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Italicized names on map represent nuclear-related sites either declared by Iraq or discovered by IAEA inspectors during implementation of Security Council Resolution 687 adopted at the end of the 1991 Gulf War. The facilities and equipment at these sites that escaped damage during the war were subsequently dismantled or destroyed by the IAEA or came under IAEA monitoring; sensitive nuclear materials have been removed. See chart.

1 **Al Tuwaittha Nuclear Research Center.** *Tammuz I (Osiraq), Tammuz II (Isis), and IRT-5000 research reactors (the first destroyed by Israel in 1981); subject to IAEA inspection prior to Gulf War.*

*Site of research and development (R&D) programs in uranium enrichment, including gas centrifuges, Electromagnetic Isotope Separation (EMIS), chemical separation, and gaseous diffusion.**

Location of “hot cells” used for separation of grams of plutonium. Experimental program for the production of lithium-6 which, if irradiated in a reactor, yields tritium for use in advanced nuclear weapons.*

*Weapons-related R&D activities in nuclear physics, uranium metallurgy, and triggering system capacitors.***

2 **Al Atheer.** *Prime development and testing site for nuclear weaponization program, including facilities and equipment for large-scale uranium metallurgy and production of weapons components; computer simulations of nuclear weapon detonations; and experiments for the development of an implosion-type explosive structure in nearby “bunker” at Al-Hateen. Possible testing of explosive structures at Al Hadre.***

3 **Al Qa Qaa High Explosives and Propellant Facility.** *Military and nuclear weapons R&D facility: development of exploding bridge wire detonators (EBW) used in the firing system of nuclear weapons; high-explosive experiments; storage of large quantities of HMX high explosive used in nuclear weapons.***

4 **Rashdiya.** *Central site of Iraq’s centrifuge research and development efforts.*

5 **Al Tarmiya.** *Industrial-scale complex for EMIS designed for the installation of 70 1,200-millimeter separators plus twenty 600-millimeter separators. Eight units were operational prior to Desert Storm bombings; if all separators had been installed, plant could have yielded 15 kg of HEU annually, possibly enough for one nuclear weapon. Replica facilities were under construction at Ash Sharqat.**

6 **Al Furat Project.** *Large-scale manufacturing and testing facility, designed for the production of centrifuges for uranium enrichment. Site of a planned 100-centrifuge experimental cascade, with an initial operational capability by mid-1993. A 1000-centrifuge cascade was to be built at Taji.**

7 **Al Jesira.** *Large-scale facility for the production of uranium dioxide (UO_2) and uranium tetrachloride (UCl_4), feed materials for EMIS. Intended site for the production of uranium hexafluoride (UF_6) to feed the centrifuge enrichment program.**

* Activities found by IAEA to be in violation of Iraq’s safeguards agreement with the IAEA.

** Activities found by the United States to be in violation of Iraq’s obligations under Article II of the Nuclear Non-Proliferation Treaty (NPT) prohibiting the “manufacture” of nuclear weapons.

IRAQ: Nuclear Infrastructure

NAME/LOCATION OF FACILITY	TYPE/STATUS	IAEA SAFEGUARDS ^a
NUCLEAR WEAPONS COMPLEX		
Al Atheer	Prime development and testing complex for nuclear weaponization program; large-scale uranium metallurgy that could produce reflectors, tampers, and other weapons components; location of two isostatic presses (hot and cold) suitable for making shaped charges, plus other remote-controlled machining equipment suitable for production of explosive structures. Operational until damaged by Coalition air attacks (1991); subsequently destroyed by IAEA inspectors.	NPT Violation
Al Tuwaitha	Nuclear physics and uranium metallurgy laboratories; research and development (R&D) in triggering system capacitors; possible site for experimental work on neutronic initiators. Operational until damaged by Coalition air attacks (1991); under IAEA monitoring.	NPT Violation
Al Qa Qaa	Military R&D facility; development and fabrication of exploding bridge wire detonators and high-explosive lenses (plane and spherical); site of shock-wave and high-explosive experiments; storage of large quantities of HMX high explosive; under IAEA monitoring.	NPT Violation
Al Musaiyib (Al Hateen Establishment)	High-explosive testing site; facility for hydrodynamic studies; facilities and equipment destroyed by the IAEA.	NPT Violation
Al Hadre	Open firing range for fuel-air bombs and fragmentation testing, suitable for experimentation with entire non-nuclear explosive structure of an implosion-type nuclear device; damaged by Coalition air attacks; under IAEA monitoring.	NPT Violation
RESEARCH REACTORS^b		
Osiraq/Tammuz I	Light-water, HEU, 40 MWt; destroyed by Israeli air attack (1981).	Yes
Isis/Tammuz II	Light-water, HEU, 800 KwT; operational until destroyed by Coalition air attack (1991).	Yes
IRT-5000	Light-water, HEU, 5 MWt; operational until destroyed by Coalition air attack (1991).	Yes
URANIUM ENRICHMENT		
Al Tuwaitha	Prototype-scale, electromagnetic isotope separation (EMIS) method; operational until damaged by Coalition air attack (1991).	IAEA Violation
Al Tuwaitha	Prototype-scale, gas centrifuge method; operations relocated to Rashdiya in 1987.	IAEA Violation
Rashdiya	Prototype-scale, gas centrifuge method; operations terminated at the outbreak of the 1991 Gulf War; under IAEA monitoring. ^{c,d}	IAEA Violation
Al Tuwaitha	Laboratory-scale, chemical exchange isotope separation method; operational until damaged by Coalition air attack (1991).	IAEA Violation
Al Tarmiya	Industrial-scale, EMIS method ^e ; partially operational until damaged by Coalition air attack (1991); EMIS-related installations and equipment subsequently destroyed by IAEA. ^f	IAEA Violation
Ash Sharqat	Industrial-scale, EMIS method; under construction until damaged by Coalition air attack (1991); EMIS-related installations and equipment subsequently destroyed by IAEA.	IAEA Violation?

IRAQ (cont'd.)

NAME/LOCATION OF FACILITY	TYPE/STATUS	IAEA SAFEGUARDS ^a
Al Furat	Large manufacturing and testing facility for centrifuge production ^g ; under construction until it came under IAEA monitoring.	IAEA Violation?
REPROCESSING (PLUTONIUM EXTRACTION)		
Al Tuwaitha	Laboratory-scale; three hot cells used for separating plutonium from irradiated uranium; operations terminated as a result of Gulf War (1991); equipment largely escaped damage; destroyed or rendered inoperable subsequently by IAEA inspectors.	IAEA Violation ^h
URANIUM PROCESSING		
Akashat	Uranium mine; operational until damaged by Coalition air attack (1991).	N/A (Not Applicable)
Al Qaim	Phosphate plant that produced uranium concentrate (U ₃ O ₈); operational until damaged by Coalition air attack (1991); recovered material under IAEA monitoring.	N/A
Al Tuwaitha	Laboratory-scale uranium purification facility (UO ₂); operational until heavily damaged by Coalition air attack (1991); recovered equipment under IAEA monitoring.	IAEA Violation
Al Tuwaitha	Laboratory-scale, uranium tetrachloride facility (UCL ₄); operational until heavily damaged by Coalition air attack (1991); recovered equipment under IAEA monitoring.	IAEA Violation
Al Tuwaitha	Laboratory-scale production of uranium hexafluoride (UF ₆); operational until damaged by Coalition air attack (1991).	IAEA Violation
Al Tuwaitha	Fuel fabrication laboratory; operational until destroyed by Coalition air attack (1991); recovered nuclear material under IAEA monitoring.	IAEA Violation
Mosul (Al Jesira)	Industrial-scale, uranium tetrachloride facility (UCL ₄); operational until damaged by Coalition air attack (1991).	IAEA Violation
Mosul (Al Jesira)	Production-scale uranium purification facility (UO ₂); operational until heavily damaged by Coalition air attack (1991); production area sustained greatest damage by subsequent Iraqi deception activities.	IAEA Violation

Abbreviations:

HEU	= highly enriched uranium
LEU	= low-enriched uranium
nat. U	= natural uranium
MWe	= millions of watts of electrical output
MWt	= millions of watts of thermal output
KWt	= thousands of watts of thermal output
?	= uncertain

NOTES (Iraq Chart)

^aFor the purposes of this chart, the designations "Yes" and "N/A" (not applicable) are used to describe the safeguards in place prior to the 1991 Gulf War at facilities processing or using nuclear materials that were declared by Iraq to the IAEA under Iraq's safeguards agreement with the IAEA (INFCIRC/172). "IAEA Violation" denotes clandestine facilities involved in processing or using nuclear *materials* that were discovered in the course of the post-war IAEA inspections and found by the IAEA to be violations of the IAEA-Iraq safe-

guards agreement. "NPT Violation" denotes clandestine facilities that were discovered in the course of the post-war IAEA inspections and were involved in nuclear weapons-related *activities* inconsistent with Iraq's NPT pledge not to manufacture nuclear arms.

^bIn late 1992–early 1993, rumors surfaced about the possible existence of an underground, plutonium-bearing, heavy-water reactor. During the tenth and eighteenth IAEA inspections, a number of sites were visited but no such facility was found. In early 1996,

Iraqi officials admitted that feasibility studies had been carried out in 1984-1988 to replace the capability that would have been provided by the Osiraq research reactor. However, the project was allowed to lapse in mid-1988 because of the "lack of available resources resulting from the higher priority needs of the EMIS enrichment and weapon development programs." See First Consolidated Report of the Director General of the International Atomic Energy Agency Under Paragraph 16 of Resolution 1051 (1996), p. 4. Also see "Report on the Tenth IAEA On-Site Inspection in Iraq Under Security Council Resolution 687 (1991)," S/23644, February 26, 1992, p. 17; "Report on the Eighteenth IAEA On-Site Inspection in Iraq Under Security Council Resolution 687 (1991)," S/25666, April 26, 1993, p. 20; Gary Milholin, "The New Arms Race: The Iraqi Bomb," *New Yorker*, February 1, 1993, p. 47; Diana Edensword and Gary Milholin, "Iraq's Bomb—an Update," *New York Times*, April 26, 1993; Maurizio Zifferero, "The IAEA: Neutralizing Iraq's Nuclear Weapons Potential," *Arms Control Today*, April 1993, p. 7.

^cA cascade hall was being constructed to accommodate supercritical centrifuges. It might have ended up housing the 100-machine cascade envisioned for the Al Furat plant, if the latter had continued to experience construction delays (see endnote g). It was also the planned site for the 50-machine cascade that would have been used to re-enrich HEU in the "Crash Program."

^dAll known centrifuge components and manufacturing equipment have been destroyed or rendered inoperable by IAEA inspection teams.

^eComponent manufacturing facilities for the Iraqi EMIS program were located at: Al Ameen (prototype components); Al Radwan and Al Amir (magnet cores, return irons, ion sources, collector parts); Sehee at Daura (vacuum chamber parts); Salladine (electrical control

panel assembly); and Tuwaitha (coil manufacturing). In January 1993, a U.S. cruise missile attack destroyed Al Rabee, an EMIS-related industrial complex near Zaafarniyah (about 20 km from Baghdad) in retaliation to Iraqi violations of Security Council resolutions establishing no-fly zones in Iraq. Al Rabee and Al Dijla, another site at Zaafarniyah that was not hit in the attack, were manufacturing plants whose activities were useful in producing EMIS components. Their capabilities included coil winding, chassis assembly, computer-aided design, printed circuit-board fabrication, and control system design and assembly. Reportedly the two plants had manufactured some EMIS equipment installed at the Al Tarmiya facility. See Mark Hibbs, "IAEA in 'Difficult Position' After U.S. Attack on Iraq Site," *Nucleonics Week*, January 21, 1993.

^fAll equipment at the Al Tuwaitha and Al Tarmiya sites that might have revealed the existence of the EMIS program was removed and transported by the Iraqi Army to six locations where Iraqi personnel attempted to destroy the tell-tale signs of the EMIS effort. After IAEA inspection teams obtained access to those locations, the inspectors concentrated their efforts on identifying key EMIS components that were still recognizable to verify Iraqi statements regarding their program. This equipment was then destroyed under the supervision of the IAEA inspectors.

^gThese facilities, which escaped damage during the Gulf War, were far from completion when work stopped in August 1990.

^hOne of the fuel elements processed was from the IRT-5000 reactor and was exempt from safeguards under Article 37 of INFC-IRC/172, Iraq's safeguards agreement with the IAEA. The other three were fabricated indigenously from undeclared nuclear material, in violation of the safeguards agreement. A total of 6 grams of plutonium was recovered.