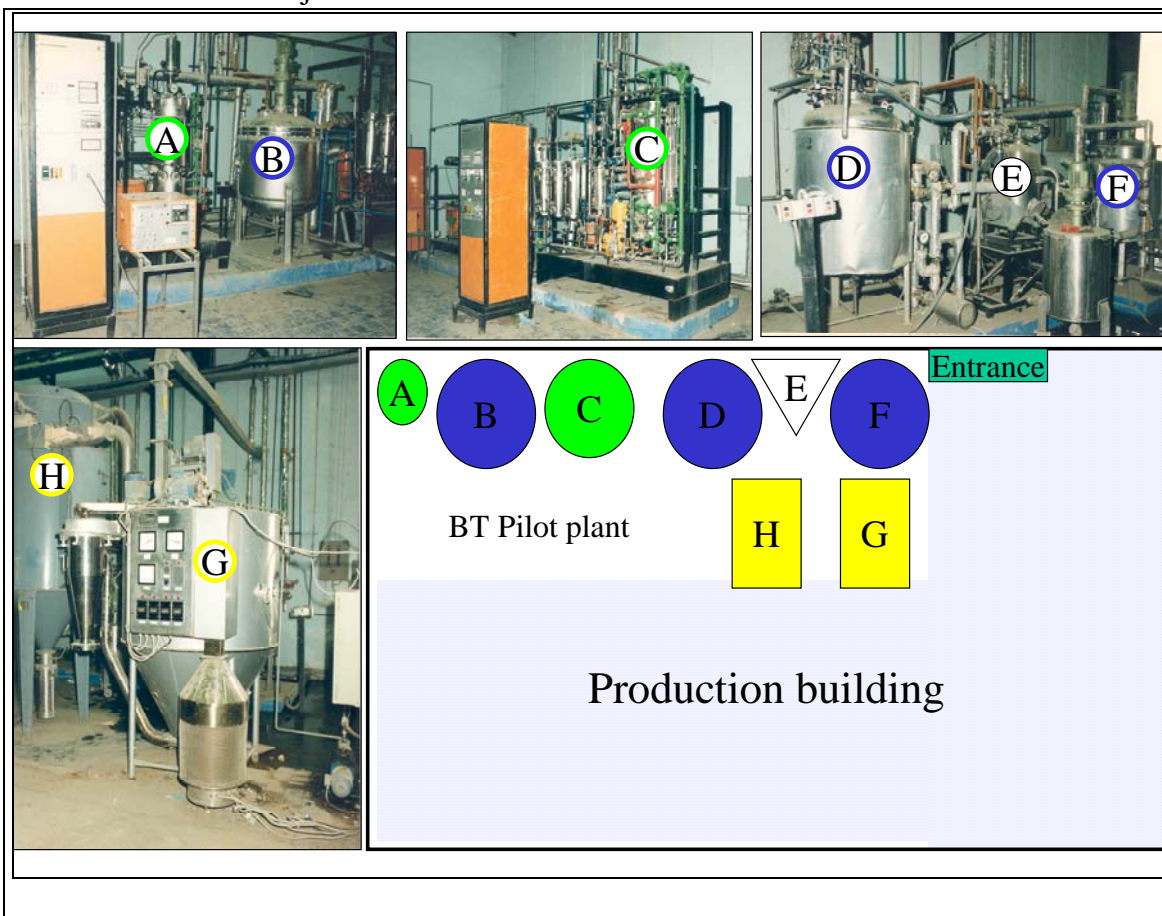
¹⁹ UNSCOM 152/BW 38, 23 July-3 August 1996

²⁰ UNSCOM monitoring team (BG-1)

Pilot-scale BT biopesticide production process

There was a seed build-up stage in a small fermenter, followed by the transfer into a production fermenter (150 and 450 litre fermenters in Shed A2 in the Northern area, or 75 and 300 litre fermenters in the Production building in the Southern area). The process line used in the Southern area is shown in Figure V.XII.VII. At the completion of the fermentation and recovery of the spore slurry via a continuous flow centrifuge, bentonite was added to the slurry to increase the recovery efficiency in the subsequent step, spray drying. After the drying, the bentonite/spore mixture was mixed with additional bentonite yielding the final product.²¹ The bentonite was supplied through a Ministry of Industry and Minerals mining company.

Figure V.XII.VII. Pilot scale process line for production of BT. A, 75 litre fermenter, B, 600 litre storage tank, C, 300 litre fermenter, D and F, 600 and 500 litre holding tanks, E, continuous flow separator, G and H, spray dryer and bag filler. All items, except the separator and spray dryer with bag filler, were transferred from Fudaliyah in 1992. The separator was appropriated from Kuwait in 1990, and the spray dryer with bag filler was transferred from Al Taji in 1989.



²¹ UNSCOM 105/BW 16, 1-12 December 1994

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In the pilot-scale production operation, the fermented culture was allowed to proceed until sporulation occurred; the spores were recovered via concentration in a continuous flow separator, and subsequently converted to a dry powder via a spray dryer. The average particle size in the powder was not known by Iraq and Al Hakam Factory did not have manuals which provided product specifications. Analysis performed on behalf of UNSCOM²² indicated an average particle size of 1-10 microns in the final product.

Directly adjacent to the production building was a shed-type structure used for the manual mixing of the BT spores with bentonite and manual bag filling. Across from this shed was a bunker used for storing the final product in sealed plastic bags (Figure V.XII.VIII). The bags were labelled with the product name and instructions for application.

There were two forms of product:

- One form²³ was developed for direct dry application to growing plants such as corn, for control of the corn stem borer. It was applied by the farmer by hand to individual plants at the junction of stem and leaf typically with a spoon.
- The second form of the product²⁴ was to be diluted 1:100 with water, thus allowing the application via agricultural liquid sprayers.

Figure V.XII.VIII. Final BT product produced at Al Hakam Factory. Left, Laboratory technician sampling the final product, and Right, Final product in sealed plastic bag



Several batches of biopesticide were made and used in trials on corn stem borers in five provinces in Iraq. Following product approval by the Ministry of Agriculture, the pilot plant was used for routine production.

At the end of 1994, the Al Hakam Factory manufactured this material in the Production building (Figure V.XII.IX).

²² UNSCOM BG-1A, June 1995

²³ containing 10^8 spores per gram of product

²⁴ containing 10^{10} spores per gram of product

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Figure V.XII.IX. Right front view of Production building in the Southern Area of Al Hakam. At the right of the photo is the entrance to the bunker or underground cooled storage; one of the trailers in front of the building was used in mixing the bentonite powder prior to putting the mixture into a plastic bag for distribution.



Amounts of BT biopesticide produced

Iraq stated that about forty to fifty tonnes of bentonite based product was made in each year 1993-1995. Iraqi declarations covering part of this period are shown in Table V.XII.II. The product had an estimated shelf life of about 14 months. Most of the product was sold to MIC, who in turn sold it to the Ministry of Agriculture. The *Bacillus thuringiensis* Kurstaki was obtained from Tuwaitha in 1992 and isolated from an insect.

Table V.XII.II. Declared production of biopesticide at Al Hakam Factory²⁵

	Declarations Nov 1994, Jul 1995, and Jan 1996
<i>Bacillus thuringiensis</i> Kurstaki	Yes
Production	20-25 tonnes (formulated) produced six-monthly
Media	Cheese whey and corn steep liquor
Collaboration	Tuwaitha

Testing of BT biopesticide product

No studies for the effectiveness of the biopesticides BT were undertaken by the Al Hakam Factory personnel. The quality and potency of the BT produced was determined by Tuwaitha on samples sent from Al Hakam for each production batch.²⁶

²⁵ Format II of Iraqi declarations from 1994-1996

²⁶ UNSCOM 105/BW 16, 1-12 December 1994

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The tests consisted of plate counts and bioassays (mortality tests), carried out on the moth larvae, *Ephestia caledilla*. According to the researcher at Tuwaitha, many batches were not active, for example, the results in July 1995 showed mortality below 25% (Table V.XII.III)²⁷. The researcher also mentioned in 1995 that because of low activity the product could not be used at that time for agricultural application. He stated that he never did a follow-up with Al Hakam when the quality control results were disappointing.

According to the researcher, he never visited the Al Hakam Factory, nor did Al Hakam personnel visit Tuwaitha.

Table V.XII.III Quality control report dated 15 July 1995 relating to BT samples from Al Hakam Factory.²⁸ The samples taken from June 1995 product batch numbers 105 and 107 were sampled by UNSCOM.

Batch no.	Spores/Gram	Insecticidal Activity Against <i>Ephestia</i> Larvae(%)	
		1 x 10 ⁸ spores/gram	1 x 10 ⁹ spores/gram
10	4.0 x 10 ¹⁰	13.3	23.3
105 ¹	40.0 x 10 ¹⁰	16.6	20.0
107 ¹	1.0 x 10 ¹⁰	13.3	18.5

Large-scale BT biopesticide production process

According to Iraq, Dr. Rehab Taha requested and was granted approval by the Military Industrial Commission (MIC) to scale the BT process into larger fermenters. For this large-scale process, Iraq designed and constructed fermenters and process tanks.

The equipment (1m³ and 5m³ fermenters, holding tanks, and the ancillary process equipment items required to recover BT spores and convert these into dry powder) was installed in the Production building, next to the pilot-scale BT production line. The fermenters and process tanks were pressure tested and apparently awaited only the installation of variable drive motors, double mechanical seals, and agitators. These latter two items, Iraq claimed, were not available due to the UN sanctions.

The large-scale BT manufacturing process was planned to be essentially the same as that used in the pilot-scale production line.

Iraq said that it anticipated that with a 5m³ production line operating at full capacity, estimated to yield 500 tonnes per year of a final BT-bentonite mixture, the revenue generated would cover the total annual cost of the site.

According to Iraq, there was disagreement among the product developer, producers, and end-users on the utility and use of the Al Hakam's dry BT-bentonite product. Farmers found it cumbersome to use, having to apply it by hand one plant at a time, and spraying the product as liquid slurry by mixing it with water was not successful. Professor

²⁷ This low activity was thought to be related to the loss of the plasmid encoding the delta-toxin, the active component, during the cultivation of the bacteria.

²⁸ Notes of an UNSCOM monitoring team (BG-1)

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Hindawi stated, “The BT produced there was not very popular with the farmers and was not a profitable endeavour.” The former Minister of Agriculture corroborated this view.²⁹

The researcher at Tuwaitha, who developed 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 and thus aerosolised into a cloud when applied and did not form an adequate residue on the plants. Those who produced the product thought otherwise of the value of the product and thought the product was well received.

Based on complaints from farmers, Al Hakam had planned to enlarge the particle size to granular form but they had not completed this work since the facility’s operation was suspended in 1995 by the UN and destroyed in 1996.³⁰

Production of biofertilizer

Iraq stated that the post-1991 activities at Al Hakam Factory involved investigations on ways to increase soil productivity for wheat crop cultivation using nitrogen-fixing micro-organisms. This project was an outgrowth of the establishment's plans to cultivate their own wheat to conduct nutrition and toxicity tests of SCP on the animal-feed end-product (as SCP must be mixed with other feed stuffs, it cannot be the sole source of nutrition). Iraq initiated the production of fertilizer via a fermentation process in 1992.³¹ The process was developed in the R&D facility at the site and then transferred into a single 150 litre fermenter located in the Production building (Southern Area).

The process was technically the simplest among all production processes at the site. Several species of nitrogen-fixing bacteria (*Rhizobium* and *Azotobacter spp.*) were grown in laboratory shake flasks. Upon sufficient growth, the culture was inoculated into a 150 litre fermenter and allowed to grow for 24 - 48 hours. At the conclusion of the run, the broth was harvested, dispensed into a mixture of dried, pulverized peat, which served as a binder, at a proportion of 10 ml broth to 100 grams of peat mix to make the final product. The product dry was placed into plastic bags and sealed. For application, the final product was mixed with water at a proportion of 100 grams of product per litre and the resulting slurry was then mixed with 20 kg of wheat seeds, which were subsequently sown.

The biofertilizer was tested together with the Technical Institute at Al Shatra³² and on test plots at Al Hakam Factory in 1994³³ and compared to standard applications of chemical fertilizers. In late 1994 the product awaited final approval from Ministry of Agriculture (Table V.XII.IV).

²⁹ Comprehensive Report of the Special Advisor to the DCI on Iraq’s WMD With Addendums, 30 September 2004 (ISG report), Vol III, Biological Warfare, page 14

³⁰ Comprehensive Report of the Special Advisor to the DCI on Iraq’s WMD With Addendums, 30 September 2004 (ISG report), Vol III, Biological Warfare, page 37

³¹ UNSCOM 105/BW 16, 1-12 December 1994

³² UNSCOM 105/BW 16, 1-12 December 1994

³³ UNSCOM monitoring team BG-2, 17 October 1995

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Products made at the Al Hakam Factory

Commercial products

Table V.XII.IV Commercial products made at the Al Hakam Factory. All products were made by fermentation except for the SCP made by extraction from beer waste.

Product	Source	Feedstock	Process	Made in	Status in late 1994
SCP	Yeast	Beer waste	Batch	Unit 1, Pilot plant	6.5 tonnes made in 1994
		Ethanol + Methanol	Batch	Unit 1, Pilot plant	Total 110 kg
		Ethanol + Methanol	Continuous	Unit 2, Pilot plant	40 kg ex. methanol
BT Biopesticide (for corn stem borer)	<i>B. thuringiensis</i> Kurstaki	Whey	Batch	Unit 2 SCP and Insecticide Pilot plant	50 tonnes of BT/bentonite unwettable powder made in each of 1993 and 1994
Bacterial fertilizer	<i>Rhizobium</i> 24 spp <i>Azotobacter</i> <i>Azospirillum</i> spp		Batch	150 litre fermenter	160 litres made in 2 batches, awaited final approval from Min of Agric

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Products in development

The laboratory research in April 1992 reflected three primary lines of planned activities. UN inspectors³⁴ observed an on-going basic work in each of these three areas: (1) single cell protein production from hydrocarbon sources - investigations were limited to methanol and ethanol, (2) single cell protein production from carbohydrate sources—investigations was limited to beer and whey residues, and projected to include molasses from date palm product, and (3) agricultural projects- the only project planned and being investigated was that of microbial fertilization enhancers, using nitrogen- fixing bacteria. In late 1994 one of the major areas of research was production of SCP by a range of yeasts from different substrates including whey, corn steep liquor, and petroleum by-products such as methanol and ethanol.

Research also targeted the production of *B. thuringiensis* biopesticide from different strains such as *B. thuringiensis* H14 israelensis against *Anopheles* spp mosquitoes and *B. thuringiensis azawai* against the wax moth *Galleria mellonella*, a pest of bee hives (Table V.XII.V). These biopesticides were evaluated against cockroaches.

Product development at the research and development level and occurring after 1991 covered the products, excluding SCP and biofertiliser, shown in Table V.XII.V.

Table V.XII.V Status and type of product development in 1991-1994 at Al Hakam R&D laboratory

Product	Source	Status in late 1994
BT insecticide	<i>B. thuringiensis</i> Israelensis (H14)	Under trial by Min of Health
BT insecticide, for honey wax worm control	<i>B. thuringiensis</i> Azawai	30 vials, freeze-dried
Beer yeast	<i>Saccharomyces carlsbergensis</i>	Under trial in breweries
Yogurt Starters	<i>Lactobacillus bulgaricus</i> <i>Streptococcus thermophilus</i>	Under trial in a dairy
Bakers Yeast	<i>Saccharomyces cerevisiae</i>	Under trial with Nineveh Bread Company in Mosul
Organic Solvents	<i>Clostridium acetobutyricum</i>	In very early stage

A submission³⁵ was made by the Al Hakam Factory in November 1994 to UNSCOM concerning establishment of a vector breeding laboratory for the purposes of the biological evaluation of laboratory products. The submission was requested under the On-going Monitoring and Verification plan of Security Council resolution 715 (1991). It was planned to evaluate *Bacillus thuringiensis* as a lethal biological pesticide against *Anopheles* spp., *Galleria mellonella*, and *Ephestia calidella* (the corn stem borer), in house, rather than using the agricultural biological laboratory at the Tuwaitha facility.

³⁴ UNSCOM 35/CW 8, 15-29 April 1992

³⁵ The submission was dated 23 November 1994, and forwarded to UNSCOM New York on the 25th November

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List of micro-organisms used in R&D at Al Hakam

Micro-organisms present at Al Hakam Factory in December 1994 are listed in Table V.XII.VI.³⁶

Table V.XII.VI List of microorganisms present at Al Hakam Factory in December 1994

Micro-organism	Declared (1994-1996) ³⁷	Stated use	Comment
BACTERIA			
<i>Azotobacter</i> Spp.	Yes (<i>Azotobacter chroococcum</i>)	Biofertilizer	Not declarable.
<i>Azospirillum</i> Spp.	Yes (<i>Azospirillum brasiliense</i>)	Biofertilizer	Not declarable.
<i>Bacillus thuringiensis</i> Kurstaki	Yes	Biopesticide	Declarable. Obtained from Tuwaitha.
<i>Bacillus thuringiensis</i> Azawai	No	Biopesticide	Declarable. Declared by Tuwaitha.
<i>Bacillus thuringiensis</i> Israelensis (H14)	No	Biopesticide	Declarable. Declared by Tuwaitha.
<i>Clostridium acetobutyricum</i>	No	Production of acetone and butanol	Not declarable
<i>Lactobacillus bulgaricus</i>	Yes	Starter cultures for yoghurt production	Not declarable
<i>Pseudomonas fluorescens</i>	No	Biofertilizer	Not declarable
<i>Rhizobium</i> Spp.	Yes	Biofertilizer	Not declarable
<i>Staphylococcus aureus</i>	No	According to information given to UNSCOM in late 1994 for earlier production of a diagnostic test for the toxin SEA (transferred to Al Raze Centre)	Declarable
<i>Streptococcus thermophilus</i>	Yes	Starter cultures for yoghurt production	Declarable
YEAST			
<i>Bretanomyces petroleum</i>	No		Not declarable
<i>Candida guilliermondii</i>	No		Not declarable. Researched at the Al Taji SCP pilot plant 1980-1983
<i>Candida stellatoidea</i>	No		Not declarable
<i>Candida tropicalis</i>	Yes	SCP	Not declarable. Researched at the Al Taji SCP pilot plant 1980-1983
<i>Candida utilis</i>	Yes	SCP	Not declarable. Researched at the Al Taji SCP pilot plant 1980-1983

³⁶ UNSCOM 105/BW 16, 1-12 December 1994

³⁷ Format I and II of Al Hakam Factory declarations for 1994

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<i>Hansenula polymorpha</i>	Yes	SCP	Not declarable. Researched at the Al Taji SCP pilot plant 1980-1983
<i>Kluveromyces (Saccharomyces) fragilis</i>	No	Production of glycerol	Not declarable
<i>Saccharomyces cerevisiae</i>	No	Production of glycerol. Starter cultures for baker's yeast	Not declarable
<i>Saccharomyces carlsbergensis</i>	No	Starter cultures for beer production	Not declarable
<i>Saccharomyces ellipsoids</i>	No	Production of glycerol	Not declarable
FUNGI			
<i>Aspergillus niger</i>	No	According to information given to UNSCOM in late 1994 for earlier production of citric acid	Declarable

Acquisition and transfer of equipment from other facilities

Three different approaches were attempted to acquire production equipment: transfer from other facilities, indigenous production, and imports.

During the years 1992 and 1993, the Al Hakam Factory obtained major equipment through either transfer from other Iraqi facilities or appropriation from Kuwait in 1991 or through the "Local Market". The majority of this equipment was of foreign manufacture and some was manufactured locally. (Chapter V.III and Table V.XII.VI).

Fermenters (75 litres and 300 litres) and storage tanks were transferred from the Agricultural and Water Research Centre (Al Fudaliyah) in Baghdad to the Al Hakam Factory in late 1991 and 1992 (Figure V.XII.X).³⁸ These vessels were from the pilot plant at Al Fudaliyah that had been imported in 1979 and 1980.

³⁸ The equipment was transferred after the UNSCOM 15 inspection mission in September/October 1991

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Figure V.XII.X Fermenters and accessories transferred from Agricultural and Water Research Centre (Al Fudaliyah) to Al Hakam Factory. Capacity in litres and number of items transferred are indicated in the table.

Item	Capacity (number)
Pilot plant (fermenter)	300 (1)
-“-	75 (1)
CF2000 fermenter	7 and 14 (2)
Jacketed and insulated closed	1,500 (5)
-“-	300 (5)
Jacketed and insulated closed tank	2,000 (1)
-“-	1,500 (1)
Jacketed and insulated tank	1,500 (1)
-“-	1,000 (2)
Jacketed closed tank	400 (1)



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Indigenous manufacturing of equipment

After trade sanctions were imposed on Iraq by the Security Council in the aftermath of the 1991 Gulf War, the country sought to acquire an indigenous capability to design and manufacture equipment in order to pursue activities in the biotechnology field. Dr. Taha explained that because of the trade embargo, it had become imperative for Iraq to become self-reliant in the production of biotechnology equipment for "strictly civilian purposes."³⁹ Equipment manufactured in Iraq and later transferred to the Al Hakam Factory is listed in Table V.XII.VII.

Table V.XII.VII Type and source of equipment manufactured in Iraq and transferred to the Al Hakam Factory during 1992-1994.⁴⁰

	Year 1992	Year 1993	Year 1994
Al Farat Co/National Co for Industries, Ltd	Steam generator		
State Establishment for Electronics Industry	Water cooler		
Ishtar (Light Industries Company, Zafaraniyah)	Freezer, Refrigerators		
Al Zawra'a Factory	Control Units	Control Unit, distribution board	
State Establishment for Heavy Engineering Equipment (SEHEE)	Tanks (2,500 and 3,000 litre), Gas storage tanks	Water tank, Fermenters (1 x 1 m ³ and 2 x 5 m ³), Jacketed and insulated tanks (5 x 2,500 litre), Jacketed and insulated seed tank	
unknown	Fuel storage tank	Incubator	
			High-pressure water sprayer

Indigenous manufacturing of equipment after 1991

Iraq's efforts in the biotechnological equipment field was led and funded by the Iraqi Government's Military Industrial Commission (MIC). It involved the collaboration of several state-owned design, engineering, manufacturing and construction authorities:⁴¹

- Design activities were concentrated in three design centres specializing in chemical, mechanical and electrical engineering,
- Manufacturing of fermenter tanks and other vessels, polishing of the vessels, and production of electronic controllers took place at State Establishments with general responsibilities for heavy equipment production, machining of mechanical parts, and production of electronic components, and

³⁹ UNSCOM 112/BW 21, 3-17 February 1995

⁴⁰ UNSCOM 127/BW 29, 7 - 14 December 1995

⁴¹ UNSCOM 112/BW 21, 3-17 February 1995

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- Construction of plant buildings, assembly and integration of biotechnological production lines were implemented by State Establishments with general responsibilities for civil engineering and industrial services

Iraq stated that its efforts were focussed on the indigenous production of complete 5m³ production lines since two 5m³ fermenters originally ordered from a foreign manufacturer, were not granted an export licence. UNSCOM obtained documents that report on the progress of three such units.⁴² The Iraqis relied on reverse-engineering of fermenters purchased before the Gulf War and original drawings obtained from foreign manufacturers to develop their own fermenters and electronic controllers.⁴³ Information in UNSCOM inspection reports, statements made during interviews and documents retrieved indicate that both 5m³ and 50m³ plant projects started in 1992 and three fermenters were designed. Two were to be used for the production of biopesticide and one was for the production of SCP.

According to minutes from a meeting with the working group for projects at Al Hakam Factory on August 4 1993, some of the activities of the project started 8/12/1992.⁴⁴ Facilities with representatives attending the meeting were: State Establishment for Industrial Projects (SEIP), CEDC (Project Management Division), MEDC, Center for Specialized Engineering Services, EEDC, SEHEE, Al Nida'a Establishment, National Company for Agricultural Chemicals, Al Ezz Establishment for Electronic Industries, Agricultural and Water Research Center, Al-Zura' Factory, and Al Hakam Factory. Moreover, in October 1992 several projects were in progress at CEDC for the Al Hakam Factory.⁴⁵ The Projects were: pilot unit industrial protein, industrial protein production system (5m³), industrial protein production system (50m³), industrial protein production system (500m³), and industrial protein system (150 liters). Furthermore, from drawings for the 5m³ project obtained by UNSCOM, the dates on these, and the revision numbers, indicates that initial design started in mid-1992.⁴⁶

According to Iraq, two 5m³ production process lines were installed at Al Hakam.⁴⁷ Within months of the initiation of this expansion, plans were implemented for the production of the 50m³ line.

Dr. Taha has stated that the first indigenously developed fermenters were present and assembled at Al Hakam Factory in March 1994, but at that time they were not equipped with stirrers and had not even been tested,⁴⁸ while the electronic components and controls were made 2 to 3 months prior to March 1994. Design activities began in 1993 which required the interaction of Al Hakam Factory personnel with personnel from the CEDC, electronics section of Sa'ad 13, Al Zawra'a Factory and vessel construction at SEHEE.

⁴² UNSCOM 142/BW34, 30 April-7 May 1996, and UNSCOM 199/BW 55, BW Site Inspection, 4 - 24 September 1997

⁴³ UNSCOM 112/BW 21, 3-17 February 1995

⁴⁴ Minutes of meeting on Al Hakam projects. UNSCOM document no. 142164 (orig. UNSCOM document no.142-2/14)

⁴⁵ Work Progress Forms CEDC Projects. UNSCOM document no. IR000975T

⁴⁶ UNSCOM Al Hakam Bioprotocols, Books 9 and 10, and UNSCOM 112/BW 21, 3-17 February 1995

⁴⁷ UNSCOM 53/BW 3, 11-15 March 1993

⁴⁸ UNSCOM 96/BW 12, 23-26 September 1994

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These indigenously produced fermenters lacked bursting seals and agitators which Iraq at that time was unable to manufacture. These fermenters were observed in 1995 by a UN inspection team.⁴⁹

5m³ Biopesticide Production Line

The 5m³ biopesticide project initiated by the Al Hakam Factory's technical report in 1992 mentioned above used preliminary drawings from an offer made by a foreign manufacturer.⁵⁰

Based on the Al Hakam technical reports, the process flow diagram (PFD), the piping and instrumentation diagram (P&ID), and data sheets for the 5m³ fermenter were developed. Subsequently, the detailed design for the various components, such as vessels and controllers was produced. Lists of items to be purchased and requirements for utilities (electricity, steam) were also developed. The project manager⁵¹ decided which items were to be produced, and where.⁵² In the next phase, manufacturing of the equipment took place in the various establishments. In the last phase, the various items of equipment were installed and integrated on-site.

Dr. Taha stated that special parts that could not be indigenously manufactured, such as oxygen probes, pH probes, variable speed controls, and concentrating equipment such as dryers, centrifuges, and pumps, had to be imported, or assembled from parts from other sites within Iraq.⁵³

On 22 June 1993, a progress report for the 5m³ protein production project was sent from the SEIP to the CEDC and Al Hakam Factory. Most of the work was projected to be finished in July 1993.⁵⁴

In June 1994, two meetings were held with a committee formed by Al Hakam Factory for receiving the 5m³ biopesticide system. Participants in the meetings included representatives from Al Hakam Factory, Al Shumokh State Establishment, Engineering Inspection and the Planning and Follow-up team. The system was inspected and operated cold with all its components. An acceptance report of the system for biopesticide production (5m³)⁵⁵, dated 23 June 1994, was obtained by UNSCOM.⁵⁶

⁴⁹ UNSCOM 113/BW 22, 23 Jan- 3 February 1995

⁵⁰ UNSCOM 112/BW 21, 3-17 February 1995

⁵¹ The project manager was from State Establishment for Design and Consultation (SEDC). SEDC was formed in March/April 1992. This establishment comprised four units: CEDC, MEDC, EEDC, and the Material Selection Center. In 1998, the SEDC changed its name to Sa'ad Center. According to other information, SEDC was created on 14 February 1994 by MIC order

⁵² UNSCOM 112/BW 21, 3-17 February 1995

⁵³ UNSCOM 112/BW 21, 3-17 February 1995

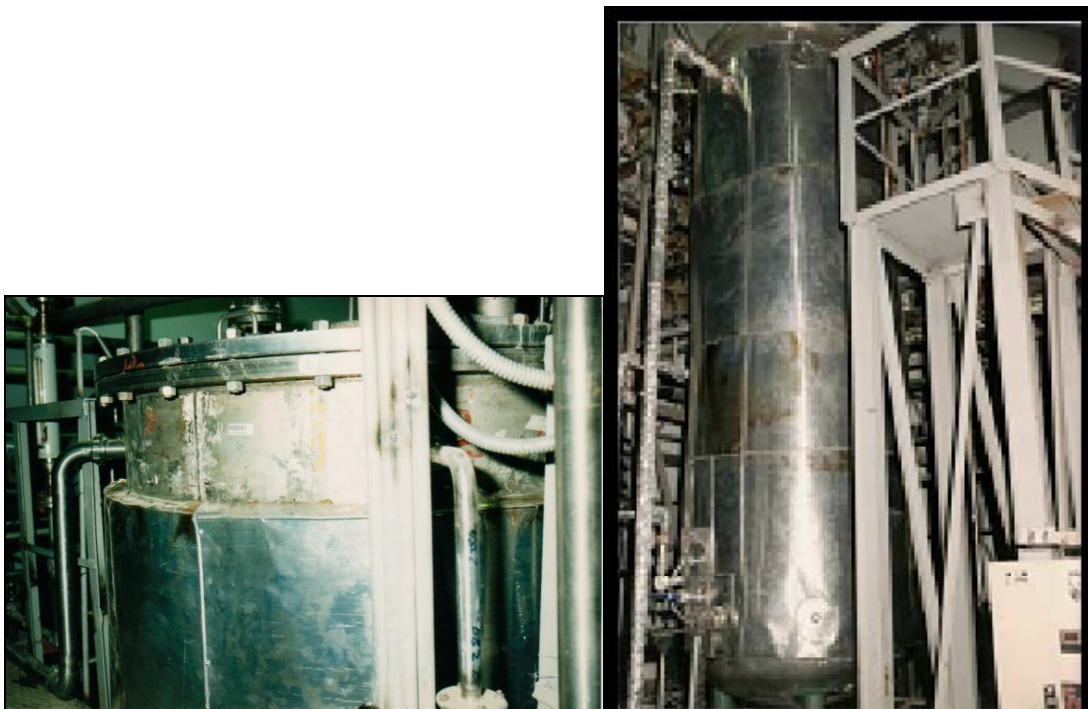
⁵⁴ Progress report to ChEDC on 5m3 project, work to be finished by July 1993. UNSCOM document no. 142161 (orig. UNSCOM no.142-2/11)

⁵⁵ The system accepted covered tanks (T104, T106, T109), fermenter (FR103), pumps (P107), filters (F108, F110, F112), heat exchangers (E104), pressure control equipment (PCV10008, PCV10014, PCV10010), vessel control equipment (FCV10012, FCV10010, FCV10016, FCV10017, FCV10014, FCV10021, FCV10024), temperature, acidity, and oxygen control equipment (TICR-10005, PHIRC-10003, POICR-10002), pressure measuring equipment (PI-10021, PI-10028, PI-10013, PI-10014, PI-10020, PI-10018),

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The system included one of the two 5m³ fermenters. Furthermore, in 1994-95 the SQCC performed tests on the equipment.⁵⁷ Pictures of one of the 5m³ fermenters are shown in Figure V.XII.XI.

Figure V.XII.XI 5m³ fermenter (top part and vessel) manufactured by SEHEE for Al Hakam Factory



The time schedule for the construction of the 5m³ line was from October 1993 to January 1994.⁵⁸ In February 1995⁵⁹, the future 5m³ biopesticide production line was still missing the variable-speed agitators and motors, as well as pH, temperature, and oxygen probes. Only the 300 litre seed fermenter was equipped with pH and pO₂ probes. All the installed valves and measuring equipment were of foreign origin, as well as the spray dryer and the centrifuge separator.⁶⁰

temperature measuring equipment (TI-10007, TI-10008, TI-10016), flow measuring equipment (FI-10005, FI-10007), and level sensors (not included due to technical problems in the manufacture).

⁵⁶ UNSCOM 112/BW 21, 3-17 February 1995. doc. no. 1.1, Folder 11201

⁵⁷ UNSCOM 112/BW 21, 3-17 February 1995. doc. nos. 5.1 and 5.2,

⁵⁸ Time schedule for construction of 50m³ line from Oct 1993 to Jan 1994. UNSCOM document no. 142262 (orig. UNSCOM no. 142-3/56)

⁵⁹ UNSCOM 105/BW 16, 1-12 December 1994

⁶⁰ According to the inspection team thermal insulation of the fermenter vessels was simple and adequate. The welding seams of the various pipe assemblies were not perfect but were fairly well done. The pipes were also of many different diameters and clearly had not been purchased new but rather cannibalized from other facilities. Several O-ring seals were old and even had cracks in them. Water was delivered to the facility via tanker trucks, but the Iraqis were laying a pipeline which they planned to finish by May 1995. The pH/O₂ control on the fermenter consisted of imported sensors connected to a simple analog controller. This homemade controller was the only electronic component in the factory that was not imported. It appeared to consist of crudely assembled, discrete components, including transistors and logic chips, and

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In a document dated 17 September 1995, reference is made to a change of project administration of the 5m³ biopesticide project and that the project was going through a true crisis.⁶¹ Deduced from retrieved documents, this crisis in part probably concerned problems with agitators. The Al Nida'a Establishment was responsible for assembling the mixers/agitators/stirrers⁶², but also a contract was signed on 24 May 1995 for the importation of mixers.⁶³ In a letter from Al Hakam Factory to the National Monitoring Directorate (NMD) of 29 July 1995, it was said that the agitators for the 5m³ biopesticide line were going to be installed with start on 31 July 1995. However, this was postponed and according to an engineer, no stirrer could be procured.⁶⁴ From a memo dated 18 December 1995 from MIC's Technical Department to the Al Hakam Factory it seems likely that the Al-Nizal Company and Al-Basha'ir Company were both involved in the 5m³ biopesticide project and that these companies were trying to import agitators.⁶⁵

The 5m³ biopesticide line was planned to be fully installed at the Al Hakam Factory at the end of 1995 or the beginning of 1996⁶⁶, according to a revised time-table set-up for the implementation of the project.⁶⁷ Responsible for the final set-up were Al-Fao General Establishment (site preparation, set-up of agitators, and completing electrical wiring), SQCC (engineering tests), and the Field Engineering Group (test runs). However, the agitators were not installed⁶⁸ because of problems with procuring appropriate variable speed motors. In addition, in December 1995 UNSCOM requested that all activities at Al Hakam Factory should cease immediately and the production buildings were sealed. The cessation of biological activities meant that all research and production activity was to cease, including laboratory work and use of laboratories and offices for report writing. It also included all administrative work with some exceptions. All equipment and materials, as well as materials produced, was to be secured at their current locations within the sites and was not to be moved. This restriction applied to all items, whether or not they had been involved with the proscribed programme, and included tagged and untagged equipment as well as spare parts, components and ancillary equipment.

was not working at the time of the visit. The controller was labeled "built 1994 Zawara'a". Also in the building were three foreign-made standard control panels with standard pressure/temperature/level analog control which belonged to the fermenters manufactured by a European company. Valves on the fermenter line were not identified with color codes or tags and a synopsis did not exist. However, "instructions for use" guidelines had been prepared by the CEDC.

⁶¹ Memo Regarding 5m³ Biocide Project Administration. UNSCOM document no. 199006.118 (IR001020T)

⁶² It has been stated at one time that the mixers manufactured by Al Nida'a Establishment were of carbon steel, due to shortage of stainless steel, and was to be coated with nickel or chromium. Another time they were said to be manufactured in stainless steel

⁶³ Letter to MIC on failure setting up stirrers for 5m³ project. UNSCOM document no. 142168 (orig. UNSCOM no.142-2/18)

⁶⁴ Letter to inform NMD on work (setting up stirrers) for 5m³ biopesticide project. UNSCOM document no. 142165 (orig. UNSCOM no.142-2/15)

⁶⁵ 5m³ Biocide Project Agitators, UNSCOM document no. 199006.112

⁶⁶ Daily Incentives for 5m³ Biocide project, UNSCOM document no. 199006.052

⁶⁷ Time Table for Implementation of 5m³ Biocide Project. UNSCOM document no. 199006.068

⁶⁸ UNSCOM 105/BW 16, 1-12 December 1994

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Comment

According to UNSCOM, the fermenters and process tanks had been pressure tested and apparently awaited only the installation of variable drive motors, double mechanical seals, and agitators in late 1994. In addition to the fermenters, the ancillary process equipment items required to recover Bacillus thuringiensis (BT) spores and convert these into dry powder were installed in the facility.

It was noted by UNSCOM⁶⁹ that the large-scale BT production line was the only line at Al Hakam Factory that was provided with a semi-automated Clean-In-Place (CIP) system, well designed and constructed. In response to queries as to why this was the only process that was provided with CIP, Dr. Taha and other key staff pointed to the glutinous and "greasy" texture of the principal medium component (whey) for the BT process and the difficulties in cleaning equipment and piping runs once this material had been steam sterilized within. The CIP system utilized an alkali wash, followed by a nitric acid wash, followed by multiple rinses with demineralised water.

50m³ Industrial Protein Project (SCP Project)

The project organization for the SCP Production Plant, including the 50m³ fermenter, was basically the same as for the 5m³ biopesticide production plant.⁷⁰ In 1994 Al Shumokh State Establishment was responsible for execution and administration of the project, in joint coordination with the Al Hakam Factory and the previous administration of the project (SEDC).⁷¹

The SCP production plant was to be located in Area D of the Al Hakam site, between the northern and southern complex of buildings, and was designed and built for full-scale production.

In the start of the 50m³ SCP project, the focus was on the buildings (Figure V.XII.XII for the status of buildings at end of 1995). On 12 October 1992, design drawings for the 50m³ Industrial Protein Project were sent to the CEDC from SEIP, to be used for execution. The drawings were mechanical drawings/administrative building/services building, cold storage building, and construction drawings/factory building.⁷²

Late in 1992, the foundations were laid for the fermentation hall for the 50m³ fermenters and ancillary downstream processing. UN inspectors observed this building during an inspection in 1994. Iraq stated that the installation of the fermenter was planned for August 1995, but the construction of the new fermenter had at that time not yet begun.⁷³

⁶⁹ UNSCOM 105/BW 16, 1-12 December 1994

⁷⁰ UNSCOM 112/BW 21, 3-17 February 1995

⁷¹ Minutes of Meeting, UNSCOM document no. 199005.091

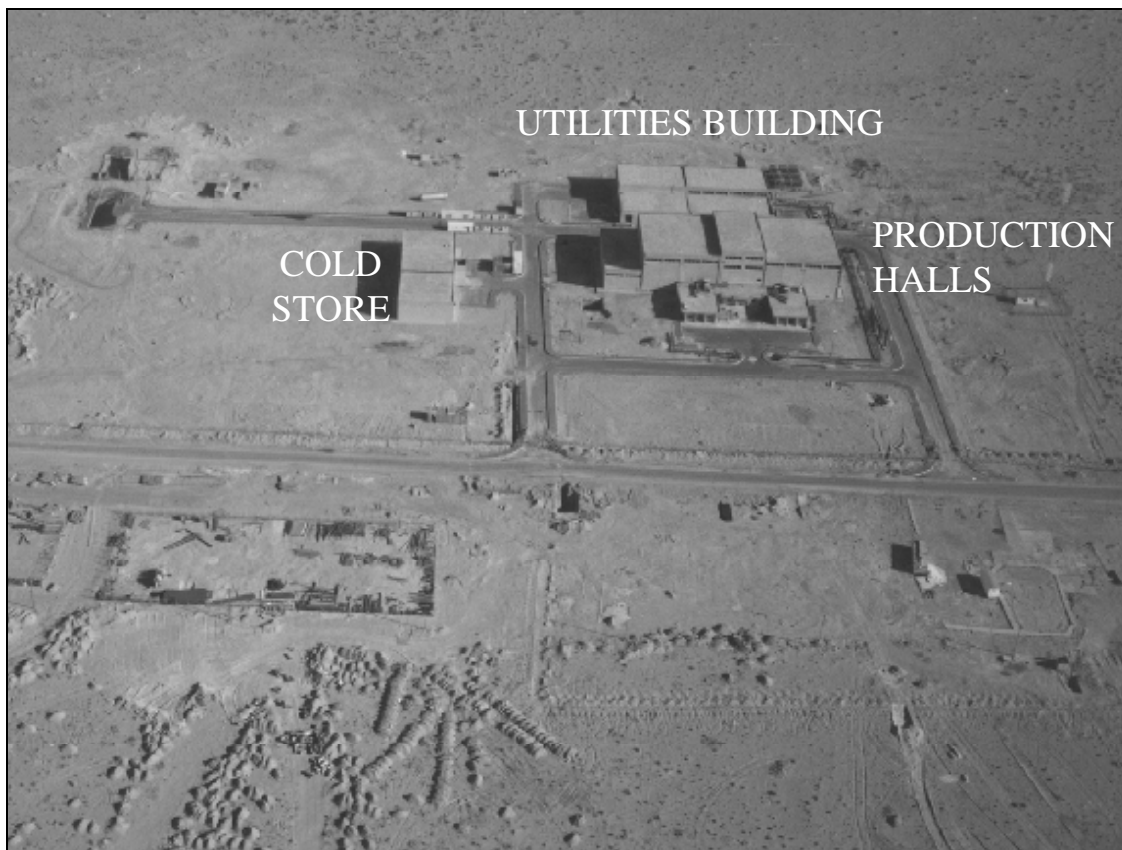
⁷² Letter to ChEDC concerning construction of warehouse for 50m³ project. UNSCOM document no. 142160 (orig. UNSCOM no.142-2/10)

⁷³ UNSCOM 112/BW 21, 3-17 February 1995, and UNSCOM 113/BW 22, 23 Jan- 3 February 1995

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In a document dated 12 December 1993 to SEIP, instruction is given to immediately start construction of a methanol building.⁷⁴ This had been discussed in the committee overseeing the 50m³ Industrial Protein Project.

Figure V.XII.XII Buildings in Area D of the Al Hakam site at end of 1995.



Early in January 1994, all documentation required, except for piping support and structure drawings, was submitted from MEDC to the project manager for subsequent distribution of engineering drawings to the appropriate manufacturers.⁷⁵

No equipment was installed in the buildings, but blueprint drawings obtained indicated a scale-up process from 0.5m³, 1.0m³, and 5.0m³ to 50m³. Downstream processing equipment was planned to include pasteurisation, continuous centrifugation, spray drying, packaging and storage.⁷⁶

A time-table was set for the 50m³ project and the start and finish of the project were projected to be 28 August 1994 and 1 September 1995, respectively.⁷⁷ During an

⁷⁴ Letter to Gen. Est. for Ind. Proj. to build methanol building for 50m³ project. UNSCOM document no. 142242 (orig. UNSCOM no.142-3/36)

⁷⁵ UNSCOM 112/BW 21, 3-17 February 1995

⁷⁶ UNSCOM 87/BW 8, 19 July-16 September 1994

⁷⁷ Timetable and Cost Assessments for 50m³ Project. UNSCOM document no. 199004.197

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inspection of the Al Hakam Factory in May 1995, the critical item was said to be the availability of stainless steel.⁷⁸

A basic design document, produced by CEDC on 17 October 1994, for the 50m³ Industrial Protein Project was provided by Iraq to UNSCOM.⁷⁹ The report covers descriptions of the production processes and the production systems, as well as the control and measurement systems for the production process. The different steps of the process described covers preparation of media, seed material (20, 300, 1,000, and 5,000 litres), continues fermentation (production), collection of material and pasteurisation, centrifugation in two successive steps, and drying of the product using a spray dryer. Iraq provided UNSCOM with drawings from December 1994 for the different units of the SCP production line.⁸⁰

According to minutes of a meeting held 6 November 1994, materials had been moved from the Ibn Sina Company, and other items were to be transferred from the Baiji 30 site to the 50m³ protein project.⁸¹ One of the spray dryers in the biopesticide production building of Al Hakam Factory was transferred from the nuclear site Ibn Sina Company (Al Safah, Research Centre for Chemical Industry) at Tarmiyah in January 1993.

An instrument list for the 50 m³ fermenter system of Al Hakam Factory was produced by the EEDC, probably in February 1995 or beginning of that year (according to date given inside the document).⁸² The list included specifications for pressure instruments, level instruments, temperature instruments, controllers (pH, pO₂, foam), panel mounted instruments, flow instruments, and control valves. A separator, dryer, and several tanks were also required for the SCP plant. Earlier, these items were imported. Iraq was in 1995 attempting to develop a spray dryer indigenously (see following paragraph), but not a centrifuge.⁸³

Repair, Manufacturing and Design of Spray Dryers

The Al Hakam Factory had indicated that of the three spray dryers which were tagged and monitored, two were in the southern area, and one damaged dryer was in the northern area. The damaged dryer was apparently brought from Kuwait during the Gulf War in 1991, and first located in storage and then moved to Shed A2. An attempt to repair the damaged spray dryer failed, and a decision was made to manufacture a spray dryer for the 5m³ plant. The intention was also to manufacture a spray dryer for the 50m³ plant. However, this never went beyond the initial design phase.

Repair of spray dryer for 5m³ project

Iraq stated that the spray dryer appropriated from Kuwait (Figure V.XII.XIII) from a SCP plant/BT plant was damaged in transit and required the repair of the rotating

⁷⁸ UNSCOM monitoring team (BG-1), May 1995

⁷⁹ Basic Design for the 50m³ Industrial Protein Project. UNSCOM document no. 142451

⁸⁰ UNSCOM 112/BW 21, 3-17 February 1995

⁸¹ UNSCOM 231/BW 67, 29 June- 9 July 1998, UNSCOM 127/BW 29, 7 - 14 December 1995

⁸² UNSCOM 112/BW 21, 3-17 February 1995. Document no. 7.2.

⁸³ UNSCOM 112/BW 21, 3-17 February 1995

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disk/nozzle.⁸⁴ Several engineering departments as well as Industrial Engine Factory (IEF) were asked to provide repair of this damaged spray dryer. An attempt was made to utilize missile engine fuel injectors to repair the disk nozzle, but it failed and the engineers were unable to produce a dry powder with the dryer. According to Iraq, no further work was done on the dryer after the initial repair attempt, and it was decided that manufacture of a complete spray dryer was needed.⁸⁵

There may have been a further contract sometime in 1993 between IEF and MIC concerning repair of a spray dryer for the Al Hakam Factory 5m³ line, and to design a spray dryer for a 5m³ line (it was not clear if it was for the Al Hakam Factory).⁸⁶

Figure V.XII.XIII The damaged spray dryer brought from Kuwait to Al Hakam in storage. Photograph taken September 1991 by UN inspection team⁸⁷.



Attempts to manufacture spray driers for the 5m³ and 50m³ projects

The Karama Centre, Ibn Al Haitham (IAH) and IEF were all involved in the construction of a spray dryer for the 5m³ production process at Al Hakam Factory. In 1992, IEF became involved with manufacturing parts for the spray dryer (Table V.XII.VIII).

The system was composed of nine operational pieces⁸⁸ and work on several parts started on 1 December 1992. On May 16 1993, the project director for the SCP Project sent a letter to MIC/Technical Dept/Protein regarding procurement of a speed controller for the 5m³ SCP projects spray dryer,⁸⁹ and in June 1993 parts were more than 65% complete.

⁸⁴ UNSCOM 231/BW 67, 29 June- 9 July 1998. Interview 22

⁸⁵ UNSCOM 231/BW 67, 29 June- 9 July 1998

⁸⁶ UNSCOM 231/BW 67, 29 June- 9 July 1998, and Document no. 228-048 (part of Supporting documents to U228, UNSCOM document IR000924T)

⁸⁷ UNSCOM 15/BW 2, 20 September-3 October 1991

⁸⁸ Document no. 228-048 (part of Supporting documents to U228, UNSCOM document IR000924T)

⁸⁹ Letter to MIC/Techn. Dep. on techn. spec. for 5m³ SCP proj. spray drier speed controller. UNSCOM document 142162 (orig. UNSCOM no.142-2/12)

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On 11 October 1993, four out of the nine components were completed. In October 1993 a work team was formed to study the manufacture of valves and sprays for the 50m³ Industrial Protein Project. Facilities represented in the work team were CEDC (president), MEDC, Al Hakam Factory, Al Nida'a Establishment, and SEHEE. The aim was to operate the dryer in November 1993.⁹⁰

However, the project was taken over by IAH in November 1993. Sometime, Karama Centre became involved in supervision and design work, while the execution remained within IAH. The four completed pieces from IEF were transferred to Karama Centre, which also apparently finished the five remaining components⁹¹. According to a document approval was obtained in 1994 from the Karama Centre to manufacture the spray dryer for the 50m³ project.⁹²

Table V.XII.VIII Follow-up on 50 m³ Project, dated 8/6/1993. From IEF⁹³

Activity	Start date	Date of expected completion	Date of actual completion	Percentage of completion	
				Planned	Actual
HOT AIR SUPPLY					
Air supply parts manufacturing	1/12/1992	1/6/1993	Not completed	95 %	67 %
Receipt and testing of air supply	1/10/1992	1/11/1993	Not completed		
Initial operation of supply	1/11/1993	1/12/1993	Not completed		
SPRAY DRYER					
Spray Dryer parts manufacturing	1/12/1992	1/6/1993	Not completed	95 %	68 %
Receipt and testing of Spray Dryer	1/10/1993	1/11/1993	Not completed		
Initial operation of Spray Dryer	1/11/1993	2/12/1993	Not completed		
CYCLON FILTER					
Cyclone filter manufacturing	1/12/1992	1/6/1993	Not completed	95 %	85 %
Receipt and testing of Cyclone filter	1/10/1993	1/11/1993	Not completed		
Initial operation of Cyclone filter	1/11/1993	1/12/1993	Not completed		

The attempt undertaken to construct the spray dryer by IEF, Al Sadiq Factory and Karama Centre apparently failed.⁹⁴ IEF was taken over by Al-Sadiq Factory in May 1993.

⁹⁰ Letter Regarding Formation of Work Team. UNSCOM document no. 199003.101 (IR000967T)

⁹¹ UNSCOM 231/BW 67, 29 June- 9 July 1998, and Document no. 228-048 (part of Supporting documents to U228, UNSCOM document IR000924T)

⁹² Minutes of Meeting. UNSCOM document no. 199005.091 (IR000983T)

⁹³ Document no. 228-048 (part of Supporting documents to U228, UNSCOM document IR000924T)

⁹⁴ UNSCOM 231/BW 67, 29 June- 9 July 1998

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In September 1994, a meeting was held at the Al Tahaddi Establishment to discuss the provision of a spray dryer for the 50m³ project. Representatives from the three design centres, Al Shumokh State Establishment, SEHEE, and the Al Hakam Factory attended the meeting. Supply of a spray dryer from the Baby Milk Factory was discussed, as well as a visit to Baby Milk Factory for becoming acquainted with the available materials located there. The minutes of the meeting also mentioned that coordination had been accomplished with the administration of the specialized technical project currently working on the project.⁹⁵

Later, on 26 March 1995, in a letter from Technical Directorate, MIC the Al Tahaddi Establishment in co-ordination with the Al Hakam Factory was asked to build a spray dryer similar to a dryer which Al Tahaddi Establishment apparently had constructed earlier. This spray dryer was large, being approximately 8 metres wide by 13 metres high and used solely for the production of magnesium carbonate from dolomite rock. It was said that it was put together at the Al Tahaddi Establishment, using parts from several places including an atomizer from the Baby Milk Factory. The spray dryer was placed in a building prior to the construction of the roof, and had been in place for approximately one year at Al Qaa Qaa State Establishment/Babil project.^{96 97} In April 1995 a work team was formed, under the leadership of the Al Tahaddi Establishment and for the Al Shumokh State Establishment, for the purpose of designing and building a spray dryer for the 50m³ Industrial Protein Project. Facilities represented in the work team were Technical Directorate of MIC, CEDC, MEDC, EEDC, and the State Establishment for Mining Industries, Al Hakam Factory, Al Shumokh State Establishment and SEHEE.⁹⁸

MEDC was responsible for the spray dryer project and a commission was set up for the project involving Al Hakam Factory as end-user, SEHEE, and Al Shumokh State Establishment. These facilities also constituted the field-engineering group, responsible for any required modifications to the design due to for example unavailability of materials, for the entire 50m³ project.⁹⁹

According to Iraq, the first meeting of the work team was held on 14 May 1995. At this meeting CEDC delivered the basic design for the spray dryer to representatives from MEDC and EEDC for preparation of detailed drawings.¹⁰⁰ During the fourth meeting (on 4 June 1995) the work team decided that the spray dryer, removed from the Baby Milk Factory and present at the Babel Project, should be studied, and that the rotary separator be inspected and transferred to the work site. Regular visits were recommended to the Baby Milk Factory in order to get acquainted with dryer design and associated equipment. It was also stated that the Al Hakam Factory representative was to remove all

⁹⁵ UNSCOM 231/BW 67, 29 June- 9 July 1998, and To MIC/Techn. Office minutes of meeting 50m³ visit babymilk factory, spraydrier. UNSCOM document no. 142304 (orig. UNSCOM no. 142-4/19)

⁹⁶ UNSCOM monitoring team (BG-5, 22 April 1996)

⁹⁷ Letter Regarding 50m³ Industrial Protein Project. UNSCOM document no. 199003.007 (IR000905T), and Spray dryer avail at Al-Qaqa St Est. UNSCOM document no. MD000214T

⁹⁸ 50m³ Industrial Protein Project, Work Team for Building Spray Dryer. UNSCOM document no. 199003.010 (IR000909T)

⁹⁹ UNSCOM monitoring team (BG-2, 18 September 1995)

¹⁰⁰ Minutes of First and Second Meetings. UNSCOM document no. 199003.020 (IR000920T)

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original documents concerning the spray dryer (presumably for the 5m³ project) from the Karama Centre for delivery to MEDC.¹⁰¹

CEDC expected the basic designs of the spray dryer for the 50m³ project to be completed between 15 and 30 April 1995. The detailed chemical designs were going to be prepared during the period from 30 March to 15 May 1995.¹⁰² In September 1995 the design diagrams were completed and the Al Tahaddi Establishment had been instructed to begin construction. According to a statement made by the Director of the Al Tahaddi Establishment to UNSCOM in October 1995, the establishment was responsible for the assembly of the equipment at Al Hakam Factory. At that time construction work was focused on preparing the needed materials. The construction was anticipated to take approximately 6 months. The capacity of the unit was estimated to be 1.5 to 2 tonnes per day.¹⁰³

Comment

A few drawings were supplied by Iraq for the 50m³ project. These drawings of the construction of the spray dryer system, supports Iraq's statements that this part of the 50m³ project was in progress in the beginning of 1995.¹⁰⁴ Drawings obtained by UNSCOM covers spray dryer, cyclone, and maybe filler, Unit 300, and Unit TL 300. Moreover, a booklet¹⁰⁵ printed by CEDC describing designs for the spray dryer was given to UN inspectors.

From documents supplied it appears that Al Tahaddi Establishment was unsuccessful and that the project was taken over by Al Nida'a Establishment in late 1995.¹⁰⁶ Al Jihad State Establishment was responsible for electrical power requirements.¹⁰⁷

Attempts to acquire technology and equipment from abroad

Due to lack of success in designing the 50m³ and 500m³ fermenters, Iraq attempted to obtain fermentation plants abroad.¹⁰⁸ This was supported by documents provided by Iraq to UNSCOM, which reported on a familiarization visit by an Iraqi delegation to a 50m³ fermentation plant.¹⁰⁹ There is no evidence of an agreement or delivery of such a plant and the foreign country involved has denied that any such agreement existed.

In June 1995, a group of Iraqi officials (with participants from SEDC and Al Hakam Factory) visited the foreign country with the objective of gaining knowledge of production and research systems available and to discuss the possibility of supplying Iraq with a complete factory for SCP production.

¹⁰¹ Minutes of the Fourth Meeting, UNSCOM document no. 199003.017

¹⁰² Spray Drier for 50m³ Industrial Protein Project. UNSCOM document no. 199005.001 (IR000986T)

¹⁰³ UNSCOM monitoring team (BG-2, 5 September 1995)

¹⁰⁴ UNSCOM Al Hakam Bioprotocols, Book 9

¹⁰⁵ ChEDC main design for spray dryer 50m³. UNSCOM document no. IR001916T

¹⁰⁶ UNSCOM 231/BW 67, 29 June- 9 July 1998

¹⁰⁷ Admin Order Regarding Heating Plan for T-302 Tank. UNSCOM document no. 199006.066 (IR000994T)

¹⁰⁸ UNSCOM 231/BW 67, 29 June- 9 July 1998

¹⁰⁹ UNSCOM document no. 199017 (this is a series of 16 documents)

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Furthermore, the Iraqi delegation wanted to discuss impediments and technical problems in designs for the 50m³ Industrial Protein Project, as well as the possibility of Iraq being supplied with equipment for the project. After the visit it was recommended to invite representatives from this foreign country to visit Iraq to complete a programme of cooperation in the field of SCP production (designs, manufacture, and laboratory research stages). This recommendation was approved in August 1995 by the Deputy Director of MIC.¹¹⁰ At the end of September 1995 a telex was sent from SEDC, inviting a team from this foreign country.¹¹¹ However, given multiple inspections of the Al Hakam Factory by UN teams and the order to close Al Hakam in December 1995, no further progress was made and all work ceased. The Al Hakam Factory was destroyed by Iraq under UN supervision in July 1996.

¹¹⁰ Single Cell Protein, 50 Cubic Meters: Presidential Project Security Instructions. UNSCOM document no. 199017, parts 30-35 (IR000899T)

¹¹¹ Text of Telex State from the State Establishment for Designs, and Consultations. UNSCOM document no. IR000892T

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Comment

The Al Hakam Factory was first inspected in September and October 1991 by the second UN biological inspection team. In the inspection report, concerns were raised regarding the true nature of Al Hakam and several unusual features of the facility were noted. The inspectors believed that the facility could have been planned as the next stage in Iraq's biological warfare programme.

The developments at Al Hakam Factory post 1991 attracted a lot of attention by UN inspectors due to the dual use nature of the activities, and questions were raised regarding the logic of such a facility. When Iraq was attempting to establish a pilot plant for the production of SCP at Al Hakam, the inspection team assessed the SCP plant to be in an embryonic stage and concluded that the SCP development programme was neither well established nor founded and that the Iraqis were unable to provide a commercial justification for the programme or a documentation concerning site development. Moreover, UNSCOM in 1995 determined through analysis of the biopesticide product that the strain used did not possess the genes necessary to produce biopesticidal proteins and thus did not have any utility as a biopesticide. Although this information was made available to UN inspectors it was not shared with the Iraqis and UN inspectors did not know if Iraqi scientists were aware of this.

SCP Production

The declared activities of SCP production at Al Hakam Factory have changed over time. In May 1991, when the Al Hakam Factory was first declared to UNSCOM, the plant was said to be in a preparatory stage. Maintenance and repair were carried out on “..Old imported production systems in an attempt to return them to service.” and use them for “..Production of vaccines or other materials produced by micro-organisms such as SCP or other synthetic products.” The Al Hakam Factory was also declared in November 1991 as a fermentation site to “..Produce enzymes from simple culture media, and add them in a dried form as concentrated protein to animal feed..”.

At the time of the first inspection of Al Hakam Factory, in September 1991, Iraq stated that the only activity was production of SCP. These SCP activities were said to have started in 1989, that is, two years before this first inspection to this site (equipment was moved to Al Hakam Factory at the end of 1988). The inspection team received research reports dated 1980 to 1983, most likely coming from the Al Taji SCP Pilot Plant.

Iraq estimated that the output from a future 50m³ fermenter was approximately 500 tonnes of SCP per year. This was consistent within an order of magnitude with the concentration of 10 grams per litre obtained in the pilot plant runs, that is, 500 kg per fermenter volume (assuming 4 to 7 fermenter batches per week). While this seemed possible, UNSCOM assessed that the lack of any process development beyond the 450 litre fermenter made the production goal unrealistic.

Furthermore, Dr. Rehab Taha stated that Iraq's total annual requirement for SCP was in the order of 200,000 to 250,000 tonnes which was approximately 400 times the annual output of the 50m³ fermenter. Dr. Taha indicated that there were no definitive plans for

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expansion beyond the 50m³ fermenter. Eventually Iraq hoped to have a fermentation capacity of approximately 10,000m³ capable of producing 200,000 tonnes of SCP per year. With such elaborate plans again it becomes difficult to assess whether these plans were part of an elaborate cover-up or whether Iraq was planning to use the Al Hakam Factory for civilian uses when not undertaking its BW agent production function.

The apparent lack of future expansion could be explained if the processes also contained an element of waste treatment in conjunction with usage as fodder. However, the expansion in Area D was geared towards production of SCP from methanol and ethanol. Another puzzling fact is that the programme for SCP production was under the control of MIC, and not the Ministry of Agriculture.

Furthermore, the location of the Al Hakam Factory was not consistent with the manufacturing of a non-pathogenic product for civilian use. The size and lay-out of the facility, 3 separate areas within 3 x 6 km in 1991, is not consistent with SCP production, the only stated activity during the second biological inspection in September and October 1991.

The media (type and amount of) present at Al Hakam Factory was not consistent with production of SCP. For example, in May 1995, more than 400 kg of Thioglycollate broth was present.

In UNMOVIC's view the start of manufacturing of SCP based on petroleum-derived feedstock is not consistent with the international development in the area at that time, when most SCP producers had abandoned this type of processes. Moreover, the facility was dependent on trucking of feedstock (beer waste, whey, petroleum-based products). Also, in the process whereby yeast cells from brewer's waste were collected, fermenters (instead of tanks, which would have fulfilled the intended purpose) were used. This could indicate that an already set-up production line, for another product, was used.

In 1995, Iraq admitted that SCP was developed as a cover story for the activities at the Al Hakam Factory, to hide evidence of the BW programme, save Al Hakam Factory with its buildings and equipment from destruction, and retain production technology know-how. To quickly come up with something that could be regarded as credible, the results of the earlier SCP activities at the Al Taji SCP Pilot Plant were used. Once using this cover story, maybe Iraq had to continue developing the SCP processes more for technology than commercial reasons.

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*The work on biofertilizers and biopesticides seems to have been introduced after the SCP, with the help of Tuwaitha. That site performed R&D in the areas and it appears that most of the strains used originated from it. The two undeclared sub-strains of *Bacillus thuringiensis* (Azawai and Israelensis) present at the Al Hakam Factory were both in use at Tuwaitha. In December 1992 three activities were on-going at Hakam: (1) SCP, first mentioned to UNSCOM in September/October 1991, (2) Biofertilizers, first mentioned to UNSCOM in April 1992, and (3) Biopesticide, first mentioned to UNSCOM in December 1992 (BT was declared as obtained from Tuwaitha in 1992). The activities focused on production of starter cultures seems to have been taken up much later (first mentioned in an UNSCOM inspection report of April 1994).*

Biopesticide production

*The technology for producing the BT biopesticide is of a dual-use nature and the processes can with minor modifications be applied for production of BW agent (*B. anthracis*). For this reason, the features of the *Bacillus thuringiensis* strain used and the particle size of the product were of interest. Thus, UNSCOM collected samples of the biopesticide produced at Al Hakam Factory on two occasions, in late 1994 and in mid 1995). In December 1994, the samples included a slope containing *Bacillus thuringiensis* H14 (Israelensis), BT biopesticide fermenter culture sample, dried BT powder product from the atomizer and final packaged BT product.*

Sampling and analysis of biopesticide product by UNSCOM

In mid-1995, UNSCOM collected 27 samples of Al Hakam Factory's spray dried biopesticide from 9 different sample points (Table V.XII.IV). All samples were sent to outside reference laboratories for analysis. (The full genotyping of this isolate has been published in the May 2007 Journal of Bacteriology). UNSCOM were told that the decision concerning the proportions of bentonite and gum arabicum to BT spores were decided by Tuwaitha based on each culture's biological activity. UNSCOM was also told that the bentonite was not processed at the Al Hakam Factory since they had no milling capability, but was used as delivered from the supplier State Enterprise for Geological Survey and Mining, Ministry of Industry and Minerals. There may have been a change in supplier since UNSCOM was told in December 1994 that the bentonite was supplied by the Baghdad Cement Company.

According to a source for the ISG, only one grade of bentonite was available in Iraq and particle size was dictated by this. Talc was also successfully tested as a carrying agent but was determined to be too expensive for large-scale production.

As shown in Table V.XII.IX, 5 out of 6 samples of dried product contained particles (round spheres) predominantly in the 1 to 10 micron particle size range. One single batch of reprocessed (bentonite and gum arabicum) dried final product contained particles with a much larger size. Neither the particle size of the bentonite itself, nor the ratio between bentonite and bacterial spores was reported.

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UNSCOM assessed that the Bacillus thuringiensis strain isolated from the samples lacked the Cry I protein toxin gene¹¹². There was only one exception; a unique colony isolated from the final product sample was shown to carry this gene.

In UNMOVIC's view, an alternative explanation for the lack of the toxin gene in the biopesticide end-products could be instability of the strain used during the production process. During cultivation of one of the samples a unique colony was obtained which actually contained the toxin gene, showing that a toxin-producing strain was present. Unfortunately, no samples were taken by UNSCOM of the seed stock or at an earlier stage during the production process.

Table V.XII.IX Sampling and analysis of biopesticide *Bacillus thuringiensis* (BT) from Al Hakam Factory taken in June 1995.

Description	Tentative identification	Analysis result by outside laboratory		
		B.t. present	Cry I protein toxin gene	Particle size (micron)
Final formulation	B.t. kurstaki in bentonite/Gum Arabic (Al-Nasr)	Yes	Yes (unique colony)	30-100
Post centrifuge, continues flow. Concentrate from 300 L fermenter run at site B	B.t. kurstaki	Yes	No	n.a.
Post centrifuge, continues flow. Concentrate plus bentonite, from 300 L fermenter run from site B	B.t. kurstaki	Yes	No	n.a.
Bentonite feedstock	Bentonite dry powder	Yes	No	n.a.
Spray dryer from 300 L fermenter run. Dried product. Fresh.	B.t. kurstaki	Yes	No	1-10
75 L fermenter. Dried powder (concentrate) from 20 Jun –95. Run 109	B.t. kurstaki	Yes	No	1-10
Dried powder. From 13 Jun –95 dryer run. Run 108. From 75 L fermenter.	B.t. kurstaki	Yes	No	1-10
Dried powder (concentrate) (3 wks ago). Dryer run 107. From 300 L fermenter. Started fermentation run 27 May.	B.t. kurstaki	Yes	No	1-10
Dried powder (concentrate)(7 wks ago). Dryer run 105.From 75 L fermenter	B.t. kurstaki	Yes	No	1-10

In summary, UNMOVIC agrees with Iraq's admission of 1995 that production of

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biopesticide at Al Hakam Factory was introduced as part of an elaborate cover story. Its aim was to conceal the former BW programme, and maintain production capability including the technology and know-how. The need for a cover story which was greater than just the SCP production was probably high, since the latter lacked credibility and was questioned by UNSCOM.

Thus, the Al Hakam Factory production of BT biopesticide aimed to disguise earlier activities at the facility, and save the facility with buildings and equipment from destruction by the UN. Moreover, the process technology and know-how could be retained and further developed. In the biopesticide manufacturing, Al Hakam Factory produced a product with particle size in the respiratory range however, most likely due to particle size of the bentonite than the spray drying process.