

Radioactive Waste Management and Nuclear Facility Decommissioning Progress in Iraq - 13216

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ABSTRACT

Management of Iraq's radioactive wastes and decommissioning of Iraq's former nuclear facilities are the responsibility of Iraq's Ministry of Science and Technology (MoST). The majority of Iraq's former nuclear facilities are in the Al-Tuwaitha Nuclear Research Center located a few kilometers from the edge of Baghdad. These facilities include bombed and partially destroyed research reactors, a fuel fabrication facility and radioisotope production facilities. Within these facilities are large numbers of silos, approximately 30 process or waste storage tanks and thousands of drums of uncharacterized radioactive waste. There are also former nuclear facilities/sites that are outside of Al-Tuwaitha and these include the former uranium processing and waste storage facility at Jesira, the dump site near Adaya, the former centrifuge facility at Rashdiya and the former enrichment plant at Tarmiya.

In 2005, Iraq lacked the infrastructure needed to decommission its nuclear facilities and manage its radioactive wastes. The lack of infrastructure included: (1) the lack of an organization responsible for decommissioning and radioactive waste management, (2) the lack of a storage facility for radioactive wastes, (3) the lack of professionals with experience in decommissioning and modern waste management practices, (4) the lack of laws and regulations governing decommissioning or radioactive waste management, (5) ongoing security concerns, and (6) limited availability of electricity and internet.

Since its creation eight years ago, the MoST has worked with the international community and developed an organizational structure, trained staff, and made great progress in managing radioactive wastes and decommissioning Iraq's former nuclear facilities. This progress has been made, despite the very difficult implementing conditions in Iraq.

Within MoST, the Radioactive Waste Treatment and Management Directorate (RWTMD) is responsible for waste management and the Iraqi Decommissioning Directorate (IDD) is responsible for decommissioning activities. The IDD and the RWTMD work together on decommissioning projects. The IDD has developed plans and has completed decommissioning of the GeoPilot Facility in Baghdad and the Active Metallurgical Testing Laboratory (LAMA) in Al-Tuwaitha.

¹ Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

Given this experience, the IDD has initiated work on more dangerous facilities. Plans are being developed to characterize, decontaminate and decommission the Tamuz II Research Reactor. The Tammuz Reactor was destroyed by an Israeli airstrike in 1981 and the Tammuz II Reactor was destroyed during the First Gulf War in 1991.

In addition to being responsible for managing the decommissioning wastes, the RWTMD is responsible for more than 950 disused sealed radioactive sources, contaminated debris from the first Gulf War and (approximately 900 tons) of naturally-occurring radioactive materials wastes from oil production in Iraq. The RWTMD has trained staff, rehabilitated the Building 39 Radioactive Waste Storage building, rehabilitated portions of the French-built Radioactive Waste Treatment Station, organized and secured thousands of drums of radioactive waste organized and secured the stores of disused sealed radioactive sources. Currently, the IDD and the RWTMD are finalizing plans for the decommissioning of the Tammuz II Research Reactor.

INTRODUCTION

The government of Iraq, through the Ministry of Science and Technology (MoST) is decommissioning Iraq's former nuclear facilities. The majority of these former nuclear facilities are in the Al-Tuwaitha Nuclear Research Center (Al-Tuwaitha), which is located on the Tigris and Euphrates floodplain, a few kilometers from the outskirts of Baghdad. Figure 1 is an aerial oblique photograph of approximately one-half of Al-Tuwaitha. Decommissioning of Al-Tuwaitha is being organized around 15 former nuclear facilities and three sites. These former facilities and sites include a fuel fabrication facility, radioisotope production facilities and partially destroyed research reactors. There was international press coverage of the 1981 airstrike that destroyed the Tammuz reactor and the 1991 airstrikes that destroyed the Tammuz II reactor.



Figure 1. Aerial oblique photograph of the Al-Tuwaitha Nuclear Research Center

There are also former nuclear sites outside of Al-Tuwaitha. These other sites include facilities at Al-Qaim (phosphate plant and uranium extraction facility), Al-Jesira (uranium processing plant, North of Baghdad (centrifuge facility), the Geopilot Plant in Baghdad (uranium extraction facility), Tarmiya (enrichment plant) and near Adaya (dump site).

Iraq's Former Nuclear Facilities and Radioactive Waste Challenges

The 15 former nuclear facilities and three sites at Al-Tuwaitha are:

- IRT 5000 Research Reactor
- Radiochemistry Laboratory
- Tammuz Research Reactor site & Tammuz II Research Reactor
- Radioactive Waste Treatment Station (RWTS)
- Russian Silos/Wells for Radioactive Wastes
- Building 39 RWTS Warehouse for Radioactive Wastes
- 73A/73B Fuel Fabrication Lab
- Russian Isotope Production Facility
- Italian Radioisotope Production Facility
- Building 36 French Radioactive Waste Storage Silo
- Technology Hall Uranium Tetrachloride Preparation
- Active Metallurgical Testing Laboratory (LAMA)
- U Metallurgy
- Po²¹⁰ Production Facility
- C/D Italian Fuel Element Thermal Test Facility
- Contaminated Site near Building 39
- Scrap Yard / Burial Sites
- OUT-1 Burial / Concealment Location, outside Berm

These former facilities/sites at Al-Tuwaitha contain large numbers of silos, thousands of drums and other types of uncharacterized radioactive waste. Most of the contaminated solid waste and destroyed nuclear buildings and facilities have been exposed to the environment for almost two decades and may pose a very real health hazard to humans, as well a threat to the environment. Figure 2 presents a photomontage of some of the radioactive waste management challenges faced by MoST.

In addition to the silos and drums, there are approximately 30 tanks that contain or did contain liquid radioactive waste at Al-Tuwaitha. None of the tanks have been used since 1991. There are no diagrams of the tanks and there is no inventory of the tank contents. Figure 3 shows a photograph of a tank vault at the Italian Isotope Production Facility. This vault had not been entered in over 20 years and was reopened in 2012.

Unique Decommissioning and Waste Management Challenges

Decommissioning old nuclear facilities and managing radioactive wastes are difficult undertakings. However, MoST faces some unique challenges, and in 2005, Iraq lacked the infrastructure needed to decommission its nuclear facilities and manage its radioactive wastes.



Figure 2. Photomontage of Radioactive Waste Management Challenges in Iraq



Figure 3. Recently Opened Radioactive Waste Tank Vault

The lack of infrastructure included: (1) the lack of an organization responsible for decommissioning and radioactive waste management, (2) the lack of a storage facility for

radioactive wastes, (3) the lack of professionals with experience in decommissioning and modern waste management practices, (4) the lack of laws and regulations governing decommissioning or radioactive waste management, (5) ongoing security concerns, and (6) limited availability of electricity and internet. Imagine managing a large decommissioning program with intermitted electricity and limited access to the internet. A more detailed summary of challenges faced by MoST in 2006 is provided in Cochran, et al., 2007, and Chesser, et al., 2009.

To address Iraq's former nuclear facilities and MoST's unique challenges, the Government of Iraq (GoI) sought international assistance.

PROGRESS IN DECOMMISSIONING AND RADIOACTIVE WASTE MANAGEMENT

International Assistance

At the request of the GoI, the International Atomic Energy Agency (IAEA) agreed in 2005 to organize an international cooperative program to assist Iraq with the characterization and cleanup of the nuclear facilities and sites in Iraq. In 2005, the GoI was represented by several Iraqi organizations including the Ministry of Environment's Radiation Protection Center, the Iraqi Radioactive Sources Regulatory Authority (IRSRA) and MoST, the owner of the facilities. . Through the IAEA, a number of other countries, including France and Italy are supporting cleanup activities in Iraq. The European Union, through their EuropeAid program and its Nuclear Safety Cooperation Instrument, is also supporting decommissioning and waste management activities in Iraq.

In 2006, the Iraq Nuclear Facility Dismantlement and Disposal Program (the NDs Program) was initiated by the U.S. Department of State (DoS) to assist the GoI in eliminating the threats from poorly controlled radioactive materials. The Iraq NDs Program is providing support to the IAEA, and also providing training, consultation and limited equipment to the GoI. Sandia National Laboratories (Sandia Labs) and Texas Tech University (TTU) are a part of the DoS's team implementing the Iraq NDs Program.

International assistance is being provided in a broad range of areas. Five examples of the support being provided to the GoI by the Iraq NDs Program are:

- Radiation Worker II Training
- Radioactive Waste Disposal Training
- Groundwater Monitoring Equipment and Training
- Development of a Radioanalytical Laboratory in Iraq and
- Development of a Law Governing Radioactive Materials.

Radiation Worker II Training - In the U.S. Department of Energy system, successful completion of Radiation Worker II (Rad Worker II) training allows: unescorted access to contamination areas; access to high contamination areas, and access to airborne radioactivity areas. Sandia Labs modified in-house Rad Worker II training materials to match international requirements, and the teaching materials were cleared, and exported to GoI representatives in early 2008. Later, two

weeks of Rad Worker II training was provided to GoI representatives in Amman, Jordan and Rad Worker II train-the-trainer training was provided to GoI instructors in April/May of 2010 in Baghdad.

Radioactive Waste Disposal Training – Iraqi scientists were hosted and toured two operating U.S. radioactive waste disposal facilities, with climatic and geohydrologic conditions similar to those in some parts of Iraq. The two facilities were the Nevada Test Site’s Area 5 RWMS and the EnergySolution’s disposal facility at Clive, Utah.

As a followup, Sandia Labs, the IAEA and the GoI jointly held a Training Workshop in Amman, Jordan on *Practical Concepts for Safe Disposal of Radioactive Waste in Arid Settings*. Approximately 12 Iraqis attended the Training Workshop and six individuals from Jordan participated in the Training Workshop.

Groundwater Monitoring - A four day training class was provided to Ministry of Environment representatives on *Monitoring Groundwater at Liquid Radioactive Waste Tanks*. The training was a combination of classroom instruction and field trips to observe operating equipment. Sandia Labs followed-up by providing groundwater sampling equipment to the GoI, along with U.S. DoS training on the use of the equipment. There are ongoing activities to support the monitoring of groundwater at Al-Tuwaitha.

Radioanalytical Laboratory – To provide needed in-country analytical capabilities, the U.S. (through TTU’s Center for Environmental Radiation Studies), is helping the MoST establish and accredit a Central Radioanalysis Laboratory at Al-Tuwaitha.

Law Governing Radioactive Materials – Another of the international initiatives has been to help the GoI develop a nuclear law. From 2006 until present, all parties in Iraq involved in the regulatory control of radioactive materials (including IRSRA, MoST and the RPC), together with the U.S. DoS and U.S. Nuclear Regulatory Commission and the IAEA, have worked extensively on a draft law for Iraq (including regulations for decommissioning, waste management and radiation protection). Although the draft nuclear law has yet to be promulgated, decommissioning activities to date have followed its legal framework, as if the draft nuclear law was promulgated.

These five areas are a sampling of the types of assistance provided by the Iraq NDs Program. The full suite of assistance, for 2006, 2007 and 2008, is described in Cochran and Danneels (2009) and Chesser, et al. (2009).

MoST has organized to Manage Decommission of Nuclear Sites and Manage Wastes

To decommission the former facilities, and manage the resulting wastes, MoST has organized into four directorates: the Radiation Protection, Health and Safety Directorate, the Radioanalysis Directorate, the Iraqi Decommissioning Directorate (IDD) and the Radioactive Waste Treatment and Management Directorate (RWTMD). The Iraqi Decommissioning Directorate (IDD) is responsible for decommissioning activities. The RWTMD is responsible for Iraq’s centralized management of radioactive waste, including safe and secure disposal.

Radioactive Waste Treatment and Management Directorate

The RWTMD is responsible for Iraq’s centralized management of radioactive waste, including safe and secure disposal. In addition to managing radioactive wastes from decommissioning activities, the RWTMD is also responsible for management and disposal of radioactive wastes from:

- Oil field activities
- Debris from the first Gulf War in 1991, and
- Sealed radioactive sources and other wastes from universities, agricultural and medical applications (there are > 950 disused sealed sources in government storage).

RWTMD Training and National Strategy

Training and building human capacity have been a high priority for the RWTMD because international sanctions against Iraq isolated their professionals from their peers for many years. The IAEA, DoS, Sandia Labs, TTU, the European Commission and others have successfully provided training and scientific visits to more than 63 personnel in the field of waste management.

As an example of the international training, three professionals from the RWTMD received two weeks of training in the characterization, conditioning and storage of radioactive wastes at Sandia Labs (see Figure 4). The RWTMD is also receiving training support from the EuropeAid Program and the IAEA’s National Technical Cooperation Project.



Figure 4. Radioactive Waste Management Training at Sandia Labs

The RWTMD, with assistance from the IAEA, drafted a national radioactive waste management strategy to outline the ways and methods used to implement the Draft Iraqi National Policy for Radioactive Waste Management. The radioactive waste management strategy (a) specified methodologies of implementations of the policy, (b) identify the competencies needed for achieving the goals and how they will be provided, (c) elaborates the ways in which the various types of radioactive wastes including naturally occurring radioactive materials (NORM) and disused sealed radioactive sources will be managed and (d) ensures public confidence. With assistance from the IAEA, this strategy was presented by Deputy Minister of MoST Dr. Al-Musawi at the Waste Management 2010 (WM'10) Conference. Unfortunately, the paper was not published in the *WM'10 Proceedings*, because an author's release signature was not received.

A radioactive waste classification scheme, based on IAEA safety standards is being established and a Waste Acceptance Criteria (WAC) has recently been developed by the RWTMD. This WAC is for the storage and conditioning program.

RWTMD Radioactive Waste Tanks

As previously noted, there are approximately 30 tanks at Al-Tuwaitha that contain or did contain liquid radioactive wastes. At the beginning of the project, there were no diagrams or inventory information. Using information from a number of sources, a detailed Tanks Database has been created. For each known tank, the Tanks Database has a number of entries such as: the tanks name, location, secondary confinement, accessibility, rated capacity, possible or known inventory, and other relevant facts. A tank "monitoring and maintenance" program will be implemented to insure that the tanks contents are safely managed until the tanks can be decommissioned.

The Tanks Database, monitoring and maintenance program and other information are available in Dennis, et al. (2011). The RWTMD is developing a mobile treatment unit to treat liquid radioactive wastes. Because groundwater at Al-Tuwaitha is occurs approximately 7 m below the land surface and rises to approximately 4 m below surface in boreholes, the Ministry of Environment will be installing new groundwater monitoring wells near some of the tanks deemed to be the greatest possible threat to groundwater resources.

To manage current and future radioactive wastes in Iraq, the RWTMD has organized itself, trained staff, rehabilitated existing facilities and initiated construction of new facilities, as described below.

RWTMD Large Scale Rehabilitation and Future Construction

There are thousands of containers of pre-1991 "legacy" containers of radioactive waste at Al Tuwaitha and ~ 950 uncharacterized, disused sealed radioactive sources in storage. The RWTMD has undertaken an aggressive program to rehabilitate existing facilities and to build new facilities where needed. For example, the Building 39 waste storage facility received a new outer skin, new lighting and all the waste packages were organized as shown in Figure 5. Because Building 39 is filled with legacy wastes, there is an urgent need for a new radioactive waste storage facility and the RWTMD will start building a new storage facility in 2013



Figure 5. Before /After Photographs of Build 39

To provide a large specialized facility to characterize, and condition legacy and future wastes, the former Radioactive Waste Treatment Station is being rehabilitation and should be available to received decommissioning wastes in 2013.

To provide a permanent solution for the large inventory of legacy solid wastes, tank wastes, and future decommissioning wastes, the RWTMD is also developing a low-level radioactive waste (LLRW) disposal facility. The MoST studied facility designs and found that an above ground concrete cell design meets their requirements and the Al Tuwaitha site was selected as the location for the facility. The EuropeAid Program will be funding the development of a conceptual design for the near surface concrete cell-based LLRW disposal facility at Al Tuwaitha. Assistance to the regulatory authority, for disposal facility review, may be provided by the U.S. Nuclear Regulatory Commission, the EuropeAid Program and the IAEA.

The RWTMD is also managing a large inventory of disused sealed radioactive sources (DSRS). Since its inception, the RWTMD has inventoried and organized the storage of ~ 950 DSRS. Figure 6 shows a before and after photographs of one corner of the DSRS storage bunker.



Figure 6. Before /After Photographs of one corner of DSRS Storage Bunker

Finally, the RWTMD and IRSRA developed a special system for safe transporting of DSRS.

Iraqi Decommissioning Directorate

The IDD is responsible for decommissioning the 15 facilities and 3 sites at Al-Tuwaitha, as well as decommissioning the former nuclear facilities at various locations in Iraq. The MoST is currently finalizing the *Overarching Decommissioning Plan for the Iraqi Decommissioning Program* (Overarching Decommissioning Plan), which is a strategic document that defines the decommissioning program. The Overarching Decommissioning Plan is being reviewed by the regulatory authorities of the Ministry of Environment's Radiation Protection Center, and the Overarching Decommissioning Plan will provide a foundation for the Site-Specific Decommissioning Plans.

As described in the Overarching Decommissioning Plan, the locations outside of Al-Tuwaitha will be cleaned up to background levels for free release and reuse. The area inside the berm at Al-Tuwaitha will be divided into two areas: (1) a restricted (industrial use) area which will contain a radioactive waste storage and disposal facility and (2) an unrestricted area that will be used by the Research Directorate of the MoST.

Based on initial estimates, decommissioning of Al-Tuwaitha will generate approximately 1000 tons of solid waste and approximately 125 m³ of liquid wastes. MoST estimates that the decommissioning activities will be completed in 2025.

Decommissioning Progress

In 2006- 2007, MoST, with assistance from the IAEA and the international community, developed a prioritization system for evaluating and prioritizing the decommissioning activities. Based on the prioritization efforts, it was determined that none of the sites posed an eminent threat, and the IDD decided to decommission relatively uncontaminated facilities first. Decommissioning relatively clean facilities allowed skills to be developed without the associated radiological hazards (although the unsafe structures hazards were significant). The Active Metallurgy Testing Laboratory (LAMA) facility at Al-Tuwaitha and the GeoPilot Facility in Baghdad were decommissioned first.

The LAMA is a nuclear facility supplied by the French as one of the 17 July projects. The LAMA laboratory was built on two floors and covered a ground surface area of 1150 m². The ground floor included very high activity laboratory consists of three concrete cells (the thickness of the walls was designed for activity up to 100,000 curies of 1 Mev gamma. LAMA was never used for its intended purpose, thus very little nuclear material was ever processed there. But for the very robust hot cells, the LAMA was destroyed in the 1991 Gulf War. Figures 6 and 7 show the LAMA facility during decommissioning.



Figure 6. LAMA after 1991 Gulf War and during Decommissioning



Figure 7. LAMA after 1991 Gulf War and during Decommissioning

During the later stages of the decommissioning of LAMA, the IDD initiated decommissioning activities at a number of other facilities, including the Italian Radioisotopes Production Laboratories (IRPL). The IRPL was designed for production of radioisotopes sources, labeled compounds and kits for medical and industrial uses. Operations at the IRPL began in 1981 and the facilities were destroyed in 1991. The three-story building and associated facilities covered about 2500 m². After the Gulf War, the only remaining structures were: two concrete hot cells, a metal chimney, four underground tanks (at -3.8 m below grade), underground pipes, and scrap and debris from the destroyed facility. Figure 3 shows one of the recently-opened tank vaults at the IRPL and Figure 8 shows the two hot cells prior to, and during, decommission. As of this writing (November, 2012) the IDD is in the process of removing the significant infrastructure that is below grade (pipes and tanks).



Figure 8. IRPL Hot Cells during Decommissioning

The IDD is now planning the decommissioning of a number of facilities, including the decommissioning of the Tammuz II research reactor. This French built pool-type research reactor went critical in 1980 with 500kW of thermal power. The reactor was destroyed in the 1991 Gulf War and has since been de-fuelled. The Tammuz II reactor building is physically dangerous (danger of collapsing) and there is contamination and medium activation of the structures and remaining equipment. Decommissioning of Tammuz II will be a test the skills of the IDD.

SUMMARY

The GoI faces very large challenges in decommissioning the former nuclear facilities at Al-Tuwaitha and at locations outside of Al-Tuwaitha. Over the past seven years, the GoI and MoST have made great strides. These strides include:

- (1) There are now staffed organizations that are responsible for decommissioning and radioactive waste management,

- (2) The Build 39 storage facility of legacy radioactive wastes has been organized and rehabilitated, the former Radioactive Waste Treatment Station is being rehabilitation and should be available to received decommissioning wastes in 2013, and a new facility for storage of radioactive wastes will be completed in 2013.
- (3) Professionals have been trained, and are being trained in decommissioning and modern waste management practices, and
- (4) A nuclear law has been drafted.

MoST has decommissioned lesser facilities (GeoPilot in Baghdad and LAML in Al-Tuwaita) and MoST is now preparing plans to decommission the Tammuz 2 research reactor. The broad suite of international assistance has greatly helped the GoI, but it is the people in the GoI that have made the great progress, despite difficult implementing conditions.

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