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THE GENIE UNLEASHED: IRAQ'S CHEMICAL AND BIOLOGICALWEAPONS PROGRAM

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PREFACE

The massive use of chemical weapons during the last stages of the Iran-Iraq war shocked the international community. In a belated response, the world's industrialized countries, led by the United States, have initiated a campaign to halt the proliferation of these weapons. This effort has concentrated on stopping the transfer of technology and material that Third World countries need to produce chemical weapons.

In this study, W. Seth Carus suggests that the West may have already lost that battle. He has compiled a prodigious amount of original research indicating that Iraq may be on the verge of having the cability to produce large quantities of chemical and biological weapons without outside help. Detailing the processes by which these weapons are produced, Carus provides new evidence which documents not only Iraq's systematic commitment to developing an independent chemical and biological weapons capability, but its ability to do so.

This development poses new threats to international stability, with profound implications for U.S. policy. As Carus demonstrates, the current emphasis on halting proliferation

may be misplaced; the difficulties confronting a successful non-proliferation regime may be insurmountable, requiring a new U.S. focus on deterring the use of chemical weapons.

The Washington Institute is proud to present this important study, in the hope that it will help provide U.S. policy-makers with the information and analysis required to develop an effective policy for coping with the dangers posed by the global proliferation of unconventional weapons.

Barbi Weinberg
President
June 1989

EXECUTIVE SUMMARY

Iraq is now investing substantial resources in its chemical and pharmaceutical industries. These investments will provide it with the ability to produce chemical warfare agents in relatively large quantities with minimal reliance on foreign sources of supply. Iraq is also in the process of obtaining the expertise and technical infrastructure needed to support a biological weapons program.

Iraq's legitimate chemical production facilities also make possible the production of the precursor chemicals needed to produce chemical weapons. This will significantly reduce Iraq's vulnerability to foreign export controls on such materials.

The United States tried to restrict Iraq's chemical weapons production by reliance on export controls to keep it from obtaining the chemical ingredients needed to produce the weapons. This policy will be of diminishing value as soon as Iraq becomes independent of foreign sources of precursor chemicals.

The United States should respond to this challenge in several ways. First, efforts to negotiate a global ban on the possession and production of chemical agents should be

continued. Second, the United States should adopt harsh sanctions aimed at countries that employ chemical agents in violation of the Geneva Protocol and at companies that assist countries in producing chemical weapons.

Ultimately, however, resolve is more important than programs. It must be made clear, both to foreign leaders and to officials in Washington, that the United States will respond strongly to the use of chemical agents. Only then will it be possible to prevent future use of such weapons.


IRAQ
Chemical and biological warfare related locations
TURKEY
SYRIA
IRAN
SAUDI ARABIA
KUWAIT
Badush
Mosul
Kirkuk
Baiji
Tikrit
Al Qaim
Samarra
Akashat
Al Fallujah
BAGHDAD
Salman Pak
Musayyib
Al Amarah
Basra
Umm Qasr

INTRODUCTION

Iraq now has the largest, and possibly the most sophisticated chemical weapons program in the Third World. It also has a biological warfare development program. Iraq employed chemical weapons against Iranian soldiers and Kurdish civilians between 1983 and 1988. The chemical agents came from plants in Iraq built with the assistance of foreign companies, primarily from West Germany.

Significantly, Iraq has continued and even expanded its efforts since the cessation of fighting with Iran in July 1988, despite widespread condemnation of its use against the Kurds. Systematic investments to create legitimate chemical and pharmaceutical industries are providing an infrastructure that will allow Iraq to minimize its reliance on outside sources of supply that could be vulnerable to foreign interference.

These developments should be considered in light of efforts by the United States and other countries to prevent the proliferation and use of chemical and biological weapons. The Geneva Protocol of 1925 forbids the use of chemical agents, except in retaliation against another country that initiates the use of such weapons, and the Biological and Toxin Weapons Convention of 1972 prohibits the possession or use of biological

agents. Iraq signed the Geneva Protocol in 1931, and it signed (but did not ratify) the 1972 Biological Weapons Convention. These legal commitments, however, did nothing to prevent Iraq from using its chemical weapons nor deter it from developing biological weapons.

Since 1984, industrialized countries in the West have attempted to stop the growth of Iraq's chemical weapons program. Under the auspices of the so-called "Australia Group," a multinational endeavor organized by the Australian government, efforts have been made to keep Iraq from acquiring precursors, which are the chemical ingredients used to make poison gas. Despite this initiative, it was not possible to prevent Iraq from making chemical agents, as demonstrated by Baghdad's extensive use of poison gas against Iran and the Kurds in 1988.

More ominously, Iraq is now making substantial investments in chemical facilities designed to reduce its dependence on foreign sources of assistance. Baghdad's willingness to invest substantial resources in its chemical and biological weapons programs suggests that its leaders believe that these programs will continue to be of tremendous strategic importance. As a result, existing efforts to constrain Iraqi chemical production through controls over supplies of precursors are increasingly irrelevant. The United States and other concerned countries will now have to develop new, more appropriate responses to meet this Iraqi challenge.

I STRATEGIC WEAPONS IN IRAQ

The government of Iraq has devoted considerable effort to develop strategic weapons to coerce and intimidate adversaries. Currently, Iraq has programs to develop chemical weapons, ballistic missiles and biological weapons. Already it has produced and employed chemical weapons and ballistic missiles, and is believed to be working on deployable biological weapons.

Iraq made extensive use of its chemical weapons during the war with Iran. According to Iranian claims, 50,000 people were killed or wounded by Iraqi chemical agents between 1983 and 1988, including a large number of civilians. Some experts believe that the use of chemical weapons, coupled with a fear that poison gas would be used against Iranian cities, may have contributed to Iran's decision to end the fighting.[1] In addition, employment of chemical weapons undermined the morale of Kurdish opponents of the Baghdad regime and played an important role in the suppression of the Kurdish armed resistance.[2]

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[1] Anthony H. Cordesman, "Creating Weapons of Mass Destruction," *Armed Forces Journal,* February 1989, p. 54.

[2] Senate Committee on Foreign Relations, Staff Report "Chemical Weapons Use in Kurdistan: Iraq's Final Offensive," September 21, 1988.

The extensive use made of chemical agents during the 1983 to 1988 period suggests that unconventional weapons now play an important role in Iraqi political-military thinking. This is supported by an examination of the circumstances facing Iraq and the character of its regime. Baghdad is driven by an unusual combination of insecurity and aggressiveness. Iraq has a deep sense of vulnerability. It neighbors Iran, a country with triple the population. Moreover, Tehran has been a long-time adversary, both as an imperial state and an Islamic republic. Although Iraq emerged victorious from the recent eight-year Gulf War, had the Iranians been better organized, equipped and led, it is possible that the war's outcome would have been very different.

In addition, the Iraqis perceive the Israelis as a potential threat. Not only do the Iraqis have a long-standing antipathy toward the Jewish state, but they also fear what Israel could do to them. The 1981 destruction of Iraq's Osirak nuclear reactor demonstrated that Israel has a long reach. Iraq fears the Israeli nuclear bomb and worries about its vulnerability to Israel's Jericho missiles.

At the same time, the Iraqis have hegemonic aspirations in the Arab east, which have led to permanent hostility with Syria, which has similar ambitions. Thus, Iraq's leaders have sought the capabilities needed to ensure their status as a respected regional power. It remains possible that they would one day seek to validate that role by again participating in a conflict with Israel.

These objectives require that the Iraqis have military capabilities that intimidate potential enemies and that, at the same time, make it possible for Iraq to inflict a decisive defeat on any military opponent. Originally, the Iraqis intended to use nuclear weapons for this role. Israel's destruction of the Osirak nuclear reactor, however, derailed this effort. Iraq has not abandoned its plans to produce nuclear weapons, but recognizes that it will take considerably more than five years

to produce a nuclear device.[3]

The delay in the nuclear program has led the Iraqis to focus their primary efforts on chemical weapons, ballistic missiles and biological weapons. These programs have been pursued with considerable tenacity. They were a high priority during the hostilities with Iran and it appears that the cessation of fighting has not led to a reduction in activity. The strategic rationales that motivated the programs remain and are unlikely to disappear in the near future.

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[3]Glenn Frankel, "Iraq Said Developing A-Weapons," *The Washington Post*, March 31, 1989, pp. A1, A32, claims that the Iraqis may be only a few years away from making a nuclear device, but officials in Washington tend to believe that it will be more than five years before Baghdad is able to build an atomic bomb.

II IRAQ'S CHEMICAL PROGRAM

Iraq appears to have initiated its chemical weapons program in the 1960s. It was not until 1974, however, that a high level decision was made to build plants to manufacture chemical agents. After a number of false starts, Iraq managed to obtain production equipment for a poison gas manufacturing complex. By 1985, Iraq was producing a number of chemical agents, including mustard gas and two different types of nerve agents.

Until recently, most reports indicated that the Iraqis were able to produce about 700 tons of chemical agents per year, but the actual production may have been lower.[1] These figures

[1]Iraq's production capacity was discussed in a documentary produced by BBC Panorama, "The Secrets of Samarra," October 27, 1986. Some of this material was also reported in Herbert Krosney, "Poison Gas: Iraq's Deadly Weapon of Last Resort," Los Angeles Times Syndicate, 1986. According to both of these sources, Iraq was able to produce 60 tons a month of mustard gas, 4 tons a month of sarin, and 4 tons a month of tabun. These figures seem to suggest an annual production rate of 720 tons a year of mustard gas and 96 tons a year of nerve agent (tabun and sarin). However, chemical plants cannot operate continuously, especially when the production process involves highly corrosive chemicals. Typically, a plant may operate for no more than about 330 days a year, even under ideal conditions. It is unclear exactly how the BBC and Krosney figures were calculated, so it is not known if they allow for such down time. Assuming that the BBC and Krosney figures do not take into account the

appear to have been confirmed in a statement made in early 1989 by William H. Webster, director of the Central Intelligence Agency, when he indicated that Iraq has produced "several thousand tons of chemical agents."[2] If it is assumed that this means at least 2,000 tons of agents, and that production has taken place since 1983, it is evident that average production must have been at least 350 tons per year. However, this is only an average. Production was probably greater in 1988 than in 1983, since some time is required to learn how to operate a chemical plant at optimal efficiency. Moreover, it is probably safe to assume that total production was greater than 2,000 tons. Hence, it appears that Iraq has developed a chemical agent production capacity of approximately 700 tons per year.

Moreover, there is reason to believe that Iraq has been expanding its facilities to produce chemical agents. According to Webster, Iraq "is expanding its chemical weapons capability and is taking further steps to make its program entirely independent of foreign assistance." Indeed, information provided by Webster suggests that Iraq now has production facilities capable of manufacturing between 3,300 and 13,200 tons a year of several different chemical agents, or a figure five to 20 times larger than previously believed. The magnitude of Iraq's current production capabilities can be deduced by a comparison with the Libyan chemical agent plant at Rabta.

According to Webster, the Rabta plant "may be the single largest chemical warfare agent production plant in the Third World." He added that "because Iraq has a number of production sites, however, its total production capacity will continue to exceed Libya's." Webster stated that the Rabta plant

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need to shut down the plants periodically, actual production capacity would be equivalent to only 10 or 11 months of production, or 600 to 660 tons of mustard gas and 80 to 88 tons of nerve agent.

[2]Statement of William H. Webster, director of the Central Intelligence Agency, before the Senate Committee on Governmental Affairs, Hearings on Global Spread of Chemical and Biological Weapons: Assessing Challenges and Responses, February 9, 1989.

is capable of making "tens of tons a day." *The New York Times* placed the capacity of the Rabta facility at between 10 and 40 tons per day.[3] This implies an annual production capacity of between 3,300 and 13,200 tons per year, assuming that the plant was able to operate at full capacity for no more than 330 days a year. Since Iraq's total production capability is larger, Baghdad should have the ability to make at least 3,300 tons a year of chemical agents, and possibly more than 13,200 tons a year.

At the present time, the Iraqi chemical weapons program is under the control of the Ministry of Industry and Military Industries. Formed in April 1988, this ministry is headed by Husayn Kamil, son-in-law and cousin of Iraqi President Saddam Husayn.[4] Iraq's chemical agent production capabilities are located at a complex near the town of Samarra, about 70 kilometers northwest of Baghdad. In addition, Webster has stated that there are "a number of other production facilities." The Samarra plants are known to produce mustard gas and two nerve agents, tabun and sarin.[5] It is possible that Iraq produces other chemical agents as well, including phosgene, arsenical compounds and cyanide compounds.[6] Iraq has employed a

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[3]Webster, "Statement," February 9, 1989. See also Stephen Engelberg with Michael R. Gordon, "Germans Accused of Helping Libya Build Nerve Gas Plant," *The New York Times*, January 1, 1989, p. A8.

[4]Economist Intelligence Unit, *Country Report: Iraq*, No. 4, 1988, p. 10. Several years ago, Kamil was placed in charge of the Military Industries Organization, which operated under the auspices of the president's office. In that capacity, it is believed that he was responsible for the successful development of the Al-Husayn surface-to-surface ballistic missile.

[5]Webster, "Statement," February 9, 1989.

[6]Iraq may have employed arsenic compounds, possibly Lewisite, against the Kurds in August 1988 in northern Iraq. See Report of a Medical Mission to Turkish Kurdistan by Physicians for Human Rights, "Winds of Death: Iraq's Use of Poison Gas Against Its Kurdish Population," February 1989, p. 11. The Iranians claim that Iraq used phosgene on at least 33 occasions during the war. See United Nations Security Council, Document Number S/19822, "Letter Dated 22 April 1988 from the Acting Permanent Representative of the Islamic Republic of Iran to the U.N.

variety of munitions filled with chemical agents, including aircraft bombs, artillery shells and rockets.[7]

Addressed to the Secretary-General," April 22, 1988. The Iranians also claim that cyanide agents were used during the attacks on Halabja in March 1988. See Jim Muir, "Iraq gas attacks revive horrors of the Great War," *The Sunday Times* (London), March 27, 1988, p. B4; Patrick Tyler, "Poison Gas Attack Kills Hundreds," *The Washington Post*, March 24, 1988, pp. A1, A36; and Norman Kirkham, "Iraq Gas Leaves 'A Modern Pompeii,' " *The Washington Times*, March 23, 1988, pp. A1, A10. Kirkham suggests that either hydrogen cyanide or cyanogen chloride were used.

[7]Webster, "Statement," February 9, 1989. A number of these weapons were identified by the U.N. teams sent to investigate use of chemical agents in the Iran-Iraq war. In 1984, they described small aircraft bombs, capable of carrying about 49 kilograms of mustard agent, apparently made in Spain. See Section III, Munitions Aspects, of U.N. Security Council Document S/16433, "Report of the specialists appointed by the Secretary-General to investigate allegations by the Islamic Republic of Iran concerning use of chemical weapons: note by the Secretary-General," March 26, 1984. In 1987, the team identified 90mm air-to-surface rockets and BM-21 122mm surface-to-surface rockets. See Sections IVc and Vc, "Munitions aspects," in U.N. Security Council Document S/18852, "Report of the specialists dispatched by the Secretary-General to investigate allegations of the use of chemical weapons in the conflict between Iran and Iraq," May 8, 1987.

III PRODUCING MUSTARD GAS

The chemical agent used most extensively by the Iraqis during the recent fighting with Iran was mustard gas. The first mustard gas used in 1983 was of an extremely pure grade, suggesting that it was made in a laboratory and not in a production plant. By 1985, however, the Iraqis appear to have activated a small plant at Samarra capable of producing about 60 tons of mustard gas per year.[1] According to press reports, this facility was built for the Iraqis by a number of West German companies.[2]

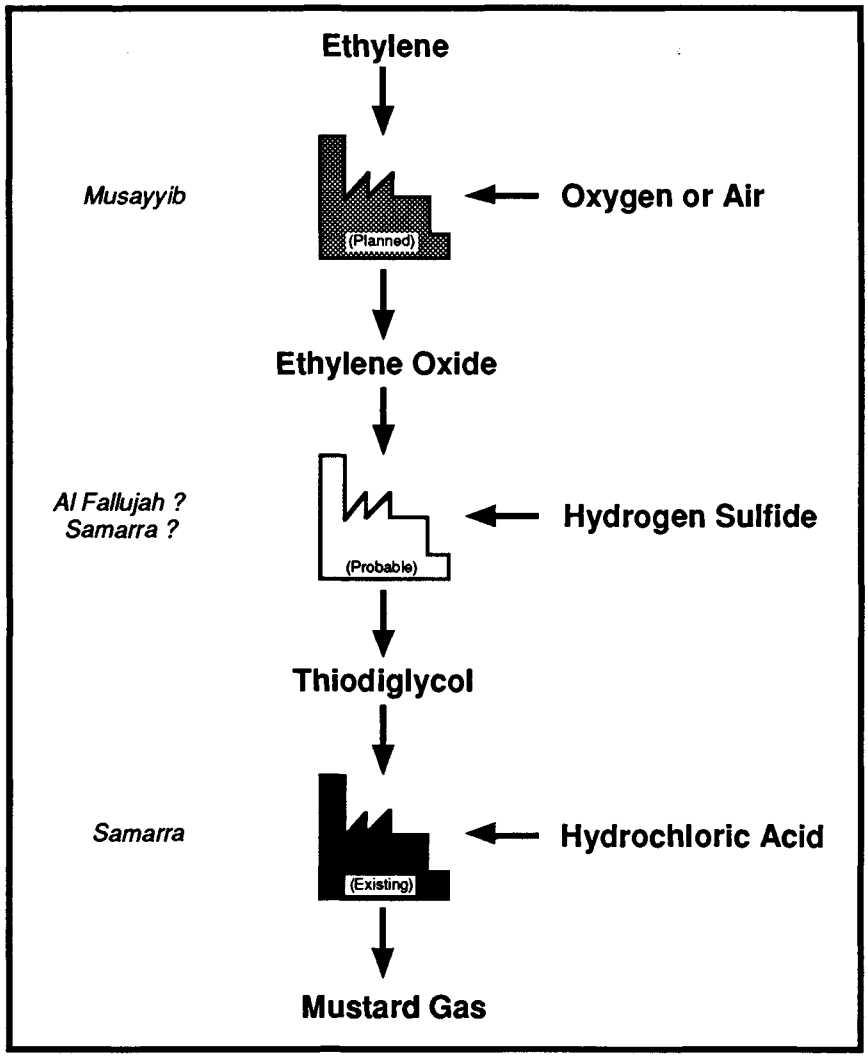
Although there are gaps in the evidence, there is at least some reason to believe that Iraq may now be able to make substantially larger quantities of mustard gas. More

[1]Krosney, "Poison Gas." This figure suggests a maximum production of 720 tons a year. However, assuming that it operates for only 330 days a year, the annual production would be no more than 660 tons per year.

[2]A more extensive discussion of the role of the German companies appears in BBC Panorama, "The Secrets of Samarra," and Krosney, "Poison Gas." According to press reports, the company primarily responsible for constructing the pilot plants at Samarra was Karl Kolb and its subsidiary, Pilot Plant. Other companies were also involved, including firms from Britain and Australia, but in many cases the corporations did not know that they were helping to build a chemical weapons complex.

significantly, it appears that in the next few years Iraq will be able to produce its own supplies of precursors, making efforts to prevent the proliferation and use of chemical weapons more difficult.

IRAQI MUSTARD GAS PRODUCTION



To put these developments in the proper perspective, it is first necessary to examine how mustard gas is produced. Although there are several methods, the most common involves the use of a precursor called thiodiglycol, a chemical most commonly used in the production of dyes and inks. Mixing this chemical with hydrochloric acid, a chemical extensively employed in a wide variety of commercial industrial applications, produces mustard gas. This process was first used by the Germans during the World War I; it was also the path adopted by the Iraqis to make mustard gas at Samarra.[3]

Because of its potential role as a mustard gas precursor, the export of thiodiglycol has been regulated by the member countries of the "Australia Group."[4] Thiodiglycol is made by a large number of companies in West Europe, Japan and the United States. The most common production method involves reacting ethylene oxide with hydrogen sulfide. Hydrogen sulfide is easily obtained and it can be produced by removing it from "sour" natural gas pumped from the ground. Ethylene oxide is a standard industrial chemical and is mass-produced throughout the world.[5]

When Iraq initiated mustard gas production in the early 1980s, it was not able to make thiodiglycol. For this reason it had to import stocks from Western Europe and the United

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[3]J.P. Perry Robinson, "The Chemical Industry and Chemical-Warfare Disarmament: Categorizing Chemicals for the Purposes of the Projected Chemical Warfare Convention," The Chemical Industry and the Projected Chemical Warfare Convention, CIPCWC/BP.1 + WP.9/Rev, November 4, 1985, SIPRI/Pugwash Conference, Stockholm, October 24-26, 1985.

[4]Gary Thatcher and Timothy Aeppel, "The Trail to Samarra: How Iraq Got the Materials to Make Chemical Weapons," *The Christian Science Monitor*, December 13, 1988, pp. B1, B4-8, B12-B15, and Krosney, "Poison Gas."

[5]"Ethylene Oxide", *Ullmann's Encyclopedia of Industrial Chemistry*, 5th, completely revised edition (VCH, 1987), volume A10, pp. 117-132. In 1987, world capacity to produce ethylene oxide was more than 8 million tons a year. Ethylene oxide is made by oxidizing ethylene using air or oxygen.

States. Press reports suggest that Iraq acquired just over 1,000 tons of thiodiglycol from Western sources.[6] About one ton of thiodiglycol is needed to make one ton of mustard gas, indicating that Iraq has obtained at least enough thiodiglycol to manufacture about 1,000 tons of mustard gas. However, it is possible that additional quantities of thiodiglycol were obtained from other sources.[7]

In the future, however, it should be possible for Iraq to avoid export controls by making its own thiodiglycol. Iraq can obtain the necessary ingredients with little difficulty. It can produce its own hydrogen sulfide, if necessary, or could easily import stocks from other countries.[8] Ethylene oxide is less common and more difficult to produce, but by the early 1990s Iraq should be able to produce it in the quantities needed to support its chemical weapons program.

There are sound economic reasons for Iraq to produce

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[6]The first large quantity of thiodiglycol obtained by the Iraqis apparently was 500 tons manufactured in Belgium by a U.S. company, Phillips Petroleum. See Thatcher and Aeppel, "The Trail to Samarra," pp. B8, B12, and Krosney, "Poison Gas." According to Thatcher and Aeppel, some Belgian officials believe that an additional shipment of Belgian-made thiodiglycol, consisting of 5 tons, was illegally shipped to Iraq by a Spanish chemical company, Cades. Phillips and Cades claim that the thiodiglycol was destroyed, and that it never left Spain. Finally, the Iraqis acquired about 500 tons from the United States in 1987 and 1988, despite controls on the export of the material. See Michael R. Gordon, "Role of Americans Is Cited in Chemical Shipments," *The New York Times*, January 31, 1989, p. A3; Paul W. Valentine, "2 Charged In Poison Gas Deal," *The Washington Post*, January 31, 1989, pp. A1, A10.

[7]Thatcher and Aeppel, "The Trail to Samarra," p. B4. A table indicates that "at least 13 companies – in Canada, Japan, and West Germany – produce thiodiglycol. Thus Iraq may have bought thiodiglycol to make mustard gas from several sources."

[8]Hydrogen sulfide can be obtained on the open market, or the Iraqis could produce it indigenously. A possible source is the sulfur extraction plant associated with Iraq's petroleum industry. Natural gas and petroleum are often contaminated with hydrogen sulfide, which has to be removed before either material can be used or refined. Iraq also mines sulfur and has a small sulfur-based industrial infrastructure. It could probably manufacture hydrogen sulfide from these sources.

ethylene oxide. It is made from ethylene, which in turn is made from petroleum or natural gas. Finished products command higher prices than crude oil, which increases the potential profits for an oil producing nation. Also, the end products can often be utilized in domestic industries to make other chemicals or for use in finished products, eliminating the need for imports. For these reasons, oil-producing countries have strong economic incentives to enter the ethylene industry. Accordingly, a number of oil-exporting countries have built ethylene and ethylene oxide plants for legitimate commercial reasons.[9]

Iraq recognized the desirability of building ethylene production facilities, but the war with Iran interfered with efforts to establish an ethylene industry. Construction of Petrochemical Complex No. 1 (PC 1), located near Basra, started in the late 1970s. The complex was ready to begin operation in the early 1980s, but the war made it impossible to start production. Iranian forces advanced to positions near Basra, and intense military operations took place in that area. Although Iraq contemplated moving the complex, by late 1987 it decided to reactivate it instead. Current plans call for the facility to be in service in early 1989.[10]

Before the cease-fire with Iran was signed, Iraq decided to build a second ethylene plant in early 1988. The new facility, Petrochemical Complex No. 2 (PC 2) at Musayyib, will produce 420,000 tons per year of ethylene and 67,000 tons per year of

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[9]The chapter on "Petrochemical Technology Transfers" in Office of Technology Assessment, *Technology Transfer to the Middle East*, OTA-ISC-173 (Washington: Government Printing Office, 1984), provides considerable detail on the efforts of countries in the Middle East to acquire such facilities. Saudi Arabia has two plants to make ethylene oxide with a total capacity of 400,000 tons a year.

[10]This discussion is based on *Middle East Economic Digest*, October 28, 1988, p. 14. The initial plans called for the complex to produce 140,000 tons per year (t/y) of ethylene and 270,000 (t/y) of liquid ethylene. It was built with the assistance of an American company, Lummus Crest, and a West German company, Thyssen Rheinstahl Technik.

ethylene oxide. In addition, it will make nearly two dozen other chemicals.[11] To provide feedstock for the complex, a 140,000 barrels-a-day oil refinery is being built at the site, at a cost of $1 billion.[12] PC 2 is being built on a "fast track": the first phase of the complex is expected to enter service in mid-1991, and the second phase is supposed to be completed two years later. The total cost is estimated at about $2.5 billion, much of it covered by foreign loans. Initial contracts for the new complex were awarded in the summer of 1988.[13] When PC 2 starts production in mid-1991, the Iraqis will have a total production capacity of 830,000 tons a year of ethylene and 67,000 tons a year of ethylene oxide.

The availability of ethylene and ethylene oxide will make it possible for Iraq to produce thiodiglycol in large quantities, since only about 45 tons of ethylene are needed to produce 100 tons of thiodiglycol. Thus, Iraq will be in a position to produce thousands of tons of mustard gas per year, should it so desire.

By 1991, the Iraqis will have most, if not all, of the elements needed for an independent production base for mustard gas. At present, there is only one missing link. None of the information on Iraq's chemical warfare capabilities made public so far suggests that Iraq has obtained a plant capable of converting ethylene oxide into thiodiglycol. According to experts familiar with the process of making thiodiglycol, a

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[11] *Middle East Economic Digest*, February 17, 1989, p. 17; *Middle East Economic Digest*, November 18, 1988, p. 17. The construction of the plant is being handled by a government-owned company, Techcorp.

[12] *Middle East Economic Digest*, December 16, 1988, p. 16.

[13] The first contract was awarded to the British branch of Bechtel, the large American construction firm. It received a contract in July 1988 for technical and management consulting services for the entire complex. In addition, it was expected to help locate financing. Lummus Crest, another American company, received a contract in the summer of 1988 to design and help build the ethylene plant. The company will provide technology, carry out the engineering design work and assist the Iraqis in construction management.

chemical industry capable of handling ethylene oxide should be able to produce thiodiglycol.

It is probable that Iraq already has such a plant. The Iraqis are known to have built an industrial complex at Al Fallujah, a town northwest of Baghdad, for the purpose of making nerve agent precursors.[14] This activity suggests that they may have acquired a thiodiglycol facility as well. It must be stressed, however, that this is only conjecture since no information is publicly available yet on the subject.

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[14]BBC Panorama, "Secrets of Samarra," October 27, 1986.

IV PRODUCING NERVE AGENTS

Iraq is also known to have produced nerve agents, including sarin and tabun, and is reported to have investigated possible production of a third nerve agent, VX.[1] Significantly, Iraq appears to have decided to control as much of the chemical process involved in the production of nerve agents as possible to ensure its independence from outside interference. In addition to producing nerve agents, it also wants to make the precursor chemicals. Moreover, there is evidence that Iraq is attempting to make the chemicals involved in the manufacture of the precursors as well.

The production of nerve agents is considerably more complex than making mustard gas. Since it is possible to make particular nerve agents in more than one way, the list of nerve agent precursors is quite long.[2] In some cases, the precursors have few legitimate uses and it is therefore easy to monitor

[1]BBC Panorama, "The Secrets of Samarra," October 27, 1986.

[2]Perry Robinson, "The Chemical Industry," pp. 20-25, notes that there are at least three methods of making tabun and eight methods of making VX. Numerous methods of making sarin are described in the open literature.

them.[3] In other cases, however, the chemicals are widely used for legitimate purposes and are difficult to monitor.

In the early 1980s, West German companies built two pilot plants at the Samarra complex capable of making nerve agents, one for sarin and the other for tabun. Each of the plants was capable of making at most 48 tons per year of nerve agent.[4] The plants apparently were designed to handle the last few stages in the process of producing the nerve agents.[5] Since Iraq did not produce the chemicals needed for these plants, it was forced to turn to foreign suppliers to obtain key precursors, which it did with considerable success.[6]

The plants at Samarra were able to produce nerve agents in sufficient quantities to be employed against the Kurds and the Iranians. Details are sketchy, but it is possible that tabun was

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[3]For example, the manufacture of soman involved the use of pinacolyl alcohol. The total global commercial demand for it is less than 25 pounds per year. See Gary Thatcher, "Their Secret Task is to Halt Spread of Chemical Weapons," *The Christian Science Monitor*, December 13, 1988, p. B15.

[4]Krosney, "Poison Gas," estimates the plant's monthly production capacity at 4 tons per month. The annual production capacity is presumably lower, probably no more than 40 to 44 tons.

[5]This is evident from the list of chemicals that the Iraqis were trying to obtain from abroad. Press reports indicate, for example, that at first they sought dimethylamine and later tried to obtain phosphorus oxychloride. See Krosney, "Poison Gas," and the BBC Panorama, "Secrets of Samarra." They do not appear to have acquired either dimethylammonium chloride or dimethylphosphoramidic dichloride. This suggests that the pilot plant was initially capable of working with dimethylamine and later with phosphorus oxychloride.

[6]Krosney, "Poison Gas," and the BBC Panorama, "Secrets of Samarra," describe in some detail the Iraqi effort to acquire nerve gas precursor chemicals in the United States and Western Europe through 1985. Among the chemicals sought were monochlorobenzene, ethyl alcohol and dimethylamine – all used in the production of tabun – and sodium fluoride, hydrogen fluoride, potassium fluoride and isopropyl alcohol – all used in the production of sarin. The Iraqis also attempted to acquire phosphorus oxychloride, which is needed for tabun.

used as early as 1984. U.N. investigative teams discovered evidence of tabun in 1984 and 1987, and it is believed that nerve agents were employed against the Kurdish town of Halabja in March 1988, and against Kurdish villages in August 1988.[7]

The nerve agent program, however, was severely constrained by its small size. The production capacity was at most only 100 tons a year, barely sufficient for the production of militarily useful quantities of nerve agents.[8] Moreover, Iraq's ability to make nerve agents was inhibited by controls imposed on the export of nerve agent precursors.[9]

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[7]Krosney, "Poison Gas," claims that tabun was used against the Iranians in 1984. A United Nations investigation concluded that tabun was probably used against Iranian forces in early 1987. See U.N. Security Council, "Report of the Mission Dispatched by the Secretary-General to Investigate Allegations of the Use of Chemical Weapons in the Conflict Between the Islamic Republic of Iran and Iraq," S/18852, May 8, 1987, pp. 10, 19. Staff Report to the Senate Committee on Foreign Relations, "Chemicals Weapons Use in Kurdistan: Iraq's Final Offensive," September 21, 1988, p. 31, suggests that nerve agents were used in the attacks on the Kurds in northern Iraq during the previous month.

[8]According to one estimate, 14 tons of tabun are needed to contaminate a square kilometer of land. Thus, a year's production of tabun from the pilot plants could contaminate less than three square kilometers. When used in aerosol form, only two tons are needed to create an airborne hazard over a square kilometer, but the effect does not last as long. Half a ton of sarin is needed to create an airborne hazard over a square kilometer. The small size of the Iraqi pilot plants also is evident when compared with German production capabilities during World War II. The Germans made over 12,000 tons of nerve gas, and at the end of the war had plants that were able to produce up to 1,400 tons a month. See Perry Robinson, "The Chemical Industry," p. 35, p. 37.

[9]The United States stopped a shipment of 6.5 tons of potassium fluoride in early 1984, and Iraqi orders to a Dutch company for 250 tons of phosphorus oxychloride, 200 tons of trimethyl phosphite and 200 tons of potassium fluoride were never filled. However, the Iraqis were able to obtain 60 tons of phosphorus oxychloride through another Dutch company, Melchemie, which acquired it from an Italian company, Montedison. When the Dutch company was accused of violating export controls, the Iraqis agreed to return the chemical. Although the Iraqis did return a container with labels indicating that it contained phosphorus oxychloride, Dutch officials have indicated that no effort was made to ensure that the chemical in the container was phosphorus

To rectify these weaknesses, the Iraqis apparently decided in the mid 1980s to expand their capacity to manufacture both nerve agents and their precursors as well. Details on production capacity are sketchy, but one report suggests Iraq may have supplemented its existing pilot plant with an additional production facility capable of producing up to 1,000 tons of sarin a year.[10] It is possible that a second plant has been added to make tabun in similar quantities. Thus, the Iraqis may now be able to produce up to 2,000 tons a year of nerve agent, or more than 20 times their capacity in 1985.

In addition to the nerve agent plants, the Iraqis also needed plants to make certain key precursors. The production of tabun requires five basic chemicals: ammonia, methanol, sodium cyanide, phosphorus oxychloride and ethanol. Except for phosphorus oxychloride, all of these are common materials which are easily obtained.[11] Because of its importance as a

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oxychloride. See Herbert Krosney, "Iraq Making Deadly Form of Nerve Agent," *The Jerusalem Post*, November 24, 1986, p. 4.

[10] *Foreign Report*, March 31, 1988. pp. 1-2. This source claims that Iraq has three plants at Al Fallujah capable of producing up to 1,000 tons a year of sarin. As discussed below, it appears that the Al Fallujah plants actually are making precursors for nerve agents, casting some doubt on the credibility of the story. However, other reports also state that there are three plants at Al Fallujah and indicate that they are making sarin precursors. Thus, it is possible that the figure for total sarin production might be accurate, even if the location for the production was mistaken.

[11] Perry Robinson, "The Chemical Industry," p. 20. The entire process of making tabun using the method developed by the Germans takes only four steps. First, the ammonia and methanol are used to produce dimethylamine. Second, the dimethylamine and phosphorus oxychloride are mixed together to produce dimethylammonium chloride and dimethylphosphoramidic dichloride. Third, phosphorus oxychloride is mixed with the dimethylammonium chloride to produce dimethylphosphoramidic dichloride and hydrochloric acid. Fourth, the dimethylphosphoramidic dichloride is mixed with sodium cyanide and ethanol to make tabun. The resulting product is diluted in monochlorobenzene to ease storage and handling. To produce 100 tons of tabun requires 25 tons of ammonia, 60 tons of methanol, 30 tons of sodium cyanide, 134 tons of phosphorus oxychloride and 37 tons of ethanol.

nerve agent precursor, phosphorus oxychloride is on the list of chemicals controlled by the "Australia Group." Considerable effort has been expended to keep Iraq from obtaining supplies of this chemical.[12] Thus, the Iraqis only needed to produce this key ingredient to liberate their tabun program from outside interference.

Now, it appears likely that the Iraqis have acquired the ability to make both phosphorous oxychloride and phosphorous trichloride. These precursors are manufactured at a complex near Al Fallujah.[13]

The facilities were built by West German companies for the State Establishment for Pesticide Production (SEPP). The equipment for the plants was delivered to Iraq by late 1987, but it is not known precisely when production began. SEPP was also responsible for the Iraqi chemical agent production facilities at Samarra.[14]

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[12]Krosney, "Poison Gas," and the BBC Panorama, "Secrets of Samarra," discuss some of the efforts of the Iraqis to obtain phosphorus oxychloride. Perry Robinson, "The Chemical Industry," pp. A3, A4, and *The Christian Science Monitor,* December 13, 1988, p. B15, provide lists of the controlled chemicals.

[13]Iraqi efforts to make nerve gas precursors were mentioned in BBC Panorama, "Secrets of Samarra." A subsequent report appeared in Economist Intelligence Unit, *Country Report: Iraq,* No. 1, 1988, p. 6. The chemicals are identified by this source as "phosphor trichloride and phosphor oxytrichloride," presumably meaning phosphorus trichloride and phosphorus oxychloride.

[14]Economist Intelligence Unit, *Country Report: Iraq,* No. 1, 1988, p. 6 states that in November 1987, the West German government intervened to prevent a German company from completing the facility but all the production equipment was delivered to Iraq before this action was taken.

Additional details appeared in the German news magazine *Der Spiegel.* According to this account, a number of West German companies were involved in the project. Known as "Project 9230", the complex consisted of three large factories. One German technician working on the project was told that it was intended for the production of detergents. Another German reportedly said regarding underground storage tanks located at the facility that "detergents for two-legged flies are stored there." The complex is about 1,000 meters long and 600 meters wide, and

West German authorities appear to believe that French and Austrian companies may have been used as fronts for the West German companies.[15]

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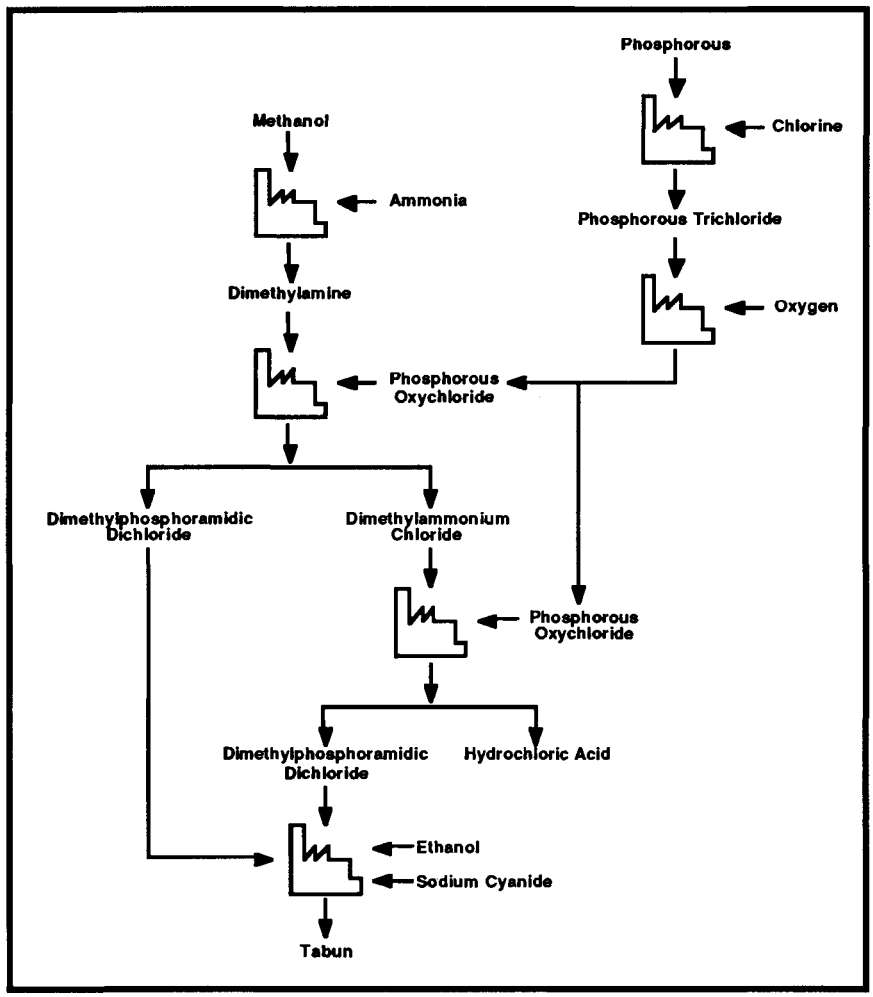
is surrounded by a barbed wire fence 2.5 meters high protected by watch towers. *Der Spiegel*, January 23, 1989, pp. 16-27, as translated in Foreign Broadcast Information Service (FBIS), *Daily Report: Near East and South Asia*, January 25, 1989, p. 8. According to the article, the Iraqi organization that handled the purchase was the State Establishment for Pesticide Production. The West German company involved was WTB Walter Thosti Boswau. A second company, Infraplan, coordinated purchases for the complex. The story places the facility at "Falludscha," a mistaken transliteration of Al Fallujah.

[15]It is unclear at this point whether the allegations refer specifically to the Al Fallujah precursor plants, or to the facilities at Samarra. Nor is it clear that the facilities involved nerve gas manufacture. Reportedly, West German officials believe that as many as five West German companies were involved in German investigations, and that in order to evade German export restrictions some of the companies convinced French and Austrian companies to ship equipment to Iraq. See *DPA* (German), January 3, 1989, as translated by FBIS, *Daily Report: Western Europe*, January 4, 1989, p. 5. The Vienna Domestic Service (German), January 4, 1989, as translated by FBIS, *Daily Report: Western Europe*, January 5, 1989, p. 2, reported that "five German companies are suspected of helping in the construction of a factory for the manufacture of nerve agents." Further, it indicated that an Austrian company, Neuberger, acted as a front company for the German company of Karl Kolb in the transaction.

The Vienna *Kurier* (German), as translated in FBIS, *Daily Report: Western Europe*, January 17, 1989, p. 6, says that two Austrian companies "acted as subcontractors in the construction of plants for the production of chemical weapons in Iraq:" a manufacturer of laboratory equipment, Neuberger Holz und Kunstoffindustrie [Neuberger Wood and Plastics Industry]; and a steel construction company, Lenhardt Metallbau und Dachdecker [Lenhardt Metal Construction and Roofing]. According to the Austrian account, the manager of the Karl Kolb office in Baghdad, Klaus Frenzel, has been a partner in Neuberger since September 1987 and now owns 13% of the company. Neuberger claims that it sold "laboratory equipment" to the Iraqis. Lenhardt claims that it provided the Iraqis with a "large scale kitchen with dishwashers" in 1983 and stainless steel parts to an oil refinery in 1984 and 1985. At least some Austrian companies have been threatened as a result of their activities. *Middle East Economic Digest*, March 14, 1987, p. 13, reports that a letter bomb was sent to Ing Grill and Grossman by a group that claims the company helped Iraq's chemical weapons program. The Austrian company denies the charge, and claims that it only supplied a plant to make synthetic resins.

TABUN NERVE GAS PRODUCTION



The production of phosphorus trichloride depends on the availability of two main raw materials: elemental phosphorus and chlorine. Phosphorus oxychloride is made by bubbling oxygen through liquid phosphorus trichloride.[16] Although the Iraqis probably do not yet have a plant to make elemental phosphorus, they are now trying to obtain such a facility.[17] If and when these new plants begin operating in the next few years, Iraq will have ensured that it is largely independent from outside sources of precursors.

An intriguing aspect of the Iraqi nerve gas program is Baghdad's effort to create a phosphorus-based industrial infrastructure. Just as ethylene is the starting point for production of mustard gas, phosphorus is the basic ingredient of nerve agents. Iraq has substantial phosphate reserves, and since the late 1970s has made considerable efforts to develop a mining and manufacturing industry based on phosphorus. Factories have been built, or are in the process of being built, to produce powdered detergents and fertilizers.[18]

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[16]Kirk-Othmer, *Encyclopedia of Chemical Technology*, 2nd completely revised edition (New York: John Wiley and Sons, 1966), Vol. 15, pp. 306-308.

[17]The Iraqis are now in the process of acquiring a plant to make sodium tripolyphosphate (STPP), a chemical used in detergents. The usual process of making STPP involves soda ash and elemental phosphorus. Thus, to supply the STPP plant it would be necessary for them to also build a facility to make elemental phosphorus. See *Middle East Economic Digest*, May 27, 1988, p. 13, for the Al Qaim STPP plant, and Kirk-Othmer, *Encyclopedia of Chemical Technology*, 3rd edition (New York: John Wiley and Sons, 1980), Vol. 17, p. 483, on the use of elemental phosphorus to make STPP.

[18]Iraq has built one plant to make raw materials required to produce powdered detergent and is building a second. The first plant, now in operation, makes linear alkylbenzene (LAB), which is the active ingredient. Several methods of making LAB are available, but the Iraqis chose to use one developed by an American company, UOP, which requires the use of hydrogen fluoride. Hydrogen fluoride also can be used in the manufacture of sarin. The LAB plant entered service in 1987, and cost $96.7 million. On Iraq's LAB program, see *Middle East Economic Digest*, March 28, 1987, p. 20. On the manufacture of LAB, see A.S. Davidsohn and B. Milwidsky, *Synthetic Detergents*, 7th edition (New York:

Iraq's phosphorus industry is centered around two sites: Akashat, a mining center in western Iraq near the Syrian border; and Al Qaim, a town on the Euphrates River only a few miles from Syria. A number of press reports have suggested that facilities at these two sites are involved in Iraq's chemical weapons program.[19] No evidence supports such allegations and it appears that they are based on a misinterpretation of the role assigned to these facilities. The phosphate industry provides an infrastructure that supports the efforts to make chemical agents, but they are not a direct component of the chemical weapons program.

As in the case of mustard gas, there is sufficient evidence to suggest a deliberate effort on Iraq's part to produce not only the nerve agents, but the precursor chemicals as well that would

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John Wiley and Sons and Longman Scientific and Technical, 1985), pp. 126-129. In addition, the Iraqis are producing "fluoride compounds" at the phosphoric acid plant located at Al Qaim. See Edward Fursdon, "Briton on the spot rejects 'Iraqi nerve gas' claims," *Daily Telegraph*, March 20, 1984. Hydrogen fluoride is a common by-product of such processes. See Bureau of Mines, U.S. Department of Interior, *Mineral Facts and Problems*, 1985 edition (Washington: Government Printing Office, 1985), p. 587. A plant to make sodium tripolyphosphate (STPP) is now being built. STPP is made from soda ash and elemental phosphorus. See, Bureau of Mines, U.S. Department of Interior, *Minerals Yearbook, 1986*, Volume I: Metals and Minerals (Washington: Government Printing Office, 1988), p. 727. The phosphorus also is needed for the phosphorus trichloride plant at Al Fallujah.

[19]Ian Mather and Robin McKie, "Iraq Reportedly Able to Produce Deadly Gases," *Philadelphia Inquirer*, April 13, 1984, p. 4, cites a London *Observer* story to the effect that a "pesticide" plant at Akashat was involved in chemical weapons production. Jim Muir, "Iraqi Gas Attacks Revive Horrors of the Great War," (London) *Sunday Times*, March 27, 1988, p. B4, reports that Iraq is believed to have a chemical weapons complex at Rutbah, immediately to the south of Akashat, the nearest inhabited place to the mine. Tehran Domestic Service (Persian), October 30, 1986, as translated by FBIS, *Daily Report: Middle East and Africa*, October 30, 1986, p. I3, says that according to a British newspaper, the *Independent*, the Iraqis have chemical weapons facilities at Al Qaim and "Ukask."

However, Edward Fursdon, "Briton On the Spot Rejects 'Iraqi Nerve Gas' Claims," *Daily Telegraph*, March 20, 1984, visited Akashat and Al Qaim, and found no evidence to support the reports.

otherwise have to be imported. This has profound implications for international efforts to control the proliferation of chemical and nerve weapons.

V PRODUCING BIOLOGICAL AGENTS

The Iraqis are believed to have embarked on a large, active biological warfare program. One U.S. government official is reported to have said that "everybody knows the Iraqis are trying to develop biological weapons."[1] Similarly, the West German government spokesman indicated in early 1989 that Iraq was conducting research on biological weapons and that there are at least some indications that production of agents may have started.[2] According to one analyst, at the end of 1988 there was evidence that Iraq "was producing botulin toxin in

[1]David Ottaway, "U.S. Gave Iraq Bacteria, Sen. McCain Charges," *The Washington Post*, January 26, 1989, p. A16. For a summary of the initial ABC News account, televised January 17, 1989, of allegations that Iraq has biological weapons, see Stephen Engelberg, "Iraq Said to Study Biological Arms," *The New York Times*, January 18, 1989, p. A7, and "TV Networks Say Iraq Developing Biological Weapons," *Reuters*, January 17, 1989. One military analyst, Anthony Cordesman, told ABC News, January 17, 1989, that "regardless of where you would go in the Middle East or for that matter which Western intelligence agency you would talk to, they would all confirm that Iraq has biological agents in actual production and is stockpiling them for military use."

[2]Hamburg *DPA* (German), January 19, 1989, as translated by FBIS, *Daily Report: Western Europe*, January 23, 1989, p. 11. The official cited is Friedhelm Ost. See also *The Washington Times*, January 27, 1989, p. 2, and Thomas F. O'Boyle, "Bonn Backs U.S. Charge That Iraq Can Produce Biological Weapons," *The Wall Street Journal*, January 23, 1989, p. A11.

military quantities, or some similar agent."[3]

The Iraqis vehemently deny possessing a biological weapons program. Allegations that the Iraqis have used biological agents against the Kurds are probably not true, and in any case, cannot be verified.[4]

A number of sources have suggested that the main Iraqi biological warfare research facility is located at Salman Pak, which is about 30 kilometers southeast of Baghdad.[5] Iranian sources suggest that they also may have biological warfare facilities at Samarra, Al Fallujah, Akashat and Badush, but it has not been possible to confirm this allegation.[6]

The Iraqis are believed to be investigating a variety of well-known diseases for use as biological agents, including typhoid, cholera, anthrax, tularemia and equine encephalitis.[7] The available evidence suggests that Iraq may not have "weaponized" any of these agents, meaning that they do not

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[3]Anthony H. Cordesman, "Creating Weapons of Mass Destruction," *Armed Forces Journal*, February 1989, p. 56.

[4]Tehran IRNA (English), September 25, 1988, as reported in FBIS, *Daily Report: Near East and South Asia*, September 26, 1988, p. 62.

[5]ABC Evening News, January 17, 1989, states that "the Salman Pak installation includes underground facilities carefully sheltered against attack." See also David Ottaway, "Official Denies Iraq Has Germ War Plant," *The Washington Post*, January 19, 1989, p. A36.

[6]It is possible the allegations refer to sites associated with the chemical weapons program, not the biological weapons program. Akashat is the location of the phosphate mine and produces the phosphorus needed for nerve agent production. Al Fallujah and Samarra are sites for chemical weapons plants. Thus, Badush also might be the site of a chemical weapons facility.

[7]Ottaway, "U.S. Gave Iraq Bacteria," mentions the last three. The first two are mentioned in "Israel Vows Action Against Iraqi Germ Research," *The Washington Times*, January 19, 1989, p. A8.

yet have the military means to deliver them.[8] According to an unidentified Israeli official:

> They may have samples but have not yet started to manufacture actual biological weapons nor, more importantly, have they yet acquired any airborne weapons, such as sophisticated missiles, to deliver the bacteria they worked on.[9]

However, there is little doubt that they have acquired much of the equipment needed to produce biological agents on a substantial scale.

West German intelligence reportedly believes that the Iraqis built a "bacteria weapons factory" near Baghdad with the assistance of West German companies.[10] German news reports indicate that the Iraqis acquired "mobile toxicological laboratories" from West German companies for "agricultural chemistry." Among the individuals involved in the project was an engineer reportedly affiliated with Karl Kolb, the German company tied to the chemical weapons facility at Samarra.[11]

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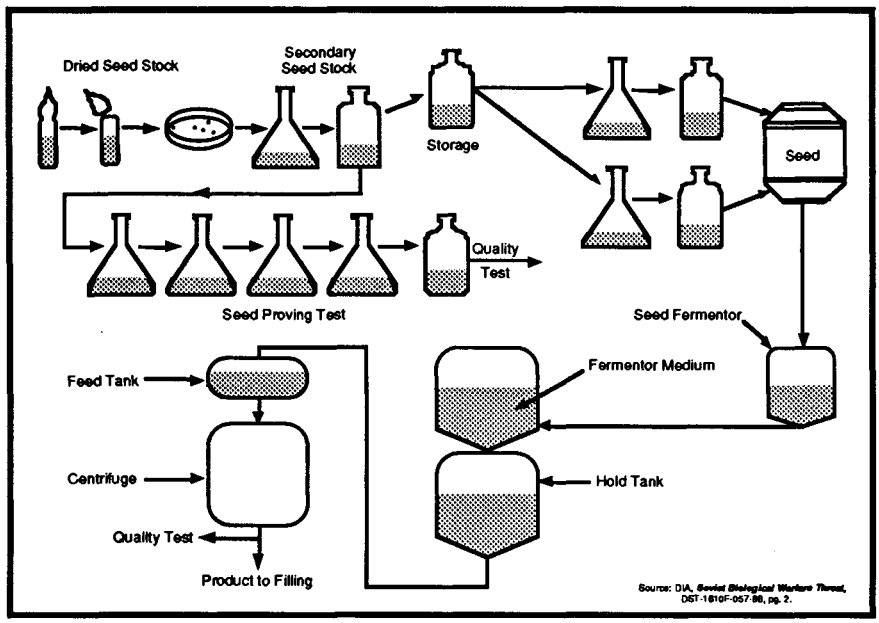
[8]Weaponization of biological agents is reportedly not easy to accomplish, especially if sophisticated delivery techniques are used. The agent must be kept alive and dispersed in a militarily effective manner.

[9]"Israel Vows Action," *The Washington Times*. Although the Iraqis now possess long-range ballistic missiles, they do not appear to have biological warheads for them.

[10]According to another German press report, the facility was south of Baghdad, implying that Salman Pak is the location of the factory. See Hamburg *DPA* (German), January 19, 1989, as translated by FBIS, *Daily Report: Western Europe*, January 23, 1989, p. 11, and *DPA* (German), February 4, 1989, as translated by FBIS, *Daily Report: Western Europe*, February 6, 1989, p. 9.

[11]*Der Spiegel* (German), January 23, 1989, pp. 16-27, as translated by FBIS, *Daily Report: Western Europe*, January 25, 1989, pp. 8. Those identified with the project were Anton Eyerle, a former German politician, and a chemical engineer from Karl Kolb. The vehicles were provided by Magirus Deutz.

BIOLOGICAL AGENT PRODUCTION



The Iraqis also obtained toxins from a West German company for "laboratory analyses." According to one report, the Iraqis may have obtained up to 2.7 grams of T-2 and HT-2 from West Germany. These are two of the toxins which the U.S. government alleged were used in Southeast Asia and Afghanistan.[12]

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[12]Thomas F. O'Boyle, "West German Export Controversy Grows With Confirmation of Shipments to India," *The Wall Street Journal*, February 1, 1989, p. A11. The original German accounts give varying figures. According to DPA (German), January 28, 1989 and January 30, 1989, as translated by FBIS, *Daily Report: Western Europe*, January 30, 1989, pp. 9-10, the sales included 500 milligrams of T-2 and 100 milligrams of HT-2. The German company, Plato-Kuehn, acquired the mycotoxins from the German subsidiary of an American company, Sigma Chemie. According to the U.S. Army, the lethal dose for such mycotoxins is between 75 and 1,000 milligrams. See U.S. Army Chemical School, *Toxins*, FC 3-9-1, August 1986, p. A-13.

Iraq's efforts to expand its pharmaceutical and biotechnology facilities also may be connected with the biological warfare program. In recent years the Iraqis have purchased equipment used in the production of pharmaceuticals, and U.S. intelligence officials reportedly believe that some of the equipment was acquired to help make biological agents.[13]

The reason for concern is a recognition that many biological agents can be made with commercially available equipment used in the manufacture of pharmaceuticals. This point was made by CIA Director Webster:

> The equipment used to produce biological warfare agents is truly dual use in nature. With currently available technology, biological warfare agents can be produced at such a rate that stockpiles are no longer necessary. There are no precursor chemicals or equipment that can be used only for the production of biological warfare agents. Actually, any nation with a modestly developed pharmaceutical industry can produce biological warfare agents, if it so chooses.[14]

Vaccines are made by injecting viruses into chicken eggs and letting them grow. At the appropriate time, the virus is separated from the eggs and treated. This is virtually identical to the process needed to produce an infectious virus. Similarly, the fermentors used to produce penicillin can also be used for other purposes, including the manufacture of toxins or bacterial disease.[15]

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[13]"Iraq Developing Germ Warfare Capability," *Jane's Defence Weekly*, January 9, 1988, p. 3.

[14]Webster, "Statement," February 9, 1989.

[15]Defense Intelligence Agency, *Soviet Biological Warfare Threat*, DST-1610F-057-6, 1986, pp. 2-4. For a fuller discussion of some of the technology involved and of the dual use nature of the technology, see the discussion by Raymond Zilinskas, "Verification of the Biological Weapons Convention," pp. 82-107, in Erhard Geissler, editor, *Biological and Toxin Weapons Today* (New York: Oxford University Press for the Stockholm International Peace Research Institute, 1986).

It must be stressed that none of the facilities identified here is known to be involved in the production of biological weapons. Indeed, it is possible that all are intended for legitimate, peaceful uses. However, even if not used to produce biological agents, these facilities do provide Iraq with the infrastructure needed to support a program to make infectious viruses and bacteria or to produce toxins.

A new component of Iraq's pharmaceutical complex is the Al-Kindi Company for Serum and Vaccine Production. Al-Kindi was created by merging a facility that makes vaccine for hoof-and-mouth disease with what is described as a factory "housing veterinary laboratories." The existing vaccine factory was built by a French company and is located at Doura, Baghdad. It can manufacture up to 12 million doses a year, but only 2 million are needed to meet local needs and the rest are exported. The Egyptians are ordering 7.5 million doses for 1989, so the plant will be operating at near capacity. The Iraqi government has made it known that it expects the Al-Kindi company to conduct research needed to produce human vaccines and expects that it will eventually make 15 different varieties.[16]

The Baghdad-based Arab Company for Antibiotic Industries (ACAI) is still being formed. It will be owned by the governments of Iraq, Jordan and Saudi Arabia, and by a company based in Amman, the Arab Company for Drug Industries and Medical Appliances (ACDIMA). It intends to build a factory capable of making 200 tons a year of penicillin derivatives.[17]

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[16]*Middle East Economic Digest*, February 10, 1989, p. 15; *Middle East Economic Digest*, June 27, 1987, p. 16. The Iraqi government has announced that it intends to sell 49 per cent of the company to the private sector.

[17]The plant is to be built at a cost of $80 million. See *Middle East Economic Digest*, August 29, 1987, p. 10; *Middle East Economic Digest*, December 5, 1987, pp. 16-17; *Middle East Economic Digest*, October 14, 1988, p. 20. Originally, Foster Wheeler Iberia was the design consultant and a Spanish firm was picked to provide the production technology. However,

During the summer of 1988, the Ministry of Industry and Minerals (now the Ministry of Industry and Military Industrialization) created the State Enterprise for Drug Industries. This new organization is a merger of two existing companies, the State Company for Drug Industries, located in Samarra, and the State Company for Manufacture of Medical Supplies.[18] The Samarra factory was apparently built with Soviet assistance, but was expanded with assistance from West German companies.[19]

Finally, in the summer of 1988 the Iraqis announced the creation of a biological research station, to be located in the southern marshes, that would incorporate a genetics research lab for agricultural improvements.[20]

By the early 1990s then, the Iraqis will have established a substantial pharmaceutical industry, as well as facilities specifically dedicated to biological weapons research. This will make it possible for them to produce biological agents in large quantities. They will also have research and development facilities, including some capable of working with new biotechnologies.

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in 1986 the Iraqis decided to reduce the size of the project, cutting the cost from $180 million to only $80 million, and turned the design over to a West German company, V-Consult Ingenieur. This company is reported to have been involved in Iraqi projects since the late 1970s. It played a key role in the expansion of the Samarra pharmaceutical plant and designed a $300 million pharmaceutical plant, which was to be located in Baghdad but was never built because of the war with Iran.

[18]*Middle East Economic Digest,* June 10, 1988, p. 9.

[19]On Soviet participation, see *The Middle East and North Africa 1988,* 34th edition (New York: Europa Publications, 1987), pp. 434-435. The original factory was expanded by V-Consult, a West German company, according to *Middle East Economic Digest,* August 20, 1987, p. 10.

[20]*Middle East Economic Digest,* June 24, 1988, p. 10.

VI THE FUTURE OF IRAQ'S PROGRAMS

By the early 1990s, the Iraqis will be increasingly independent of foreign sources of assistance for their chemical and biological weapons program.[1] They will have in place the production facilities needed to manufacture chemical precursors to supply their chemical weapons production facility. According to CIA Director Webster, this is part of a process "to make its program entirely independent of foreign assistance."[2]

Several broad conclusions arise from this survey of Iraq's biological and chemical warfare programs. First, the Iraqis have devoted considerable effort to create an industrial and scientific infrastructure to sustain these programs. Not only have they invested substantial resources to acquire production and research capabilities, but considerable technical and managerial talent has been involved in this pursuit. This suggests that the programs have a high national priority.[3]

[1]It is unclear, however, that the Iraqis will be able to independently develop all the delivery systems needed for the biological agent, chemical agents and toxins.

[2]Webster, "Statement," February 9, 1989.

[3]Ironically, it appears that the Iraqis may have found a means of making

Second, the cease-fire with Iran in August 1988 did not lead to a slowdown in Iraq's efforts. If anything, Iraq may be intensifying its endeavors, since the end of the fighting has freed them to devote greater resources and energy to such matters. This suggests that Iraq hopes to use the current lull in the hostilities to strengthen and expand its biological and chemical weapons programs in case the cease-fire breaks down and the war with Iran is resumed.

Third, these developments cast considerable doubt on the reliability of assurances that Iraq will not use chemical weapons in the future. Following the employment of chemical agents against the Kurds in August 1988, the United States received assurances that Iraq would abide by the Geneva Protocol prohibiting the use of chemical weapons. U.S. officials were informed that this meant no additional use of chemical agents against either domestic or foreign enemies.[4] These guarantees must be weighed against a number of contrary indications: continued heavy investments in the chemical and biological weapons programs; previous Iraqi violations of the Geneva Protocol; and Iraq's future ability to claim justification for the use of chemical agents because of Iran's alleged prior use of poison gas.

Ultimately, however, the value of the assurances are reduced by the size of Iraq's chemical weapons program. It is unlikely that the Iraqis are devoting such a large effort to

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their biological and chemical warfare programs pay for much of their costs. The chemical program will rely on production plants built using loans from western banks. Thus, even though the amounts involved will be quite large (probably more than $3 billion), it will not require out-of-pocket expenditures by the Iraqis. In addition, when the petrochemical complex becomes operational, the profits it generates in the production and export of legitimate chemicals should cover many of the expenses entailed in operating the facilities making chemical agents. Since the petroleum can be provided virtually for free, the complex should produce a substantial profit.

[4]Norman Kempster, "Iraq Tells Shultz It Won't Use Poison Gas Against Rebel Kurds," *Los Angeles Times*, October 4, 1988, p. 10.

programs intended only for show. Even if Baghdad hopes to use chemical and biological weapons to deter Iran, the programs make possible a sustained war-fighting capability. They have the production capacity to create large inventories and to replenish inventories depleted during hostilities. Thus, should the cease-fire with Iran come to an end, it is highly possible that Iraq would be tempted to make use of chemical weapons once again.

As a result, potential victims of Iraqi chemical and biological agents, including Iran, Israel and the Kurds, are unlikely to be convinced by any assurances from Baghdad. They are apt to believe that if Iraq does not use chemical weapons, it will be because it has nobody to use them against. The Kurdish opposition has been destroyed, making it unlikely that Baghdad will have to resort to chemical attacks in that arena any time soon. It is also unlikely that the Iranians will choose to resume hostilities with the Iraqis in the near future. Thus, predictions of nonuse may be correct, but not because the Iraqis have learned any lessons about the dangers and costs of using chemical weapons.

Fourth, it is unlikely that Iraq will shut down the biological and chemical warfare programs in the next few years. Even if the Committee on Disarmament in Geneva should adopt a treaty to prohibit the production and possession of chemical agents, there is little reason to believe that Iraq would ratify and abide by the agreement. The Iraqis have built their chemical and biological capabilities for serious strategic reasons. Even if it signs a treaty, difficult compliance questions will remain. Iraq has already violated its agreement to abide by the Geneva Protocol banning the use of chemical agents, suggesting that it is not likely to take other similar agreements very seriously. In the more distant future, it may be possible to convince Iraq to abandon these programs, but this will not happen soon.

Fifth, Iraq's continued interest in biological weapons is particularly disturbing. Some experts believe that it may attempt to develop an operational capability in this area, even

though Baghdad has signed (but not formally ratified) the treaty banning the possession and use of biological weapons. The implication of these efforts remains uncertain, since rapid advances in biotechnology may make frightening innovations possible in toxin and biological agents. Should Iraq attempt to "weaponize" its biological agents, it would have "the Third World's equivalent of nuclear weapons."[5]

Sixth, there is a disturbing possibility that Iraq may be tempted to export the products of its chemical weapons program. Not only will the Iraqis be in a position to supply chemical agents, including mustard gas and nerve agents, but they will be able to provide precursor chemicals as well. Thus, Iraq will have the capability to undermine efforts to inhibit the proliferation of chemical weapons in other parts of the world.

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[5]Cordesman, "Creating Weapons,"*Armed Forces Journal,* p. 56.

VII COPING WITH NEW REALITIES

Since the early 1980s, the United States has adopted a variety of unilateral and multilateral initiatives to inhibit the proliferation of chemical weapons in the Third World. Ultimately, it was hoped that the problem would be dealt with by implementing a treaty being negotiated in Geneva by the Committee on Disarmament to establish a global ban on the production and possession of chemical agents. However, U.S. officials recognized that protracted negotiations would be needed to reach such an agreement and that in the meantime a growing number of countries around the world were acquiring poison gas production capabilities.

To stop proliferation of chemical agents, the United States adopted policies that took advantage of the dependence of chemical agent production on the existence of a well-developed chemical industry. Most Third World countries, including those attempting to acquire chemical agents, have small chemical industries. For this reason, they rarely have the infrastructure needed to produce chemical agents in large quantities using only their own resources. Few of them manufacture key precursors -- the chemical ingredients needed to produce poison gas. Moreover, it is often not economical to make precursors in the relatively small quantities needed to operate a chemical weapons program.

Thus, a lack of expertise and limited resources made chemical weapons programs in the Third World reliant on outside sources of supply for critical materials.

For these reasons, Third World countries have tended to concentrate only on the final steps involved in the manufacture of chemical agents. They have built plants to make the actual chemical agents, but have relied on foreign suppliers to provide precursors. Since most precursors are widely available, produced by companies in Japan, Western Europe, Canada and the United States, it is possible to make chemical agents even with small chemical industries.

These realities led the U.S. government to concentrate its efforts on steps to restrict the flow of precursors to the Third World. By making it difficult to acquire critical precursors, policy-makers in Washington and elsewhere believed that it would be possible to stop, or at least slow down, efforts to produce chemical weapons in the Third World. To inhibit the trade in precursors – and thus cripple chemical weapons programs – industrialized countries have instituted export controls on the trade in such chemicals. Since effective export controls must be adopted by all the countries that produce precursors, Australia organized a voluntary supplier's group to coordinate the national efforts of 19 Western nations. The members of the "Australia Group" have adopted regulations to monitor the export of certain key chemicals, and prohibited the sale of certain precursors to countries like Iran and Iraq.[1]

Unfortunately, the "Australia Group" has had a mixed record. Although its activities have made it more difficult to obtain key precursors, countries intent on acquiring such chemicals can still do so. In some cases, industrialized countries have been less than vigilant in enforcing export controls. Often, it is suspected, officials in some countries are bribed to allow illegal exports to go unchallenged. Certain

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[1]Gary Thatcher, "Their Secret Task," *The Christian Science Monitor*, p. B14.

precursors have even been exported from the United States.[2] Despite these problems, however, export controls have made precursors more expensive to locate and purchase, and have made supplies less certain. Thus, they at least increased the difficulty of operating facilities that manufacture chemical agents.

As developments in Iraq suggest, however, in some circumstances export controls are no longer enough. Baghdad is now able to manufacture many of the precursors that the United States and other members of the "Australia Group" have tried to prevent it from acquiring. As a result, Iraq will be able to make chemical agents even if export controls on precursor chemicals are enforced with total effectiveness.

This is not to suggest that export controls are no longer necessary. There are countries, like Libya, that cannot manufacture precursors and that will remain vulnerable to export controls. Moreover, export controls are one key indicator of national policy, and efforts to stem the spread of chemical weapons will be effective only if stringent export controls are in place. The inadequacies of export controls, however, suggest that additional policies are needed as well.

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[2]An American company, Alcolac, was convicted of illegally exporting thiodiglycol, a chemical precursor of mustard gas, to both Iran and Iraq in 1987 and 1988. See Michael R. Gordon, "Role of Americans Is Cited in Chemical Shipments," *The New York Times*, January 31, 1989, p. A3; and Paul W. Valentine, "2 Charged In Poison Gas Deal," *The Washington Post*, January 31, 1989, pp. A1, A10.

VIII IMPLICATIONS FOR U.S. POLICY

The policies adopted by the Reagan Administration to confront chemical and biological weapons proliferation will not work in today's environment. Ultimately, the only way to curb proliferation of such weapons is to eliminate the incentives to employ them. Countries possess chemical and biological weapons because they believe that such weapons possess strategic utility. Should they decide that the costs of employment are too great, and the potential benefits too limited, the incentives to acquire them will begin to disappear.

Creating disincentives will not be easy, but it is possible. Foreign governments must be convinced that the world community will take harsh measures to punish countries using chemical or biological weapons. This will only happen if it is made evident that the United States will take the lead. For this to happen, U.S. policy-makers must take the problem seriously, and communicate the intensity of U.S. resolve to foreign governments. So long as our own officials are unwilling to act harshly, adoption of policies or enactment of legislation will be fruitless.

An essential first step in this process is the adoption of new policy initiatives. The United States must enact legislation

creating sanctions to be imposed on countries that use chemical or biological agents. Moreover, efforts to negotiate a convention that would ban production and possession of chemical weapons should be given a high priority.

These initiatives must overcome the legacy of U.S. policy during the Iran-Iraq war. The failure of the U.S. government to respond harshly to Iraq's employment of chemical weapons set a dangerous precedent. Officials in Washington did their best to ignore the problem, until Iraq's brutal attacks on Kurdish civilians in 1988 finally forced the United States to take notice.

Unfortunately, bilateral and regional concerns tend to dominate U.S. diplomatic activity, to the detriment of global considerations. This is responsible for the inaction of the United States during the Iran-Iraq war. The United States feared that Iraq might lose the war, and was unwilling to take steps that might undermine its strategic position. Moreover, the United States wanted to coax Iraq into the moderate Arab camp, and hoped to strengthen long-term relations with Baghdad. These were laudable objectives, but not at the cost of permitting extensive use of chemical weapons. Ironically, it is now widely recognized that Iraq did not need chemical weapons in order to survive the war with Iran.

It is clear that narrowly defined short-term interests took precedence over global considerations. Even after Iraq used poison gas against the Kurds in the spring and summer of 1988, the United States was content to rely on quiet diplomacy and secret assurances. By not reacting harshly to Iraq's use of poison gas, the United States has made it appear that chemical weapons are useful and that they can be used with impunity. This appears to have encouraged other countries to pursue chemical weapons programs, thus creating a global problem for the United States and its allies. No country intent on making use of chemical agents is likely to be impressed by U.S. reactions to date.

To prevent future use of chemical or biological agents, it

will be necessary to adopt a variety of policies, aimed simultaneously at officials in Washington and foreign governments. Such efforts should strive to institutionalize reactions to the proliferation and use of chemical and biological weapons by shifting the balance of power in Washington in favor of those who support harsh responses.

There will always be tension between those responsible for bilateral or regional relations and those who must deal with policy problems in a wider context. It appears that at least some officials in the Bush Administration recognize the importance of giving greater weight to the long-term implications of chemical and biological weapons proliferation, but it is too early to tell if any real reforms will result.

A starting point in these efforts should be a convention banning production and possession of chemical agents, now being negotiated at the Committee on Disarmament in Geneva. Elimination of chemical weapons stocks in the United States would enhance the effectiveness of U.S. efforts to convince other countries to do the same. This would provide considerable legitimacy to U.S. diplomacy, and a convincing indication of how seriously the United States takes the spread of these weapons. In addition, making such negotiations a high priority would lend additional clout to those who take a global view of the consequences of chemical proliferation.

Unfortunately, a convention will not necessarily eliminate the problem. Unless signatories are convinced of the serious costs of breaking the agreement, violations easily may occur. Just as Iraq ignored its obligation to abide by the Geneva Protocol, and suffered few consequences, a future treaty also could be flouted. In addition, it is possible that many countries in the Third World may not ratify the convention. Hence, a treaty alone is not sufficient. Other steps will be necessary to ensure compliance with a treaty, and to respond to countries that refuse to accept it.

Accordingly, it is necessary to adopt policies that mandate

strong U.S. reactions to the use of chemical or biological agents. Sanctions are critical to this process. The United States needs to declare in advance that it will take steps to impose economic and political costs when violations of the Geneva Protocol take place. In this manner, the United States would be putting on notice anyone tempted to make use of chemical and biological weapons.

Congressional efforts are critical. Formulating harsh responses to the use of chemical and biological agents will take place only if the Congress takes the initiative. Congress can force the articulation of a national policy of this type. Equally important, it can take steps that will change the balance of political influence in the the policy-making community. By giving more leverage to those concerned with the proliferation and employment of chemical and biological weapons, it may be possible to reduce the power of those disinclined to react at all.

Unfortunately, available evidence suggests that little will be done unless Congress acts. Although the Bush Administration has indicated that it considers the proliferation of chemical weapons a major priority, it has done little to address the problem. Rhetoric is not enough. What is needed are clear policies that give practical meaning to the tough words. Until such steps are taken, it is all too likely that the United States will again be faced with policy failure and the use of chemical weapons.

APPENDIX

IRAQ'S PHOSPHORUS-BASED CHEMICAL INDUSTRY

Akashat – A large phosphate mine located near the Syrian border in western Iraq. Initial investigation of the site may have started in 1972, but full-scale development did not start until the late 1970s. Production of phosphates started at this mine in 1981. It is capable of producing up to 1.7 million tons of phosphate a year.[1] The phosphate is present in sedimentary form and is strip mined. Located in the middle of the desert, the Iraqis had to create a considerable infrastructure to exploit the mine. They built a new road from Al Qaim to Akashat, and from Akashat to Ar Rutbah to the south. Two high-tension power lines connect the site to the national power grid, one from Al Qaim and the other from Ar Rutbah. A rail line, built between 1979 and 1981 by a Brazilian company, links Akashat to Al Qaim.[2] Water for the site is provided by a water pipeline

[1]Bureau of Mines, U.S. Department of the Interior, *Phosphate Availability: A Minerals Availability Appraisal,* Information Circular 9187 (Washington: Government Printing Office, 1988), p. 37.

[2]This was one segment of a new rail line that also extended from Al Qaim to Baghdad. Although the entire line was completed in 1983, the Al Qaim to Akashat segment was the only part open for service until

stretching 155 kilometers to the Euphrates River. There is no confirmation of reports that there are industrial facilities also located at Akashat.

Al Qaim – Industrial facilities at this town process the phosphate rock mined at Akashat. A phosphoric acid plant built by a Belgian company produces 1,260 tons of phosphoric acid per day. Current plans call for the Arab Company for Detergent Chemicals (Aradet) to build a plant capable of producing 50,000 tons a year of sodium tripolyphosphate (STPP). It should be ready in 1990.[3] The phosphoric acid is made by mixing phosphate rock with sulfuric acid made at the Al Mishraq sulfur works. A by-product of this process is hydrogen fluoride. The phosphoric acid is mixed with phosphate rock to make triple superphosphate. An expansion program is now in the early planning stages. The State Establishment for Phosphates plans to add a 2 million tons per year phosphate beneficiation plant, a 2.1 million tons per year sulphuric acid plant, a 640,000 ton per year phosphoric acid plant, fertilizer plants and plants to make ammonia and urea for use in fertilizers.[4] There is no confirmation of reports that Iraq has chemical agent production facilities at this location.

Baiji – An industrial complex north of Baghdad. Fertilizer complex No. 4, capable of making 1,750 tons a day of urea and 1,000 tons a day of ammonia, is about to enter production. A basic raw material for these plants is phosphoric acid. The capacity of the complex is to be doubled as a result of a

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early 1988. See *International Railway Journal*, April 1988, p. 11; *International Railway Journal*, September 1987, p. 30; *Railway Gazette International*, August 1987, p. 498; *Railway Gazette International*, February 1982, p. 122; *Railway Gazette International*, November 1978, p. 831.

[3]*Middle East Economic Digest*, April 11, 1987, p. 13; *Middle East Economic Digest*, May 27, 1988, p. 13; *Middle East Economic Digest*, June 10, 1988, p. 8.

[4]*Middle East Economic Digest*, April 28, 1989, p. 15.

cancellation of plans to build a fifth fertilizer plant at Mosul.[5] It is expected that the Iraq-Jordanian Company for Industry (IJCI) will build a factory able to produce 60,000 tons a year of detergent at or near this site.[6] A linear-alkyl benzene (LAB) plant to support the detergent industry started production in 1987. It was built by the Arab Company for Detergent Chemicals (Aradet).[7]

Basra – At least two of Iraq's three fertilizer plants, capable of producing 990,000 tons of fertilizer per year, reportedly were built near Basra before the start of the war with Iran. Two of them may have been destroyed during the fighting and the third has not been able to operate because it cannot obtain natural gas supplies.[8] Fertilizer complex no. 1, built at Al Khasib, reportedly has had to be abandoned. Fertilizer complex no. 3 at Khor al Zubair was extensively damaged during the fighting, but the Iraqis plan to repair it and to double its production capacity.[9]

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[5] *Middle East Economic Digest*, April 28, 1989, pp. 15-16; *Middle East Economic Digest*, 5 December 1987, p. 17; *Middle East Economic Digest*, September 17, 1987, p. 19.

[6] *Middle East Economic Digest*, May 27, 1988, p. 13.

[7] *Middle East Economic Digest*, February 27, 1988, p. 12; *Middle East Economic Digest*, March 28, 1988, p. 20; *Middle East Economic Digest*, June 10, 1988, p. 8. The plant produces 50,000 tons a year, of which 70 to 75 percent will be exported. It also produces toluene and paraffin, apparently for export.

[8] *Middle East Economic Digest*, September 19, 1987, p. 19.

[9] *Middle East Economic Digest*, April 28, 1989, p. 16.

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