

IAEA nuclear inspections in Iraq

A report on the unprecedented series of on-site nuclear inspections under terms of UN Security Council resolutions

by Leslie Thorne

When the United Nations Security Council in April 1991 called upon the IAEA to carry out nuclear inspections in Iraq, it presented a challenge to the IAEA's ability to respond to an entirely new and demanding situation. Not only did trained teams have to be provided from un-budgeted resources but the first inspection had to be carried out almost immediately.

The sequence of events started when the Security Council adopted Resolution 687 on 3 April 1991. (*See box and map.*) Among other measures, the resolution called upon Iraq to make a declaration of all nuclear weapons-usable material, components, and related manufacturing facilities. It further called upon the IAEA Director General to carry out immediate on-site inspection of Iraq's nuclear capabilities based upon this declaration and to develop a plan within 45 days for the destruction, removal, or rendering harmless of these capabilities.

The resolution also established a United Nations Special Commission (UNSCOM) and authorized it to carry out similar work in the fields of biological and chemical warfare and long-range missiles. It was instructed to assist and co-operate with the IAEA in the nuclear field.

In response to the resolution, IAEA Director General Hans Blix set up an Action Team on 15 April 1991 headed by Prof. Maurizio Zifferero, at that time the IAEA's Deputy Director General for Research and Isotopes. The rest of the team was made up of three senior professionals and two clerical staff. Their task was to plan and lead the first, and all subsequent, nuclear inspections.

As with all new teams faced with an empty office and an urgent task, the immediate problem was to decide where to begin. A central question was how to utilize the extensive range of technical and administrative resources of the IAEA and its Member States, including the Agency's analytical laboratories.

Mr Thorne is a former member of the IAEA's Action Team established to implement United Nations Security Resolution 687, and a former senior staff member of the IAEA's Department of Safeguards.

The known and the unknown

The known information about Iraq was limited to that acquired from the IAEA's twice yearly inspections of the facilities at the Tuwaitha Nuclear Research Centre. The Centre was declared under the safeguards agreement concluded between Iraq and the IAEA in connection with the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), to which Iraq has been party since 1969. These facilities were primarily the IRT-5000 research reactor, the Tamuz-2 research reactor, a small fuel fabrication laboratory, and a storage facility.

The site was large and these areas, occupying not much more than a quarter of the site, clearly represented only a part of the total activity. There had been speculation for some years in the press as to the nature of possible clandestine activities but no hard information was available. What little additional information was available lay with national sources, and sanitized versions were now filtered to the Action Team.

One of the team's first objectives, based on these sources, was to trace a suspected uranium enrichment programme which would be using the centrifuge system. A primary objective was to locate and take control of highly enriched uranium fuel, both fresh and irradiated, for the Tamuz-2 and IRT-5000 reactors, and the rest of the safeguarded nuclear material. These had been under IAEA safeguards before the military campaign but it was feared that they might have been removed and hidden since then.

A 35-member inspection team was quickly assembled, in part drawn from experienced staff of the IAEA's Department of Safeguards but with other experts supplied by governments in such highly specialized areas as enrichment and weapons technology. Since safety would be a major problem, experts in explosive ordnance detection and structural safety joined the team, as did experts from the IAEA's own radiation protection staff. Some armed guards were provided from New York, since nothing was known



at this stage about the possibility of civil disorder in Iraq.

The first on-site mission

The first team, headed by Chief Inspector Demetrius Perricos, a member of the IAEA's Department of Safeguards and Deputy Leader of the Action Team, assembled and received its briefing in Vienna on Monday, 13 May 1991, and departed for Baghdad by chartered plane in the early hours of the following morning. Morale was high since each team member clearly felt the challenge of a new experience. At the same time there was some apprehension about the sort of situation and reception that would await them in Iraq.

Briefings before departure, together with aerial photographs, had prepared everyone to expect a devastated site. Yet no briefing or previous experience could prepare anyone for the scale of destruction at Tuwaitha or the degree of precision of the bombing. Every important building had received a dead-centre hit, putting each one out of action immediately. This had been followed by more scattered action to complete the destruction.

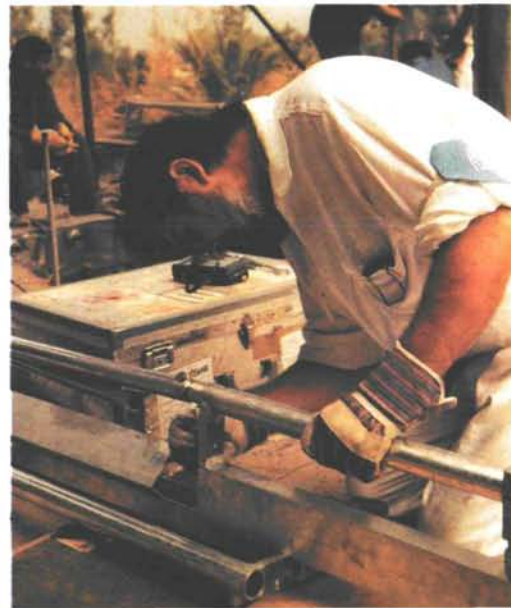
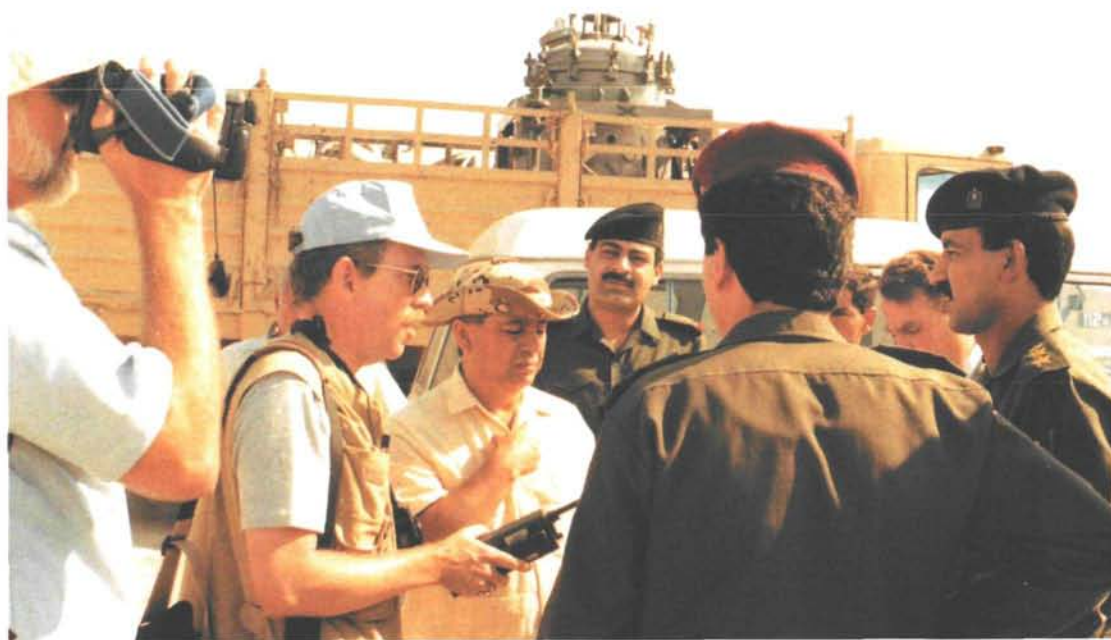
Straight away, the team was faced with problems — on the one hand, from the dangers of unexploded ordnance and unsafe residual structures, and on the other hand, from trying to find the trail of a clandestine programme when no building or equipment remained.

The team split into two groups each with an IAEA co-ordinator. One group concentrated on locating and measuring the nuclear fuel. The other took on the task of examining every part of the site to establish the use to which it had been put and to ascertain what future action was necessary to render the site harmless in terms of the Security Council resolution.

The measuring group was quickly able to establish the location of most of the safeguarded material and to begin verification by non-destructive analysis. Iraqi professional and technical staff at Tuwaitha provided assistance for the measurements. It was surprising to find that the irradiated highly-enriched material had been moved from Tuwaitha at the height of the bombing and buried in pits in a farmland. The location of the pits was readily revealed to the inspectors, who also received help in verifying the material.

The initial omens looked good.

IAEA inspectors at the damaged IRT-5000 research reactor at Al Tuwaitha. (Credit: Mouchkin, IAEA)



Scenes from IAEA inspections in Iraq

This page (clockwise from top): In June 1991 Chief Inspector David Kay of the 2nd IAEA inspection team talks with Iraqi military authorities after the team is denied access to sites. An IAEA radiation expert at the IRT-5000 research reactor at Tuwaitaha. An aerial view of the Ash Sharqat complex that was planned for uranium enrichment. Under supervision of the IAEA team, Iraqi workers pour concrete into glove boxes so they can no longer be used for proscribed activities at Tuwaitaha.



This page (clockwise from top): Huge magnet poles required for the Iraqi calutron enrichment programme were found and checked by members of the IAEA inspection team. These and other components of the calutron programme later were destroyed or otherwise rendered harmless under the supervision of inspectors. A close-up view of a fresh fuel element stored in a bunker at the Tuwaiha Nuclear Research Centre. Chief Inspector Leslie Thorne of the 5th IAEA inspection team at the pool of the damaged IRT-5000 research reactor at Tuwaiha. (Credits: Mouchkin, Pavlicek, & IAEA UN Action Team)

The group examining the site did not have any such surprises. But neither could it find any positive evidence of the nature of the activities in the suspected areas. The wrecked buildings had been stripped of equipment. More ominously, in one area the indications to a careful eye were that some buildings had been further wrecked after the bombing, and debris from elsewhere had been scattered around to cover traces of former activity. There were signs of burned records inside and outside the buildings.

A visit was paid to another suspected site, Tarmiya, but a similar pattern was found. One very important observation made here, however, was the huge electrical load the site had required and the large number of identical electrical distribution cabinets. These did not fit with Iraq's declared use of the site, namely the fabrication of transformers.

By the end of its mission, the first team had been highly successful in establishing a path for future on-site inspections. The mission showed that the IAEA's logistic and administrative procedures could respond quickly to such a novel situation and that the leadership and morale of the team could cope with the difficult situation of a country emerging from war. The nuclear material had been located, but the questions relating to a clandestine programme had not been answered. On the contrary, a large number of new questions were generated regarding the use of some sites.

In terms of conducting such inspections, the first mission was bound to provide valuable experience, and it did. To benefit from the lessons learned, UNSCOM had sent as team members one senior political officer and one of its Special Commissioners. For their part, the UN staff appeared to have been impressed by the organization and discipline of the IAEA inspectors, all of whom previously had worked together in an established organization. The UN inspection teams for missiles and chemical warfare did not have this advantage and took correspondingly longer to train and organize before they could carry out their first missions. In many areas, the first IAEA mission created precedents that were subsequently followed by all the other teams implementing Security Council Resolution 687.

The role of intelligence information

Between the first and second missions, a dramatic increase in available intelligence information took place.

Reconnaissance photographs showed that immediately after the first inspection team departed, the Iraqis had uncovered and removed

buried disc-shaped objects from a location outside the Tuwaitha site. At the same time, information surfaced about an enrichment programme that had been under way using an electromagnetic isotope separation (EMIS) method, which employs machines called calutrons.

In studying the information, experts who had been involved in the calutron programme of the USA's Manhattan Project evaluated photographs of buildings at Tarmiya taken during the first mission.

A far clearer picture of Iraqi efforts thus started to emerge.

The second inspection took on the character of a chase to locate the discs, which turned out to be magnets for the EMIS process. The team visited a military camp where the equipment was known to have been taken but inspectors were denied access. Three days later, after protests at the highest level, access was allowed. But by then no trace of the equipment could be found.

The equipment was relocated three days later. This time, no warning of where the inspection was to take place was given to the Iraqi authorities and the team appeared without notice at the gates of a large military camp. The usual altercation took place at the gates as admission was refused.

While this was going on, two members of the team climbed to the top of a nearby water tower and spotted a convoy moving off in the distance through a rear exit. Two other team members drove off at high speed to intercept. This was not so simple since the convoy was several miles away and the only way to bypass the camp was by a tortuous route through local village markets and cutting onto a motorway. The chase was rewarded with the sight of nearly a hundred heavy vehicles loaded with the equipment. Surprise had been so great that in many cases equipment was exposed, not fully covered, vehicle loading ramps were not secured, and several vehicles had stalled in the rush to clear the camp. Set after set of detailed photographs were taken.

The evidence was obtained.

Documenting enrichment activities

The third mission, from 7–18 July 1991, took place only a few days after the second one ended. In between, a high-level delegation, including IAEA Director General Hans Blix, under authority of the UN Secretary General visited Baghdad to try to persuade the government to make a full declaration of its enrichment programme, and to cease the obstruction tactics. It received no immediate positive response and the

third team started its work under the same disadvantages as before.

The evidence of the programme was now overwhelming, however, and the international pressure to strengthen sanctions against Iraq was growing. A deadline was set by the UN Security Council, and on the mission's second day, 7 July 1991, Iraqi authorities presented the team leader with a list of equipment and its location. The declaration covered uranium enrichment by the EMIS method, centrifuge and chemical enrichment, and reprocessing activities for plutonium separation. A list of facilities involved in manufacturing and other activities related to the enrichment programme also was provided. The rest of the inspection team's time was taken up with verifying the Iraqi declaration.

Most of the equipment had been buried in a number of sites dispersed throughout the desert areas. In some cases, attempts had been made to blow it up but the thickness of the metal for the EMIS magnets proved too much, even for modern explosives. Checking this equipment in the remote desert at the height of the Iraqi summer was an arduous task.

The Iraqi declaration revealed the existence of nearly 400 tonnes of natural uranium in various chemical forms which had never been reported to the IAEA before. Some of this had been imported from Brazil, Niger, and Portugal, and some had been produced from indigenous ores as a byproduct in phosphate fertilizer production. Some had been converted into metal and some into compounds such as uranium tetrachloride, which is used as the source material in the electromagnetic process. The sites where this was done ranged from areas near Mosul in the north to Al Qaim in the west near the Syrian border. All were visited. In addition, a remote mountain plateau site was uncovered which was to be a duplicate of the now positively identified Tarmiya enrichment plant.

Some descriptions of the Iraqi programme have referred to the electromagnetic separation method as an "obsolete process" since it was abandoned by the United States once the diffusion process was established. Such comments fail to take into account the developments in technology over the past 46 years. Computers and the development of huge particle accelerators with the associated beam and magnet techniques have the possibility to revolutionize the process, providing economy is not a prime objective. The lesson for those concerned with non-proliferation is to keep an open mind and not discount any possibility. The Iraqis showed their ability to innovate and improve.

Revelations about Iraq's EMIS programme did not prevent the inspection teams from inves-

tigating other enrichment methods. The fourth team followed up leads related to a centrifuge programme that took it to many sites. The team also attempted to build up a more complete picture of the production of the uranium that Iraq declared on 7 July.

Among their activities, inspectors visited the Al Furat Centrifuge Production Complex and the Al Atheer Materials Science Centre, which the Iraqis later acknowledged as being built to serve the nuclear weaponization programme.

By the time of the fifth team's visit in September 1991, the nuclear material and all recovered equipment from the enrichment programmes were being collected for verification and control at Tuwaitha. Inspectors spent most of their time on careful precise measurements. They also arranged for the transport and removal from Iraq of the six grams of plutonium that had been clandestinely produced and declared by the Iraqis in July.

Efforts to develop a nuclear weapon

Excitement was generated during the sixth inspection in September 1991, which sought to document the secret nuclear-weapon programme.

Acting on information received from intelligence sources, the team visited two buildings in the centre of Baghdad which had been secretly used for the weapons development project. A security lapse had left a considerable quantity of documents in the buildings. Most of these were seized by the inspectors, leading to a major confrontation with Iraqi authorities who refused to let the inspectors leave the building's parking lot unless the seized documents were left behind. The confrontation lasted three days and nights and was played out with television cameras relaying the event around the world.

The team's perseverance was rewarded with one document in particular, a progress report detailing the work in key areas of weapons development. This established that work had been going on to develop a polonium-beryllium initiator for an implosion type weapon. Theoretical calculations had been carried out on the hydrodynamics of a simple implosion system and work had started on detonation and firing systems. Organization charts and payrolls among the other documents showed the programme to be large, well-organized, and well-funded.

The seventh inspection team followed up on its predecessors' discoveries. It included a number of weapons experts who repeatedly inspected certain sites suspected to be involved in the nuclear weapons programme. As the inspection progressed, the team became more and more

IAEA nuclear inspections in Iraq: Year in review

APRIL 1991

- **3 April** — UN Security Council adopts resolution 687, which expressly authorizes the IAEA to inspect known or suspected nuclear sites in Iraq; to destroy, remove, or otherwise take exclusive control of all material and equipment usable for nuclear weapons; and to develop a comprehensive plan for future monitoring and verification of Iraq's nuclear programme. It requires Iraq to declare to the IAEA the locations, amounts, and types of all nuclear-weapons usable material and related systems, components, and equipment. It establishes a Special Commission authorized to carry out similar work in the fields of biological and chemical weapons and ballistic missiles, and to assist and co-operate with the IAEA in the nuclear field.
- **6 April** — Iraq formally accepts conditions of UN Security Council Resolution 687.
- **18 April** — Iraq submits its first declaration, denying it has nuclear-weapons usable material.
- **27 April** — Iraq submits its second declaration and first admits to having some nuclear material and facilities in addition to those known to the IAEA.

MAY 1991

- **14-22 May** — First IAEA on-site inspection under resolution 687. The team inspects declared Iraqi facilities and the Al Tarmiya site.

JUNE/JULY 1991

- **17 June** — UN Security Council adopts resolution 699, approving the IAEA's plan for the destruction, removal, or rendering harmless of items specified in paragraph 12 of resolution 687.
- **22 June-3 July** — Second IAEA on-site inspection in Iraq. Access to various sites is denied.
- **4 July** — A high-level UN mission reports that Iraq's response to the second IAEA inspection team's request for access to sites was less than what was called for by the Security Council.
- **7-18 July** — Third IAEA inspection in Iraq.
- **7 July** — Iraq submits its third declaration of its nuclear programme to the Security Council, maintaining that it had complied with the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and its IAEA safeguards agreement. It declares three methods of enrichment: centrifuge, chemical, and electromagnetic.
- **14 July** — Iraq clarifies its third declaration and provides a list of manufacturing facilities related to its nuclear programme.
- **25 July** — UN Security Council sets deadline for Iraq's declaration of all remaining nuclear sites.
- **28 July** — Iraq submits an additional list of nuclear material.

JULY/AUGUST 1991

- **27 July-10 August** — Fourth IAEA on-site inspection in Iraq. The mission encompasses the Al Furat site

intended for production of centrifuges, and the Al Jesira plant, intended for production of feed material.

- **15 August** — UN Security Council adopts resolution 707, which obliges Iraq to "halt all nuclear activities of any kind, except for use of isotopes for medical, agricultural, or individual purposes" until the Council decides that Iraq has complied with its obligations under terms of Security Council resolutions.

SEPTEMBER 1991

- **14-20 September** — Fifth IAEA on-site inspection of Iraqi facilities. Its main emphasis is on verification of nuclear material, removal of plutonium that had been produced, and investigation of the chemical enrichment process.
- **22-30 September** — Sixth IAEA on-site inspection of Iraqi facilities containing documentation on the Iraqi nuclear programme and nuclear weapons development.
- **24-28 September** — The sixth team is detained by Iraqi authorities in a Baghdad parking lot outside the headquarters of the nuclear-weapons development programme, known as Petrochemical 3. The team obtains documentation on key areas of Iraq's efforts to develop a nuclear weapon.

OCTOBER 1991

- **11 October** — The UN Security Council adopts resolution 715, approving the IAEA's plan for future ongoing monitoring of Iraq's compliance with resolutions 687 and 707.
- **11-21 October** — Seventh IAEA on-site inspection of Iraqi facilities. The destruction of equipment related to enrichment and reprocessing begins.
- **14 October** — Iraq acknowledges that research and studies had been under way in the area of nuclear weaponization.
- **21 October** — Iraq admits that the Al Atheer site was built to serve the weaponization programme, in addition to its use as a materials production site.

NOVEMBER 1991

- **11-18 November** — Eighth IAEA on-site inspection of Iraqi facilities. The team's main emphases are on activities for destroying equipment related to the centrifuge and chemical enrichment programmes; initiating systematic destruction of large double-pole magnets related to the electromagnetic enrichment method; and on conducting field activities related to Iraq's procurement of equipment. Together, the seventh and eighth IAEA inspections determined that Iraq had established a large, secure, well-funded, and highly successful procurement network in support of its uranium enrichment and planned weaponization efforts.
- **15 and 17 November** — Shipments from Iraq of fresh highly enriched uranium of Soviet origin from the IRT-5000 research reactor at Al Tuwaitha.

Uranium mining, production, processing sites

- Al Tuwaitha Nuclear Research Centre
- Al Jesira
- Al Mosul (processing)
- Al Qaim
- Tikrit (yellowcake storage)
- Akashat (phosphate & uranium processing)

Sites related to uranium enrichment

- Al Tuwaitha Nuclear Research Centre
- Al Tarmiya (EMIS)
- Ash Sharqat (planned)
- Al Jesira
- Al Radwan
- Al Amir
- Al Furat (centrifuge production)
- Daura (manufacturing)
- Badr (engineering complex)
- Salladine
- Nassar Works



Sites related to weaponization

- Al Tuwaitha Nuclear Research Centre
- Al Atheer
- Al Qa Qaa
- Hatteen (high explosives test site)
- Al Hadre (high explosives test site)

JANUARY 1992

● **12-15 January** — Ninth IAEA inspection of Iraqi facilities. The team verified information concerning Iraqi procurement of large quantities of raw materials and components required for the manufacture of centrifuges to produce enriched uranium.

FEBRUARY 1992

● **5-13 February** — Tenth IAEA on-site inspection of Iraqi facilities. The team visits a number of new sites designated by the Special Commission, including one alleged to be an underground plutonium production

reactor, but is unsuccessful in uncovering evidence that the sites were used for nuclear activities.

MARCH/APRIL 1992

● **25 March** — Following 4 days of technical discussions in Vienna with Iraqi authorities about the Al Atheer facility, the IAEA's UN Action Team decides to proceed with the destruction of buildings and equipment at the site connected with Iraq's nuclear-weapon development programme. Activities are planned to begin during the 11th IAEA inspection to Iraq in early April.



Prof. Maurizio Zifferero,
Leader of the IAEA's UN
Action Team for nuclear
inspections in Iraq.

certain that they had indeed identified the sites where development and testing of the high-explosive components of a nuclear weapon were to be carried out. These sites were part of larger military explosives test sites which acted as a "cover". Iraq fully acknowledged that research and studies had been under way in the area of weaponization.

While this group pursued the weaponization aspect, other groups destroyed or rendered harmless the equipment which had been accumulating. Centrifuge rotors were crushed in a large press. Magnets were cut up using a special plasma cutting tool developed by the Iraqis themselves. This illustrates one of the paradoxes of the whole series of inspections. On the one hand, deception was encountered on a scale which was

Demetrius Perricos,
Deputy Leader,
Operations, of the
IAEA's Action Team
making notes during an
IAEA inspection of the
Al Tuwaitha Nuclear
Research Centre near
Baghdad. (Credit:
Pavlicek, IAEA)



unimaginable. On the other hand, once the high-level decision had been taken to end that particular deception co-operation was complete. Some of the equipment, such as "hot cells" and glove boxes, could not be destroyed. These were rendered harmless by cutting all control cables and pouring in cement and epoxy resin.

Preparing for the next phases

The eighth mission in November 1991 completed the destruction work and oversaw the removal from the country of fresh highly enriched uranium for the IRT-5000 research reactor. Because the fuel could have been readily used in weapons production, it had always been a source of concern to anyone doubting Iraq's intentions. Its removal represented an important stage. Although mechanically simple, it had taken a major effort to find a contractor willing to accept the material.

Despite persistent efforts by Iraqi authorities to conceal information, inspectors also continued field activities related to Iraq's foreign procurement of equipment essential to its nuclear programme. Manufacturers of a number of specific items of equipment were identified.

At the beginning of 1992, arrangements to remove the irradiated fuel remaining in Iraq were at an advanced stage. The cost is high and involves a consortium of nuclear transport companies and processors from two countries. Regarding the enrichment process, all known components have been destroyed or removed and all immovable equipment has been rendered harmless.

As the IAEA's UN Action Team prepared for the 11th on-site inspection to Iraq scheduled for early April 1992, its attention was directed at the Al Atheer facility, which earlier had been identified as part of the Iraqi weaponization effort. At the request of the Iraqi authorities who sought to clarify the purposes of Al Atheer, four days of technical talks were held at the IAEA in late March 1992. The IAEA remained convinced, however, that the technical core of this facility was designed for special processes needed for nuclear-weapons development and manufacturing, including uranium metallurgy. Consequently, on 25 March 1992, the IAEA transmitted to the Iraqi Government its decision to proceed with the destruction of the relevant facilities and equipment at the Al Atheer site.

Simultaneously, the IAEA's Action Team is organizing the longer term continuous monitoring of nuclear-related activities in Iraq. This is being done under terms of a plan approved by the UN Security Council to ensure that a nuclear-weapons capability cannot re-emerge.