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CHARACTERIZATION OF IRAQ'S REMOTE NUCLEAR FACILITIES FOR DECOMMISSIONING AND WASTE MANAGEMENT

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ABSTRACT

The Government of Iraq (GOI) has undertaken efforts to decommission and dismantle former nuclear facilities. The GOI has only preliminary information on some the former nuclear facilities. This paper will highlight the challenges involved in conducting inspections of the outlying former nuclear facilities in Iraq and present a brief summary of the results of those inspections. The facilities discussed in this paper are located at various sites throughout Iraq, from locations close to Baghdad to those in the north and far western desert areas. Some of the facilities, such as those at the Al Tuwaitha Nuclear Research Center have been visited and characterized. Other facilities, including the following, have not been visited or thoroughly characterized.

- Akashat Mine, Uranium ore production
- Al Qaim, Uranium enrichment facility
- Al Jesira, Uranium feed stock production facility
- Adaya, Burial location for contaminated equipment
- Al Tarmiya, Electromagnetic isotope separation site
- Rashdiya, Centrifuge development center
- Djerf al Naddah, Spent fuel storage facility

The visits were conducted to develop an inventory of the buildings/structures that need to be included in decommissioning/dismantlement efforts. The number of buildings, type of construction, size and general condition of the buildings were noted. In addition, attempts were made to determine contamination levels on surfaces, equipment, rubble, etc. This information will be used to support the Iraqi decommissioning and dismantlement project.

Because the facilities are scattered throughout the country of Iraq, significant pre-planning and coordination was required to ensure personnel security. Teams consisting of individuals from the Iraqi Ministry of Science and Technology (MoST) and Americans were under military escort when traveling to and visiting the sites. Because of the security issues, time on the ground at each site was limited.

This paper will highlight the challenges involved in conducting the inspections of the outlying former nuclear facilities In Iraq and present a brief summary of the results of those inspections.

INTRODUCTION

During the Saddam Hussein regime Iraq actively developed the infrastructure for a nuclear weapons program. Consequently, facilities dedicated to the mining, refining and enrichment of uranium were constructed at remote sites around Iraq. Many of the facilities were destroyed or severely damaged during Operation Desert Storm (Gulf War) in 1991. The Ministry of Science and Technology (MoST), through the Iraqi Decommissioning Program (IDP), is committed to cleaning up the remains of the nuclear facilities and advancing Iraq's peaceful use of radioactive materials. The Ministry of Environment (MoEN) Radiation Protection Center (RPC) is supporting the IDP as the regulator for clean up and remediation of these sites.

At the request of the Government of Iraq (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 its nuclear facilities and sites. In 2006 the Department of State (DOS) Bureau of International Security and Nonproliferation, Office of Nuclear Energy, Safety and Security (ISN/NESS) developed the Iraq Nuclear Facility Dismantlement and Disposal (Iraq ND) project. In October 2010, the DOS ISN/NESS set the objective for inspection of Iraq's remote facilities in order to assist the MoST by collecting information for use in their IDP.

In February and May of 2011 inspections were conducted of the following remote sites in Iraq.

- Al Tuwaitha Nuclear Research Center
- Rashidiya
- Djerf al Naddah (Location B)
- Al Jesira
- Adaya , and
- Al Qa'im

This paper will highlight the challenges involved in conducting inspections of the outlying former nuclear facilities in Iraq and present a brief summary of the results of those inspections.

AL TUWAITHA NUCLEAR RESEARCH CENTER

The Al Tuwaitha Nuclear Research Center (ATNRC), located 18 kilometers (km) south east (SE) of Baghdad, served as the primary research and development facility for Iraq's nuclear weapons program. Research at the site focused on developing and improving techniques for uranium enrichment, metallurgy for uranium pellet design, designs for weapon implosion mechanisms, radioisotope production for medical and oil exploration applications, and radioactive waste treatment and storage. Technologies developed at the ATNRC, especially in the area of uranium enrichment, were being implemented on larger scales at other sites scattered across Iraq. Nuclear facilities at the ATNRC include Russian (IRT 5000) and French (Tammuz-2) reactors, fuel fabrication facility, isotope production facilities (Russian and Italian) with hot cells, an active metallurgy analysis laboratory (with hot cells) and radioactive waste treatment facilities. Multiple facilities at the ATNRC were severely damaged or destroyed as a result of bombing during Operation Desert Storm. A survey of the ATNRC conducted in June 2005 identified locations of elevated radiation readings where radioactive materials had been released to the environment.[1]

Decommissioning and Dismantlement Efforts at the ATNRC

For several years the MoST has been engaged in the dismantlement and clean up of facilities at the ATNRC. Clean up of the ATNRC will take many years to complete and will require specialized equipment and international support for success.

The ATNRC was visited in February and May of 2011 to evaluate progress. The construction of the radioactive sample diagnostics laboratory is progressing as is the continuing efforts to clean up the less contaminated sites like the Active Metallurgy Analysis Laboratory (LAMA). The MoST has plans to begin dismantling and cleaning up some of the more challenging facilities, such as the Tammuz-2 reactor, beginning in 2012.

AL JESIRA URANIUM PROCESSING SITE

The Al Jesira site is in northern Iraq 35 km west of the city of Mosul. The mission of Al Jesira was to refine uranium (yellowcake) received from the Unit 340 plant at the Al Qa'im phosphate fertilizer facility. At Al Jesira the yellowcake was processed to produce uranium dioxide (UO_2) and uranium tetrachloride (UCl_4) which were used as feedstock for enrichment processes at other locations in Iraq. The total production at Al Jesira reported by Iraq was 99.5 metric tonnes (MT) of UO_2 and 1.2 MT of UCl_4.

During Operation Desert Storm the facilities at Al Jesira were bombed and many were damaged or destroyed. However, a large portion of the equipment was unharmed. Beginning in February 1991 Iraq removed processing equipment, materials and uranium products from the Al Jesira site. In an attempt to hide the mission of Al Jesira, the equipment, materials and uranium products were transported for burial near the village of

Adaya, 23 km southwest of Al Jesira. Inspection teams soon discovered the real mission of the Al Jesira site and much of the equipment buried at Adaya was returned. Some of the equipment and materials were sold as scrap or looted by residents.

Al Jesira is a large site containing 23 different structures. After Operation Iraqi Freedom in 2003, local residents assumed residence in several of the abandoned intact structures. Two new homes were under construction at the time of the February 2011 inspection. These residents were primarily sheep herders who utilized the surrounding area as grazing lands.

It was not possible for the inspection team to visit and collect data on all 23 structures. Nine of the 23 structures were being occupied by local residents and official written permission was required to enter those residences. Therefore, only external measurements, radiation readings, structural descriptions, and GPS positions were acquired at those structures. With permission of the residents a water sample was obtained from one well.

Site Survey Preliminary Findings

There were no detectable radiation readings above background levels at the Al Jesira site. A total of 34 soil samples and 6 water samples were collected from the site. The analysis of the soil samples will be completed at the International Radioecology Laboratory in Slavutych, Ukraine and at Texas Tech University in Lubbock, Texas. All soil samples were split with the MoST for their analysis.

ADAYA BURIAL SITE

The Adaya Burial Site is located approximately 27 km west of Mosul, Iraq and about 23 km south-southwest of Al Jesira. The Adaya Site was not one of the facilities constructed for support of the Iraqi nuclear weapons program, but is a dump site created in an effort to conceal the activities conducted at Al Jesira. Equipment and materials including solid wastes contaminated with uranium compounds were buried on a hillside near the villages of Adaya and Tall ar Ragrag. In 1991 United Nations Inspection Teams estimated the inventory of uranium compounds buried at the Adaya Site to be as much as 5000 kg. In 1994, the site was partially excavated, confirming the presence of equipment and uranium compounds. However, the total inventory of contaminated equipment and materials is unknown.

Site Survey Preliminary Findings

The February 2011 inspection resulted in the discovery of several areas where uranium compounds were contained in damaged/corroded drums as well as on the soil surface and near subsurface. Above background radiation readings were also measured on other materials scattered throughout the site. Fifty-two soil samples were collected from across the site. The analysis of the soil samples will be completed at the International Radioecology Laboratory in Slavutych, Ukraine and at Texas Tech University in Lubbock, Texas. All soil samples were split with the MoST for their analysis.

A more thorough inspection was conducted in May 2011 resulting in the discovery of small pieces of yellowcake spread throughout the site. Discussions with the MoST representatives were held resulting in recommendations for control and remediation of the Adaya Burial Site.

The Adaya Burial Site is on a hillside and water flows through the site toward the village of Tall ar Ragrag. After the February 2011 inspection a recommendation was made to the MoEN RPC to perform a health survey of the residents of Tall ar Ragrag. During the May 2011 inspection, representatives from the RPC were at the burial site to participate in the inspection and perform the health survey. Results of the survey are not available at this time.

DJERF AL NADDAH NUCLEAR FUEL STORAGE SITE

Djerf al Naddah (Location B) is a farming area located approximately 5 km from the ATNRC. Location B was used for emergency storage of irradiated nuclear fuel elements and control rods from the Tammuz-2 reactor. The site is an open field (142 x 122 meters) surrounded by a concrete wall. There are two large tanks used for diesel fuel storage, one small building, a loading ramp, a platform scale, and large mounds of rubble. The nuclear fuel and control rods were stored in 13 separate storage tanks located around the perimeter of the site. The fuel elements and control rods were washed upon receipt at Location B and in preparation for shipment to Russia for final disposition in the early 1990's. Potential areas for radioactive contamination are the wash station and the loading ramp.

Site Survey Preliminary Findings

A radiological survey of the site revealed no external radiation readings above background levels. Surface soil samples were taken for detection of any contamination which may have occurred due to the washing and handling of the fuel elements and control rods. The analysis of the soil samples will be completed at the International Radioecology Laboratory in Slavutych, Ukraine and at Texas Tech University in Lubbock, Texas. All soil samples were split with the MoST for their analysis.

RASHIDIYA SITE

Located on the northern outskirts of Baghdad, the Rashidiya complex was initially an irrigation technology center for the Ministry of Agriculture. In 1987 the site was taken over by the Iraqi Military Industrial Corporation and used for water treatment and water quality projects. Later it was revealed the Rashidiya complex had also been used as the headquarters of the Iraqi centrifuge development program which started in mid-1987. Uranium compounds present at Rashidiya were UO_2, UF_4, UF_6. Except for a centrifuge accident, Rashidiya would not have been contaminated by the use of uranium compounds. The Rashidiya complex was not targeted during Operation Desert Storm, and subsequently the facility was thoroughly cleaned to conceal the Iraqi centrifuge development program.

The Rashidiya complex is now used by the Ministry of Water. This complex includes many buildings, which are currently used for operations by the Ministry of Water for the analysis of both water and soil samples.

Site Survey Preliminary Findings

There were no detectable radiation readings above background levels at the Rashidiya complex. Based upon the current use and visual inspection of the facilities, combined with no elevated radiation readings, no samples were collected.

AL QA'IM PHOSPHATE ORE PROCESSING SITE

The primary mission of the uranium processing facility (Unit 340) at Al Qa'im was to produce uranium compounds (yellowcake) required for the enrichment process. Uranium bearing ore mined at the Akashat phosphate mines was transported to Al Qa'im for refinement. Between 1984 and 1990 Al Qa'im produced an estimated 160 MT of yellowcake which was shipped to the Al Jesira facility. Al Qa'im is still a functioning fertilizer production plant which employs about 700 people.

The Unit 340 processing facility was partially destroyed during the Operation Desert Storm and was never restarted. Disassembly and demolition was begun soon thereafter and was completed in 2000. Some equipment was removed and stored in the adjacent elongated warehouse building and some was re-used in the fertilizer plant. As might be expected the equipment in the warehouse is contaminated with low levels of natural uranium. Equipment and materials including drums containing hazardous waste and uranium compounds were placed in the basement of Unit 340. Concrete slabs were then place over the basement to entomb those materials.

There is no evidence of efforts to rebuild uranium extraction capability at the Al Qa'im fertilizer plant. Unit 340 has been reduced to a series of concrete slabs and barren pits with no technical capability for production of any uranium product.

Construction of a Freon Production Facility (FPF) began in 1991 after Operation Desert Storm; however the facility was never finished. An inspection revealed an unfinished skeleton structure with no walls and only a partial roof.

Site Survey and Preliminary Findings

Approximately 20 soil samples were taken from the areas adjacent to the Unit 340 site for assessment of uranium concentrations in the soil. All radiation measurements of the soil samples taken from the area were within expectations, i.e., slightly elevated due to increased concentrations of natural uranium.

A rusted and corroded barrel containing waste materials including some yellowcake was found in a pit adjacent to the rafinate tank. The yellowcake/waste was confined in a large, folded plastic bag similar to those found at the Adaya burial site.

The equipment warehouse across a road from the Unit 340 site contains equipment which had been removed from the Unit 340 processing facilities. Low levels of contamination were detected on some of the items. Samples were taken from the inside of pipes and other available equipment items.

Water samples were collected from a drainage area adjacent to Unit 340 site. In addition, samples of fluids and materials near the sulfuric acid and phosphoric acid plants were also collected. A sample was also taken from a thin stream of bright white fluid as it flowed into a ditch near the rotary kilns. Also entering the ditch was a stream of thick black oil that was leaking from a tank.

Samples of materials on the ground below the rotary kilns and adjacent to the crusher where the ore from Akashat is first processed were also collected.

Representatives from the MoST collected samples from different segments of the slurry piles.

The Al Qa'im Fertilizer Plant is a site contaminated with radioactive materials (uranium from the phosphate ore) and hazardous chemicals. The only area requiring attention due to radioactive materials was adjacent to the rafinate tank where the barrel of yellowcake was found.

The Ministry of Environment, Radiation Protection Center (RPC), recently conducted a health survey of the workers at the Al Qa'im Fertilizer Plant. Results of the survey are not available at this time.

The analysis of the soil samples will be completed at the International Radioecology Laboratory in Slavutych, Ukraine and at Texas Tech University in Lubbock, Texas. All soil samples were split with the MoST for their analysis.

CHALLENGES INSPECTING THE REMOTE SITES

Due to the state of security in Iraq, significant logistical support was required in order to conduct the inspections of the remote sites. The logistical support was provided by personnel in the US Embassy Baghdad, ECON Section.

For those sites close to Baghdad (Al Tuwaitha, Rashidiya and Djerf al Naddah) the US Embassy served as a base of operations. The US Embassy Regional Security Office (RSO) provided transportation via helicopter to and from the United States Forces – Iraq (USF-I) Forward Operating Bases (FOB). The USF-I provided secure transportation to and from the sites as well as on-the-ground security. USF-I helicopters provided aerial security while the inspection team conducted site inspections. The Iraqi Army (IA) provided additional security services via escort through Baghdad neighborhoods and necessary control of traffic and roadways.

Visits to the sites remote to Baghdad (Al Qa'im, Al Jesira and Adaya) required additional support. As much as possible each site had to be secured before the inspection team arrived and at all times while the team was on the ground. This required pre-deployed USF-I forces as well as continuous aerial security via helicopter, fixed wing and unmanned aerial vehicles. The US Embassy Baghdad, ECON Section coordinated with the responsible US DOS Provincial Reconstruction Team (PRT) to ensure logistical support. The PRT (Ninewa for Adaya and Al Jesira; Ramadi for Al Qa'im) provided interface with the USF-I and the IA for security forces. In addition the PRTs provided or arranged for housing, meals, telephone and internet access. Without this tremendous level of support the inspections of the remote sites would not have been possible.

SUMMARY

The GOI has undertaken the enormous task of cleaning up and remediating the sites associated with its former nuclear weapons program. Inspection of the remote sites provides important information for the MoST IDP and the MoEN RPC. As the efforts of the MoST and RPC continue to implement the IDP, Iraq will make progress toward improving the health and safety of its citizens and reducing the impacts of these facilities on the environment.

REFERENCES

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