# THE NEW RADIOACTIVE WASTE TREATMENT FACILITY AT THE JORDAN RESEARCH AND TRAINING REACTOR

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## ABSTRACT

The need for building a national radioactive waste treatment facility was recognized during the first steps of constructing the Jordan Research and Training Reactor (JRTR), as this was a solid block for introducing nuclear energy to Jordan. To address this need Jordan Atomic Energy Commission (JAEC) agreed with the KAERI-DAEWOO Consortium (KDC) to add the Radioactive Waste Treatment Facility (RWTF) to the JRTR EPD contract. The technical proposal for the RWTF was submitted in July 2014. While the construction and commissioning of the RWTF were finished in June 2017 and obtained the operation license in March 2019. The RWTF facility is capable of receiving low and intermediate-level Radioactive Waste (RW) from the JRTR reactor and other producers. This paper summarizes the status of the RWTF project as well as the operational capabilities of the facility.

**Key Words**: Radioactive Waste, Treatment, LLW/ILW, JRTR.

## 1. Introduction

Jordan imports over 95% of its energy needs, at a cost of about one-fifth of its GDP. Therefore, in 2007, Jordan's Committee for Nuclear Strategy was formed to launch the development of nuclear energy programs in Jordan to reach the goal of generating 30% of its electricity by nuclear power in 2030 and reduce the total energy generation in Jordan. To support the development of its nuclear energy program, the Jordan Research & Training Reactor (JRTR) was introduced. The JRTR is a 5 MW multipurpose research reactor serving as an integral part of the nuclear technology infrastructure with a key role in educating and training future generations of nuclear engineers and scientists. The JRTR utilization includes medical and industrial radioisotopes production, Neutron Activation Analysis, Neutron Transmutation Duping, Neutron Radiography, and other uses.

During the planning and design stage of the JRTR reactor, the need for establishing a radioactive waste treatment facility for managing the radioactive waste generated from the reactor operation and utilization was recognized [1,2]. Therefore, the RWTF project was added to the JRTR contract to be designed and constructed by the KAERI-DAEWOO Consortium (KDC). In 2016, the construction of the RWTF started at the JRTR site, and the operation license was issued by the Energy and Minerals Regulatory Commission (EMRC) in 2019.

## 2. The RWTF design

The RWTF is situated inside the JRTR site at Ar Ramtha city in northern Jordan. The RWTF is designed to handle, collect, process, store, and release solid and liquid radioactive waste generated from JRTR and radioactive waste from other producers in Jordan that satisfy the RWTF Waste Acceptance Criteria (WAC). Different radioactive waste processing methods are utilized at the RWTF depending on the radioactive waste characteristics and are performed promptly to ensure safe storage of the processed radioactive waste [2,3].

The RTF consists of the Radioactive waste Treatment Building (RTB) and the Natural Evaporation Installation (NEI). The RTB comprises the Radioactive waste Treatment System (RTS) area and the Interim Storage (IS) area. The RTS area is composed mainly of the following systems and components: Liquid Radioactive waste Treatment System (LRTS), Solid Radioactive waste Treatment System (SRTS), control room, access control, HVAC system, Health Physics (HP) room, electric room, and communication room. RTB stores the conditioned RW packages as interim storage. It provides a radiation barrier against the liquid and solid RW. The IS area consists of the truck bay, the Low-Level Waste (LLW) storage area, and the Intermediate Level Waste (ILW) storage area.

The NEI is designed for the evaporation of liquid radioactive waste that is within the safe release limits to the ambient atmosphere. The NEI is an open water pond with a movable cover. The pond is constructed with reinforced concrete and lined with epoxy liner.

## 3. The RWTF construction, commissioning, and licensing

The site permit and construction permit for the RWTF were issued by EMRC in 2016. The construction works started in March 2016 and finished in July 2017. The RWTF systems, equipment, and components were verified to operate following the design goals and meet the performance requirements through commissioning activities. RWTF commissioning was comprised of the Construction Acceptance Tests (CAT) and the System Performance Tests (SPT). CAT and SPT started at a component basis the extent to the systems level functional tests. Going through 17 electrical, 9 mechanical, and 13 instrumentation & control" different types of CATs, in addition to performing 9 SPT, the RWTF components, equipment and systems were assured to be ready for normal operation of the facility.

The process of obtaining the operation license started in 2015 and it was extended until the issue date of March 2019. The regulator issued the operation license based on the review of the RWTF Safety Analysis Report (SAR), Waste Management Program, Radiation Protection Program, Quality assurance program, commissioning Reports, and other supporting documents [4,5]. In addition to the reviewing process, EMRC performed different inspections through the process of construction and commissioning the RWTF. The Ministry of Environment (MoE) reviewed the Environmental Impact Assessment (EIA) report and the mutual impact Analysis between the JRTR and RWTF before approving it in February 2016.

### 3.1 RWTF safety analysis report

As stated previously, the Regulator relied on the RWTF SAR as one of the main requirements for issuing the operation license. The SAR for the RWTF summarizes the safety assessment necessary to confirm the safe operation of the facility. To fulfill its goal, the SAR took into account the site characteristics, Waste streams and their characteristics, planned processes in the facility, and the risks associated with its operation [6].

## 4. Radioactive waste streams at the RWTF

The RWTF is designed and constructed to process liquid and solid radioactive waste of very low, low, and intermediate levels of activity [7]. Most of the radioactive waste to be received at the RWTF is generated at the JRTR reactor, while the RWTF is receiving a smaller

amount of solid radioactive waste from local generators; mainly hospitals and labs. The RWTF is receiving liquid radioactive waste only from the JRTR and through the underground pipes connecting the JRTR sumps and the RWTF sumps, while the solid radioactive wastes are transferred using vehicles that are satisfying the safe transport requirements. The solid radioactive waste is mainly composed of spent resin, wet and dry filters, irradiated capsules, and other dry active wastes [8,9].

Tables 1 and 2 show the influx sources and quantities of the solid and liquid radioactive wastes at the RWTF, respectively. It is shown that the RWTF is expected to receive and manage annually around 23 $m^3$ of solid waste, and 63 $m^3$ of liquid waste [3,6].

| Location | Influx Activity Level | Influx Sources | Anticipated Quantity ($m^3$/y) |
|---|---|---|---|
| JRTR | ILW | Spent Resin | 2.4 |
| | | Spent Filter (Wet) | 0.04 |
| | | RI Capsules | 0.23 |
| | LLW | HVAC Filters | 7 |
| | | Spent Resin (HWS) | 0.025 |
| | | Other DAW | 2 |
| RWTF | LLW | Spent Resin | 0.2 |
| | | DAW | 6.3 |
| Other Sites | LLW | DAW (Additional Waste) | 4.5 |
| | | **SUM** | **22.695** |

Tab 1: The Influx Sources of Solid Radioactive Wastes at the RWTF

| Location | Influx Activity Level | Influx of Sources | Anticipated Quantity ($m^3$/year) |
|---|---|---|---|
| JRTR sumps | LLW | Reactor Pool Liner Leakage<br>PCS, PWMS & HWLS Drains<br>Dewatering Hopper Room Drain<br>Decay Tank Drain<br>Decontamination Drain<br>Hot Sink Drains from Hot Cell<br>Fume Hood and Glove Box Drain | 25 |
| | VLLW | Drains from Hot Shower Room, Laboratory, floors, equipment, and hot sinks | 25 |
| RWTF sumps | LLW | Decontamination Drain | 5 |
| | VLLW | Drains from Hot Shower Room, Laboratory, floors, equipment, laundry, and hot sinks | 7.5 |
| | | **Sum** | **62.5** |

Tab 2: The Influx Sources of Liquid Radioactive Wastes at the RWTF

## 5. Radioactive waste handling and processing at the RWTF

After receiving the radioactive waste from the JRTR or other local producers, the RWTF is required to manage it depending on the package's characterizations and classifications. The

solid radioactive waste can be processed by volume reduction, cement solidification, decontamination, recycling and reuse, storage until decay, direct storage, or applying a clearance approach [10,11]. Figure 1 shows the flow chart for the solid radioactive waste at the RWTF [12].

In the case of liquid radioactive waste, it should be sampled in the sumps to check if clearance criteria could be applied by comparing activity concentration levels with the regulator's clearance limits [13]. If clearance is not applicable, liquid waste should be processed using the evaporation system to generate a concentrated liquid which will go to the cementation system while the evaporated liquid could be sent to the NEI after confirming its activity concentrations with the accepted limits [14]. Figure 2 shows the flow chart for the liquid radioactive waste at the RWTF.

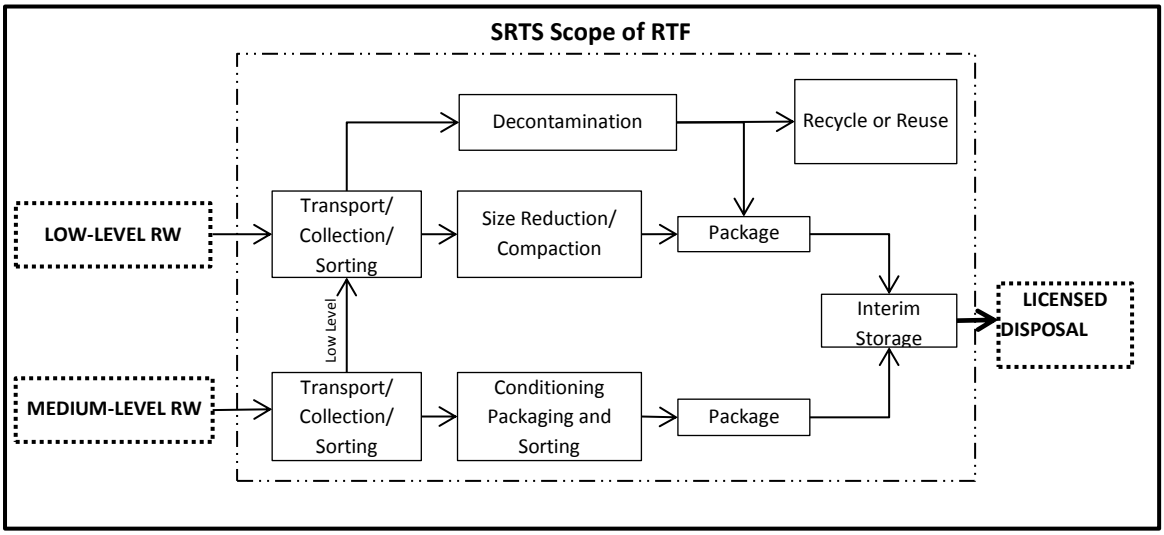


Fig 1. Flow Chart of the solid radioactive waste processing at the RWTF

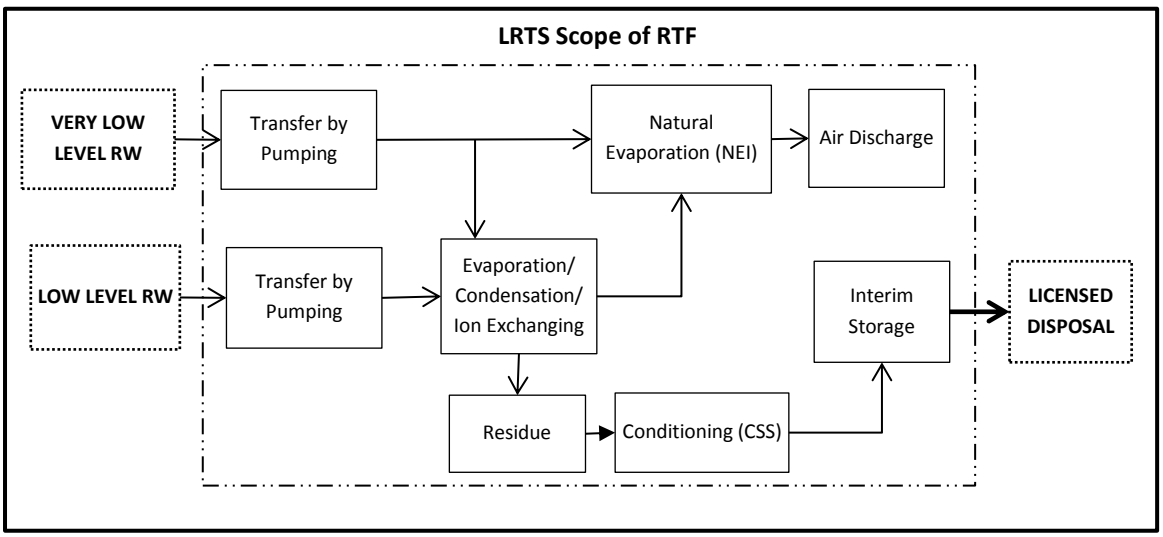


Fig 2. Flow Chart of the liquid radioactive waste processing at the RWTF

## 6. Outlook

The RWTF has recently obtained its operating license after submitting all licensing documents to the EMRC. It is expected from RWTF to serve the JRTR reactor by managing all its generated radioactive materials, in addition to receiving radioactive wastes generated from other local generators in Jordan. Since the RWTF is the first and only treatment facility

in Jordan, it will serve also as a center for educating and training engineers and technicians on radioactive waste management to support building the nation's nuclear power program in Jordan. It is expected that the RWTF will be the start-up point for developing the national radioactive waste disposal facility that will serve the whole national nuclear program.

## 7. References


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