

## **A National Disposal Facility for Radioactive Waste for Iraq – 16610**

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### **ABSTRACT**

Radioactive waste resulted in the past in Iraq from a number of nuclear activities and facilities all of them seriously damaged or destroyed during the Gulf war. The task of decommissioning such facilities and managing the resulting waste is being supported by the International Atomic Energy Agency (IAEA), the European Union (EU), and the United States (US).

A national policy for radioactive waste management for Iraq has been drafted by the Ministry of Science and Technology (MoST); a draft strategy for radioactive waste management implementation is in preparation. In this framework, Iraq is considering locating a radioactive waste disposal facility at the Al-Tuwaitha site, near the capital city of Bagdad. In the framework of its Instrument for Nuclear Safety Cooperation the EU has recently started a cooperation project named "Feasibility Study, Basic Design, and Engineering Design of an Engineered Radioactive Waste Disposal Facility" for Iraq (Project IQ4.01/11). The project aims at producing the design of a repository for the radioactive waste resulting from the decommissioning activities and from the continuing use of radioisotopes in medicine and the oil and gas industry in the country.

The contract for this cooperation project was awarded by the European Commission in April 2015 to the consortium of two international engineering companies, Nukem Technologies Engineering Services GmbH and DBE TECHNOLOGY GmbH, both of Germany, and Javys a.s., the national waste management agency of Slovakia.

The planned Iraqi near-surface repository is constrained by the complex security conditions in the country. This has led to the decision of using whenever possible the Al-Tuwaitha site, where most of the waste is located, as the repository location. The project work will therefore focus on assessing whether and which part of the waste expected to result from the decommissioning and remediation activities is amenable for surface disposal in an appropriately engineered facility. In addition, careful review of the site characteristics shall provide enough elements to justify and validate the political decision of disposing of the waste in Al Tuwaitha. Thereafter, the project work will focus on the conceptual and later the engineering design of the repository. Finally, a Safety Analysis will provide the basis for regulatory decisions about the further steps for realization of the Iraqi final disposal facility.

### **INTRODUCTION**

In the past decades Iraq had a significant nuclear program conducted at ten nuclear sites all over the country. These were: Al-Tuwaitha, Adaya, Al Jesira, Al Q'aim, Al Tarmiya, Ash Sharqat, Rashidaya, Al Atheer, Al Furat and GeoPilot with a particular concentration at the at Al-Tuwaitha site, near Bagdad, where 18 nuclear facilities were located. As a result of the 1991 bombing during the Gulf war and subsequent

looting significant damage occurred at all the nuclear sites, and most notably at Al-Tuwaitha. The ensuing actions taken by the IAEA to implement United Nations Security Council decisions further reduced the use of nuclear installations in the country. In 2004 the IAEA launched the Iraq Decommissioning Project (IDP) to assist Iraq in planning for, and decommissioning of, the existing nuclear facilities, radioactive waste management, remediation of contaminated sites, as well as drafting the relevant legal and regulatory framework. The IDP has been supported by the US State Department and coordinated by the IAEA. Ten sites and two mines (Akashat and Abu Skhair) were evaluated. Special attention received the Al-Tuwaitha site, where the destroyed research reactors Osiraq I & Osiraq II (Tammuz I & II), the IRT-5000 radioisotope production facilities, as well as waste storage facilities were located. Also the Adaya sites were a focus of attention, where in 1991 radioactive waste, yellow cake, and contaminated equipment were disposed of near the surface. Now some of the equipment is visible on the surface, and part of it has been looted and used by the local population.

In recent years, international support has allowed making significant progress in the decommissioning of a number of nuclear facilities at the Al-Tuwaitha site, e.g. decommissioning of the LAMA facility and the Italian Radioisotope Production Laboratories. The Ministry of Science and Technology is the operator of the nuclear facilities in Iraq, while the Ministry of Environment (MoE) act as the regulatory authority, and is in charge of radiological surveys in the country. With that, both MoST and MoE are the relevant national authorities involved in the decommissioning and radioactive waste management activities.

The European Union (EU) supports international efforts to enhance nuclear safety and, in particular, the safety of the resulting radioactive waste through its Instrument for Nuclear Safety Cooperation (INSC). Several such projects have provided support to among others Ukraine, Armenia, Georgia, and Mexico. In spite of the difficult times the country is living through, the Iraqi government has endeavored to draft a national policy for radioactive waste management and, with support from the INSC, a strategy for implementation is being prepared. In this framework, Iraq is considering locating a radioactive waste disposal facility at the Al-Tuwaitha site, some 30 km south of Bagdad. The near-surface disposal facility is intended for disposal of short-lived low- and intermediate level waste (SL-LILW) from past activities as well as future radioactive waste expected to arise in the country, e.g., from decommissioning and remediation. The EU project IQ 4.01/11 this paper refers to will provide, among others, an engineering design for the Al-Tuwaitha repository at a detail level suitable for licensing and later construction.

## **CURRENT WASTE MANAGEMENT SITUATION**

At present MoST is the radioactive waste management operator in Iraq and also the license holder for the ten Iraqi nuclear sites, all of them, as mentioned, heavily damaged. The Iraq Decommissioning Program, aimed at decommissioning and remediating all nuclear facilities in the country, is carried out under full MoST responsibility. The current Iraqi Regulatory Body for decommissioning and radioactive waste management is the Radiation Protection Center (RPC), which reports to the Ministry of the Environment. In addition, the Iraqi Radioactive Sources Regulatory Authority (IRSRA) is responsible for both: orphan radioactive sources, which are a

serious safety and security concern, and for the safe management of new radioactive sources imported into Iraq for medical and industrial applications.

In the past few years significant progress in the implementation of the Decommissioning Program has been achieved. The activities were mostly concentrated on the Al-Tuwaitha site, which, founded in 1967, is the oldest and by far largest and most relevant nuclear site in the country. Al-Tuwaitha is located approximately 30 km south of Bagdad, as shown in the map included in Fig. 1.

A comprehensive decommissioning plan for the entire Al-Tuwaitha site was drafted by MoST with US support. A number of facilities have already been decommissioned, as the Italian LAMA Isotope Production Facility, or are currently being decommissioned, as the Tammuz-2 research reactor. The general approach is to decommission such facilities with lower level of contamination first to allow transferring expertise and best practices on remediation and waste management from foreign partners to Iraqi experts. A major difficulty for the decommissioning work is the lack of reliable data and information. Many of the nuclear facilities at the Al-Tuwaitha site were originally provided by France, Italy, and the then Soviet Union in the 1960s and 1970s. During the turmoil within Iraq since the 1991 Gulf war most of the records, plans, and documentation for these facilities have been lost or destroyed.



Fig. 1. Nuclear Sites in Iraq

All fuel and enriched uranium has been shipped out of the country. Many orphan sources were also recovered by MoST. In a comprehensive campaign in 2006, 260 missions covering all Iraqi governorates were performed and about 1,130 radioactive sources recovered. Another 1,680 radioactive sources were accounted for and information about them updated.

The facilities at the Al-Tuwaitha site, all of them severely damaged in the 1991 Gulf war, include:

- The Tammuz-2 research reactor, supplied by France and also known as Osiraq-2, is a pool type 500 kW reactor and the next large facility to be decommissioned. According to IAEA studies the decommissioning activities are expected to result in about 50 tons solid wastes and 35 m<sup>3</sup> of liquid waste. The Decommissioning Plan was finished and unsafe structures removed in 2013.
- The IRT-5000 research reactor, a pool type reactor of Russian design, which was destroyed in 1991. Decommissioning started in 2013. Due to the lack of necessary information and operational records and to the lack of experience in such work MoST now intends to subcontract decommissioning and is developing contract arrangements. According to the IAEA studies the decommissioning work is expected to render approximately 85 tons of solid waste and 55 m<sup>3</sup> of liquid waste.
- The Radiochemistry Laboratory, used for reprocessing of irradiated fuel to extract radionuclides and plutonium for research purposes. This complex includes two laboratories, hot-cells, glove boxes, ventilation trap filters, and storage tanks for liquid waste; it was destroyed in 1991. According to IAEA the storage tank contains about 5 m<sup>3</sup> of high level liquid waste. The total solid waste is estimated to be about 55 tons. Some areas inside the building are heavily contaminated.
- The LAMA (Active Metallurgy Testing Laboratory) facility was used for destructive and non-destructive testing of irradiated experimental fuel pins or materials. It was destroyed in 1991 and decommissioned in 2010. Some sources and hot spots were found during decommissioning. The final survey report was submitted to the RPC.
- The Italian Isotope Production Facility was built for production of isotopes for medical purposes. It consists of two hot-cells damaged in the 1991 war and is now at the final stage of decommissioning.
- The Fuel Fabrication and Uranium Purification Facilities were constructed to manufacture natural UO<sub>2</sub> nuclear fuel at laboratory scale. They were operated since 1981 and damaged in 1991. According to IAEA studies there are about 10 tons of solid waste contaminated with natural uranium, including pipes and metallic storage tanks. A pit nearby contains sludge with estimated 150 kg U as U oxides. Work for decommissioning was started in 2014.
- The Radioactive Waste Treatment Facility, designed to deal with low and intermediate level waste (LILW) from the French complex, was destroyed in 1991. The solid radioactive waste storage unit was refurbished. According to IAEA studies there are about 25 m<sup>3</sup> of liquid LILW containing alpha, beta, and gamma emitters and about 50 tons of solid waste stored at the site. A mobile treatment unit was built and tested by MoST and commissioned in 2014.
- Radioactive waste storage facilities: several facilities as the solid waste silo for waste from the French complex, a storage facility at the Radioactive Waste Treatment Facility with radioactive solid waste and sludge, and Russian waste silos with radioactive waste from upgrading of the IRT-5000 research reactor. Improvements were made to the security of Bunker B, used for radioactive sources storage. Construction of a new waste interim storage facility was completed in 2013.

Site investigations and characterization was carried out at the Al-Tuwaitha site with international assistance. Groundwater monitoring results to date have shown a potentially high groundwater level. This aspect will receive special attention in the disposal facility design.

Waste acceptance criteria (WAC) for radioactive waste storage at the Al-Tuwaitha site were developed by MoST and approved by RPC. In the course of the project the compatibility of these WAC for storage with those for waste disposal will be carefully reviewed.

According to the current estimates of MoST, the amounts of radioactive waste to be disposed of in Iraq (excluding waste from the Adaya site and military waste) are the following:

- More than 2,700 tons of solid radioactive waste
- Around 350 m<sup>3</sup> of liquid radioactive waste with different levels of activity;
- More than 1,000 tons of naturally occurring radioactive materials;
- More than 250 tons of metals contaminated with depleted uranium.

## **REGULATORY FRAMEWORK**

A new National Authority for the control of nuclear and radiation-involving activities, the Radiation Protection Center was created in 2011 in Iraq within the Ministry of Environment (MoE) by Prime Minister's order and Cabinet Resolution No. 169. A draft Law on National Nuclear and Radiological Regulatory Commission is in preparation with the intention to combine the RPC and the Iraqi Radioactive Waste Source Regulatory Authority, (IRSRA) into one entity.

The responsibilities of the RPC are currently defined by the Iraqi Law No. 99 "Radiation Protection from Ionizing Radiation" of 1980. A draft Nuclear Law, prepared with the support of the IAEA and US Nuclear Regulatory Commission, is being discussed. Further legal instruments currently in force in the country are the Law No. 80 of 1973, "Control of Ionization Radiation", the Law No. 37 of 2008 "Ministry of Environment", the Law No. 27 of 2009, "Protection and Improvement of Environment" and the Order No. 72 of 2004 "Safety and Security of Radioactive Sealed Sources".

The regulatory framework covers the following aspects:

- Radioactive Dose Limits
- Exemption Levels for Solid Waste
- Exemption Levels for Liquid Waste
- Clearance Limits

Pending approval of the draft national regulations on Safe Transport of Radioactive Materials, Decommissioning of Nuclear and Radioactive Facilities, Radioactive Waste Management, and Radioactive Waste Disposal, Iraq currently applies the IAEA Safety Standards and derived recommendations. A Licensing procedure and requirements for an application for repository construction and operation are still to be developed.

Whenever national regulatory requirements are not in place, the Project Team will propose appropriate standards in line with international best practices and will seek approval by MoST and the Regulatory Body RPC. The relevant international safety standards and recommendations of the IAEA and of the International Commission on Radiological Protections (ICRP) will be taken into account.

A parallel EU funded project will run to support the Regulatory Authority in the licensing of the waste disposal facility and is planning to start in the beginning of 2016.

### **REPOSITORY PROJECT OBJECTIVES AND EXPECTED RESULTS**

The overall objective of the EU Project IQ4.01/11 is to achieve the safe disposal of the SL-LILW arising from the decommissioning of Iraqi nuclear installations and for the continuing use of radioisotopes in the oil and gas industry and medicine. To this aim, the following specific objectives shall be achieved:

- A critical assessment of the envisaged siting of an engineered radioactive waste disposal facility within the premises of the Al-Tuwaitha site
- A comprehensive inventory of the radioactive waste to be disposed of at this site
- A basic (conceptual) design of the disposal facility, including its siting
- A Preliminary Safety Assessment Report
- A detailed engineering design of the disposal facility
- A Final Safety Assessment Report for facility licensing

The corresponding results to be delivered by the consortium include:

- A set of design criteria and applicable standards for the disposal facility
- A SL-LILW inventory for the disposal site, including existing waste and the waste expected to arise in the future from the decommissioning of shutdown nuclear facilities and medical and industrial applications in Iraq
- An evaluation of the characteristics of the proposed site, based on existing data and additional site characterization, in regard to its suitability to host a near-surface repository
- A conceptual design and supporting PSAR for the disposal facility
- A detailed engineering design and supporting FSAR for the disposal facility
- Further licensing documentation required by the Regulatory Body RPC

### **PROJECT STRUCTURE**

In compliance with the Terms of Reference of the project's international call for tenders, the project work has been structured around the following tasks:

- Task 1: Project preparation and management of the project implementation
- Task 2: Review and integration of the inventory of LILW
- Task 3: Definition of design criteria and standards
- Task 4: Site characterization
- Task 5: Development of the conceptual design
- Task 6: Development of Preliminary Safety Assessment
- Task 7: Development of the detailed design
- Task 8: Development of Final Safety Assessment
- Task 9: Development of additional licensing documentation
- Task 10: Final report and dissemination of results

An overview of the tasks and their interrelationship is included in the Work Breakdown Structure (WBS) shown on Fig. 2.

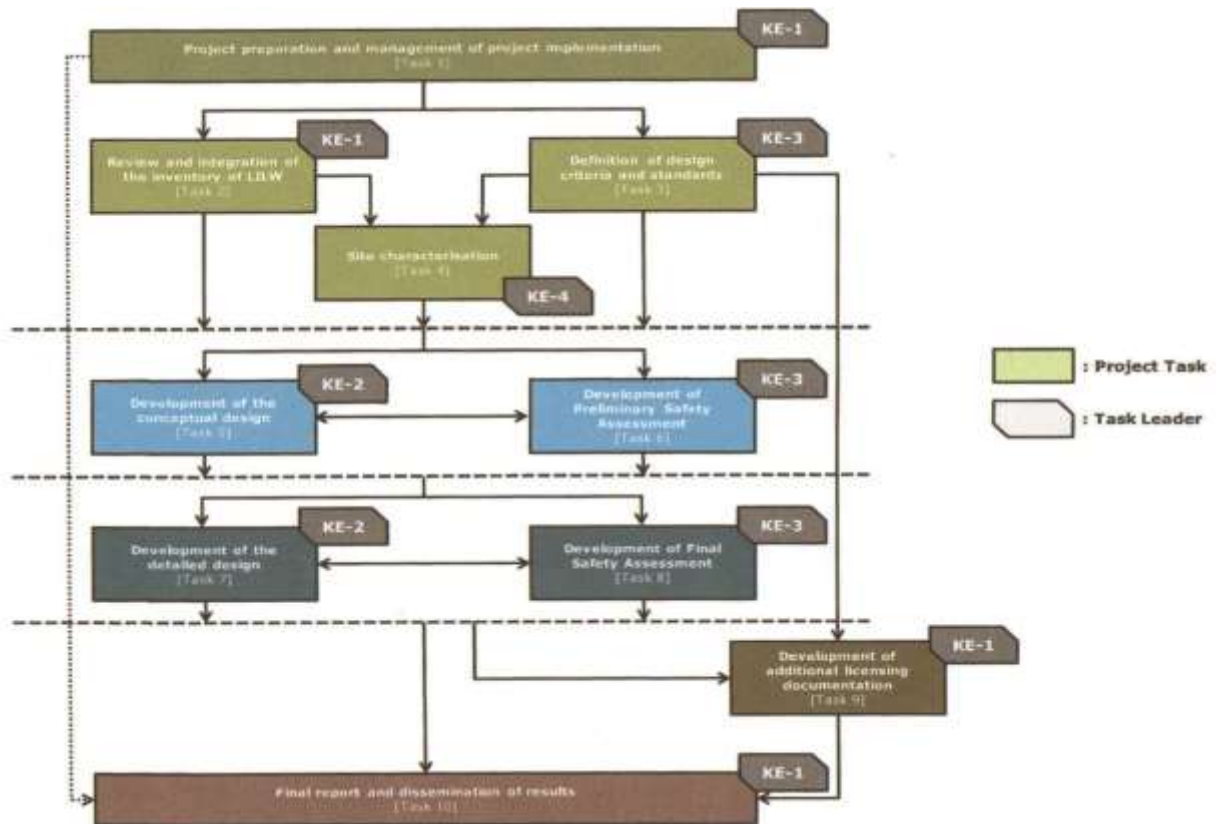


Fig. 2. Project Work Breakdown Structure

The project team is structured around four so-called Key Experts, one of them (the main author of this paper) being the Team Leader. The joint expertise of the key experts covers all fields of activity required for the project execution. The key experts are supported by several non-key-experts from all three members of the engineering consortium in charge of the project. Figure 3 outlines the structure of the project team and its interactions with the Iraqi partners MoST and RPC as well as with the European Commission (EC) and the EU Joint Research Center (JRC), the organizations steering and monitoring the project course on behalf of the EU.

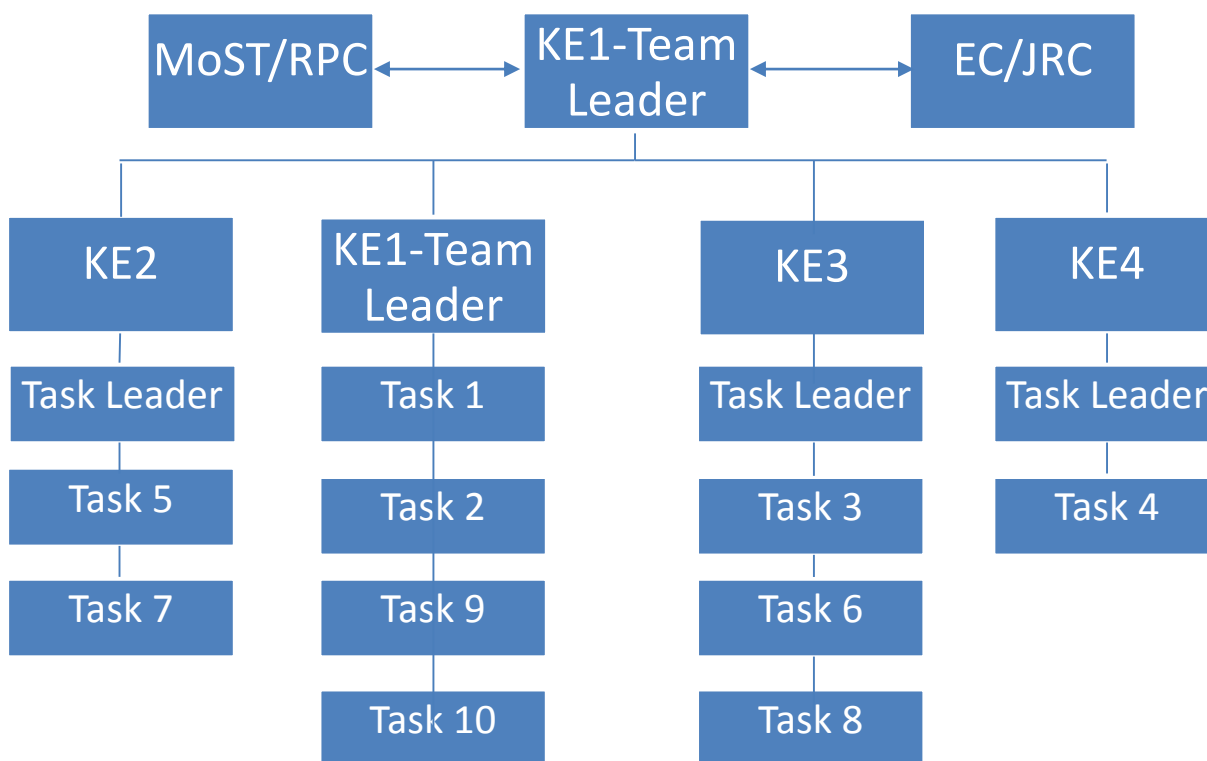


Fig. 3. Project Team Structure

### PROJECT DELIVERABLES AND SCHEDULE

After signature of the service contract INSC Contract No. 2013/330-638 between the Consortium and the European Commission effective as of April 27, 2015, the effective project work began in May, 2015. A project Kick-off Meeting with the participation of representatives of the Iraqi Ministry of Science and Technology and the Regulatory Authority RPC as well as of the European Commission and the JRC took place in Alzenau, Germany, end of June. Work on the project, which has an anticipated duration of three years until May 2018, is now progressing as planned.

The project expected results will be produced in a number of documents delivered, after endorsement by the Iraqi Ministry of Science and Technology to the EC and to the Iraqi partners. Whenever required, the contractor will also seek the approval by the regulator RPC. Table I below lists the project planned deliverables as agreed with MoST and the EU.



TABLE I. List and Schedule of Planned Project Deliverables

<b>No.</b>	<b>Title</b>	<b>Delivery Date</b>
1	Project Inception Report	July 2015+
2	Quality Plan and Annexes	July 2015
3	Task 2 Report: Review and Integration of the LILW Inventory	May 2016
4	Task 3 Report: Definition of Design Criteria and Standards	May 2016
5	Task 4 Report: Site Characterization	May 2016
6	Task 5 Report: Repository Conceptual Design	Nov 2016
7	Task 6 Report: Preliminary Safety Assessment Report	Nov 2016
8	Task 7 Report: Repository Detailed Design	Nov 2017
9	Task 8 Report: Final Safety Assessment Report	Nov 2017
10	Task 9 Report(s): Additional Licensing Documents	May 2018
11	Task 10: Final Report	May 2018
12	1 <sup>st</sup> Project Progress Report	Nov 2015
13	2 <sup>nd</sup> Project Progress Report	May 2016
14	3 <sup>rd</sup> Project Progress Report	Nov 2016
15	4 <sup>th</sup> Project Progress Report	May 2017
16	5 <sup>th</sup> Project Progress Report	Nov 2017

## CONCLUSIONS

At the onset of the project the activities were planned in detail and a Kick-off meeting was organized and held with the participation of representatives of the Iraqi MoST, the Regulatory Authority RPC, as well as of the European Commission and the JRC. Prior to the meeting a detailed work plan had been prepared and a dedicated Quality System issued. These documents were distributed to the EC, the End User, and the team members for comments and updated and issued upon endorsement and approval by all involved parties following the discussions held during the Kick-off meeting.

During the summer the inception report was prepared and submitted for commenting to all relevant partners. The final version was issued in Revision 1 after updating to incorporate comments on August 28, 2015. Work on the different tasks started immediately thereafter and is basically on schedule in spite of some delay due to unexpected external causes. The next milestones are anticipated for the course of 2016, as during this year the finishing of the Tasks 2 to 6 is planned. Correspondingly, until the end of 2016 the waste inventory will have been estimated and the suitability of the site assessed. With these results, as well as with the repository conceptual

design and preliminary safety assessment, the path forward will be appropriately delineated. At present all project partners: the European Union as the donor organization, the Iraqi colleagues, and the engineering consortium are confident that the project ambitious objectives can and will be achieved and that a substantial contribution to the nuclear safety and security of Iraq will be made.