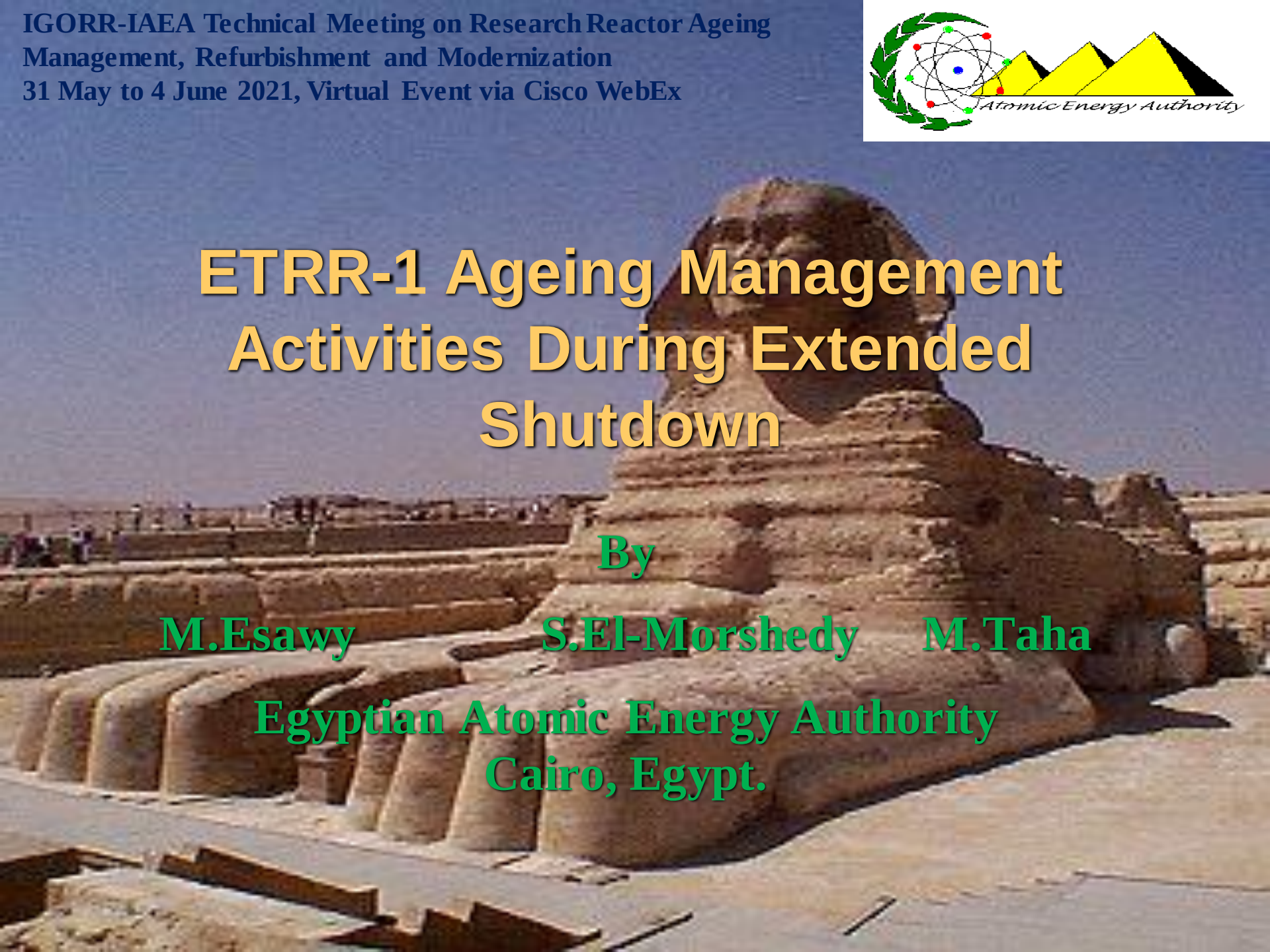
IGORR-IAEA Technical Meeting on Research Reactor Ageing Management, Refurbishment and Modernization
31 May to 4 June 2021, Virtual Event via Cisco WebEx



ETRR-1 Ageing Management Activities During Extended Shutdown

By

M.Esawy S.El-Morshedy M.Taha

Egyptian Atomic Energy Authority
Cairo, Egypt.

Contents

1. Introduction

- With the majority of research reactors having more than 50 years of operating experience; maintenance, modernization and refurbishment is increasingly more important for safe and viable operation.

- The First Egyptian Research Reactor (ETRR-1) is one of the oldest operating research reactors. It was supplied by the former Soviet Union and reached its first criticality in 1961.

- The reactor was in extended shutdown state since April 2010. The core was entirely unloaded and the fuel is transferred to the old spent fuel storage tank in September 2011.

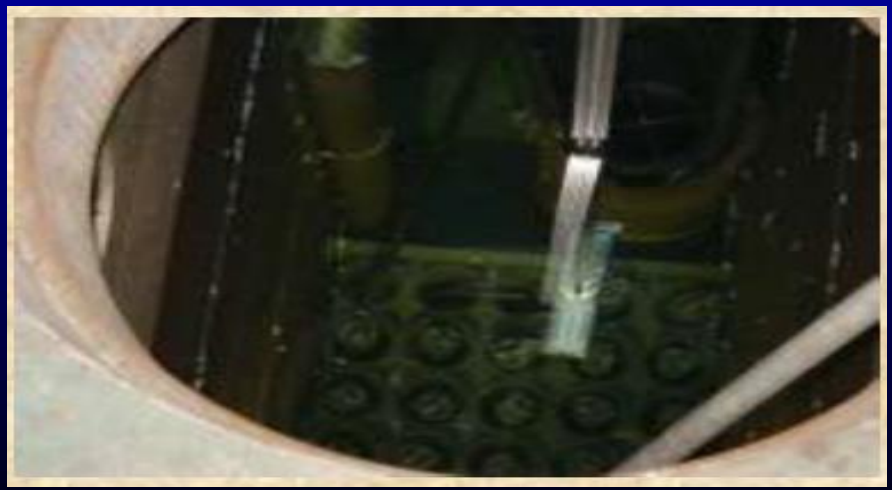
- Ageing , Modernization of the reactor passes through a series of small individual projects and activities.

2. Reactor Description

ETRR-1 Research Reactor

Reactor Description

- ETRR-1 reactor is of former Soviet Union origin
- It is a tank-in-pool type research reactor,
- Reached its first criticality in 1961,
- Has nominal thermal power of 2 MW,
- Moderated, cooled and reflected by distilled light water
- Operates by the well known Al claded, 10% enriched EK-10 type fuel rods in 4×4 fuel rods
- The reactor was used for AA, NS, NRE, RIP, as well as educational purposes



Historical Review

1961 – 1967 The reactor operation was heavily scheduled

1967 The reactor core was unloaded due to the 1967 War

1969 Operation was resumed

1986 – 1989 The reactor was shutdown for major maintenance, especially in the HXs

1989 -1998 Operation was resumed

1998 – 2000 The reactor core was unloaded for comprehensive inspection by the Hungarian experts - installation of new spent storage tank.

2000-2010 In operation

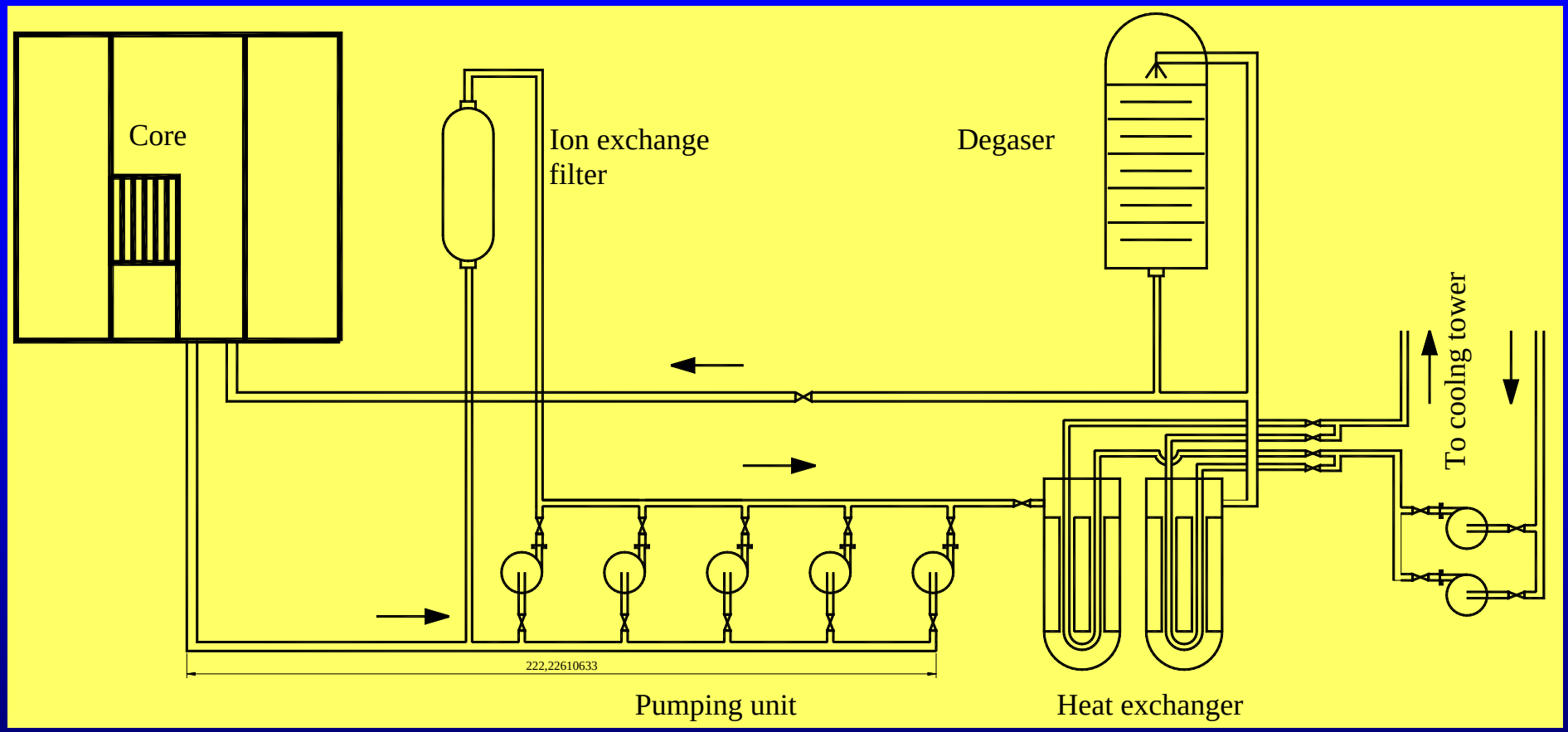
Since 2010 in extended shutdown state for major maintenance and refurbishment

Current Status of ETRR-1

- The reactor was in extended shutdown state for major maintenance and refurbishment since April 2010
- The reactor core was completely unloaded in September 2011 and the fuel is stored in the old Spent fuel storage Pool (OSFSP)

Core Cooling System

- The core is cooled by forced downward circulation of light water, after leaving the core, water is driven by circulating centrifugal pumps. Two pumps out of five are sufficient to provide the nominal flow rate.
- The primary cooling system is equipped with two similar shell and U-tube type heat exchangers in series. Water of the secondary cooling system passes through the inner pipes of the heat exchangers while the primary coolant passes through the shell side.
- The primary cooling system is equipped with a degasser to eliminate the hydrogen and other gases released in the core due to fission process.
- The system is also equipped with an ionic filter which is matched in parallel to the primary circuit.



Schematic diagram of the core cooling system

3. ETRR-1 Ageing, Modernization and Refurbishment Program

In this section, the past and current modernization and refurbishment projects are described as will as the suggested future projects.

- **3.1 Past Ageing & Modernization Activities**

  As ETRR-1 was operating since 1961, a renewable program was started long time ago.

- **Fire alarm system :**

  A new automated fire alarm system was installed.

- **Installation of new Radiation Monitoring System (RMS) project:**

  This project included the installation of a Low Range Noble Gas Measurement channel, NGM 204 L and a Gamma Irradiation Measurement Channel, GIM 204.

Low Range Noble Gas Measurement Channel (NGM 204 L)

- The NGM 204 L (Low Range Noble Gas) measurement channel is designed for continuous monitoring of the integrated volumetric activity of radioactive gaseous samples.

- The samples are drawn from discharge stacks, ventilation ducts or working areas via a pumping system and admitted into a shielded vessel for detection.

- The monitor displays the integrated volumetric activity in units that can be chosen by the operator. Visual and audible alarms are generated whenever pre-set threshold levels are exceeded.

➢ Gamma Irradiation Measurement Channel (GIM 204)

- **The GIM 204 Gamma Irradiation Measurement Channel is used to continuously monitor the γ dose rate in the work places of a nuclear facility to define accessibility or to carry out peripheral monitoring around the installation.**

- **The channel displays the dose rate equivalent (Sv/h) or the dose rate (Gy/h) measured in the units selected by the operator.**

- **Electrical system (2007):**

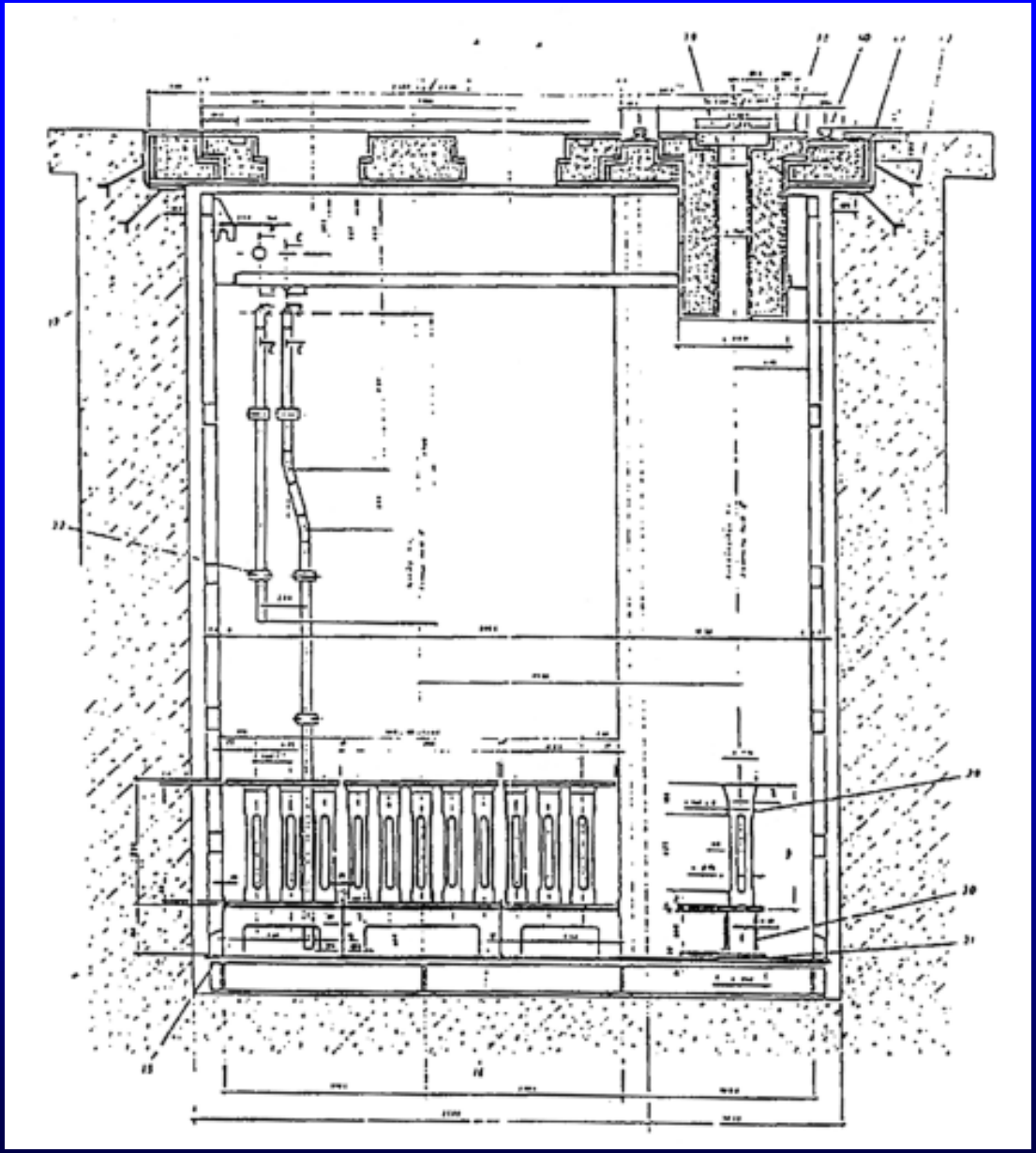
  The AC electrical power supply was replaced.

- **Secondary cooling system (2004):**

  Rehabilitation of the system

- **Building a new spent fuel storage facility project (1998-2000):**

- **Since the start of operation of ETRR-1 reactor in 1961, the spent fuel was stored in the old storage affiliated with the reactor facility. Nearly after forty years the problem of accumulated spent fuel became serious and a new storage had to be built.**
- **It was decided to construct a new fuel storage facility (NSF) to be within the premises of the reactor facility and as close as possible to the old storage.**



Storage tank

New Spent Fuel Storage Pool & Encapsulation Facility

Old Spent Fuel Storage Pool

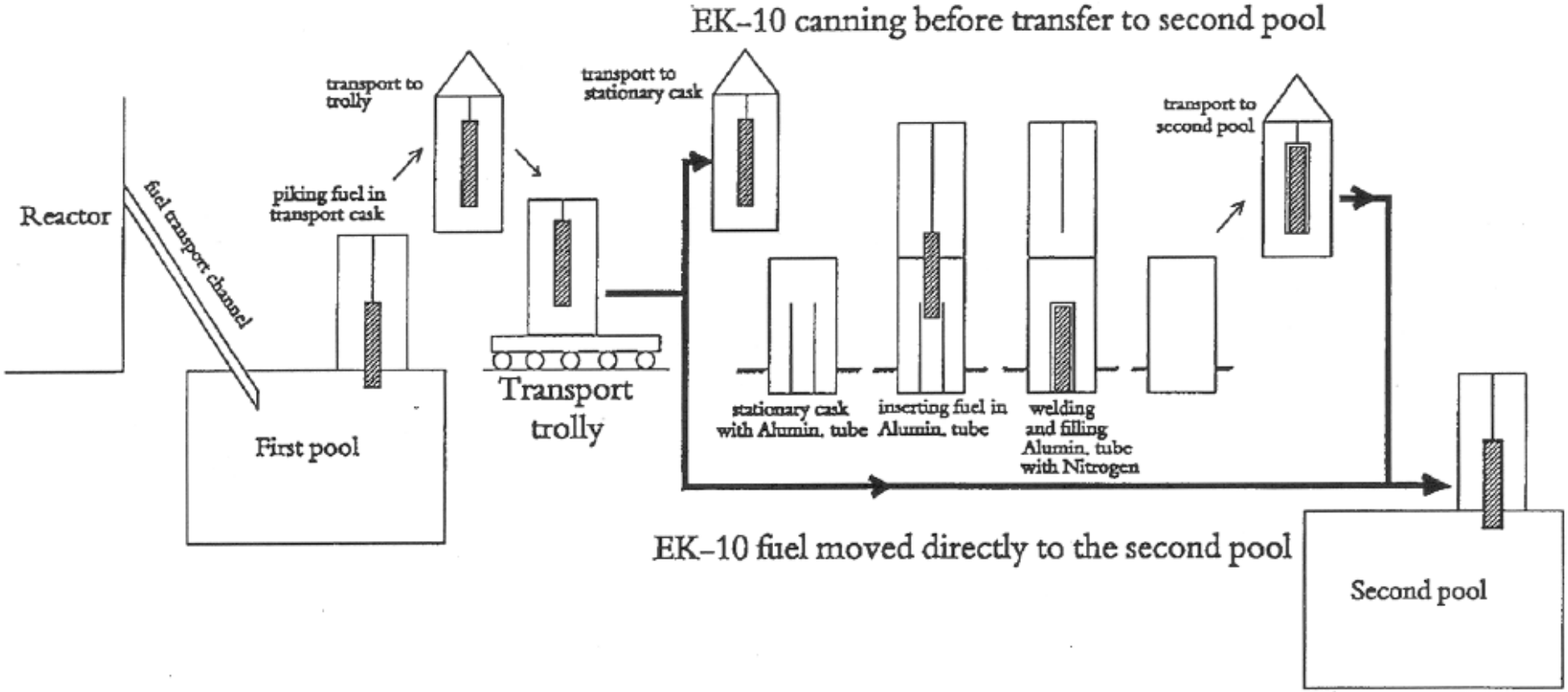
- The design concept justifies simple and safe handling of the transporting cask during loading from old storage, during unloading in the NFS and also during shipment of spent fuel outside the reactor facility.
- The design concept takes into consideration the accommodation of all inventory of fuel of the type (EK-10) owned by the operator.

- **Data Acquisition System:**

  Installation of Data Acquisition System (DACUS)
- **Horizontal channels control system:**

  System refurbishment.
- **Fuel handling & transportation system:**

- **For safe transfer of fuel, the NSF facility is provided with Fuel Handling System and Canning Tools including:**
  - **- Cask transfer trolley**
  - **- Drying system**
  - **- Reception cask**
  - **- Mobile platform**
  - **- Overhead crane**



Fuel handling, transportation and canning system

- **Instrumentation and control system (1988-1990):**

  Replacement of the instrumentation and control system, rehabilitation of signaling system, refurbishment of Computerized Safety Logic System (CSLS), and replacement of the conventional measuring system (flow, temperature, pressure and water level).

- **Instrumentation and control system (1982-1984):**

  Replacement of nuclear instrumentation.

3.2 Current Ageing & Modernization Activities

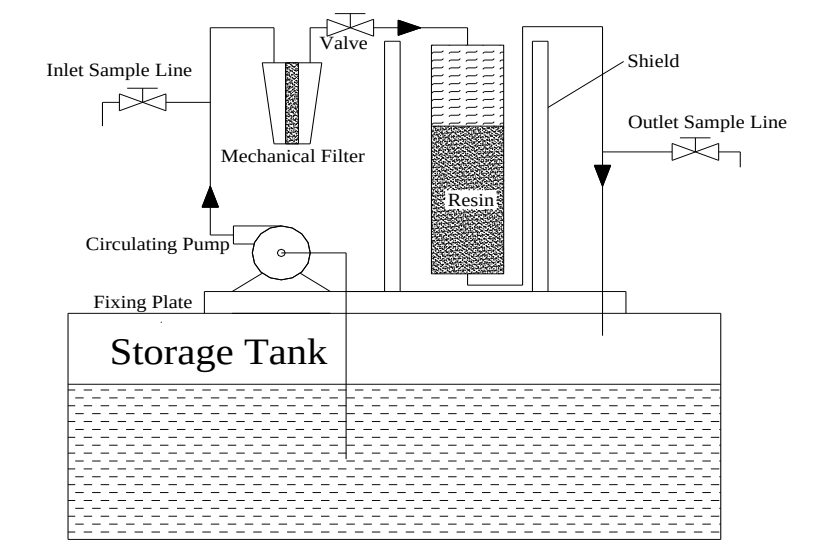
The current reactor ageing & modernization is based on IAEA-TECDOC *"Safety considerations for research reactors in extended shutdown"* includes the RPSS project, SAR updating, SFSF, FH system in addition to the P&S systems .

- SFST and fuel handling system
- Periodic water analysis
- Maintenance and periodic testing
- Preparation of documentation
- EPR activation and its maintenance
- Quality assurance system
- Radiation protection
- Physical protection & Security
- SAR review and updating

Water Sampling and analysis

- The purity of water is checked periodically .Many parameters is monitored such as: activity, conductivity, ph, and TDS.

- To enhance the water quality in the old storage pool an IE filter was designed and equipped (mixed bed)
- The new spent storage will equipped with a similar filter to monitor and improve water qualifications



Layout of OST Ion Exchanger

Water Quality Program

- ETRR-1 is in extended shutdown state and with these prolonged reactions between water and structure material (aluminium is common made material of ETRR-1 reactor) may lead to degradation (corrosion) and loss of the structural integrity of the component (Primary Loop, Secondary Loop and Spent fuel storages).

- In ETRR-1 reactor we focus on the prime parameters and processes that are relevant for the interaction between water and aluminium (pH, conductivity, Radiation level.., etc..) according to the environmental zone which contain water and structure materials with measuring frequency.

Recommended limits and monitoring frequency for water quality parameters in the primary cooling system

Parameter	Value (limit)	Monitoring frequency
Conductivity (*)	< 1.0 µS/cm	On-line; and confirmation of laboratory sample each two weeks
pH (*)	Between 5 and 6.5	On-line; and confirmation of laboratory sample each two weeks
Chloride (Cl–)	< 0.05 mg/L	Each Two Weeks laboratory sample
Silver (total)	< 0.05 mg/L	Monthly laboratory sample
Copper (total)	< 0.05 mg/L	Monthly laboratory sample
Nitrate (NO3 –), mg/L	< 0.05 mg/L	Each Two Weeks laboratory sample
Dissolved substances	< 0.1 mg/L	Monthly laboratory sample
Fe (total)	< 0.1 mg/L	Monthly laboratory sample
Sulphate (SO4 2–), mg/L	< 0.1 mg/L	Each Two Weeks laboratory sample
Solids, mg/L	< 5 mg/L	Monthly laboratory sample
Ca, Na, Mg	< 50 ppb (each)	Once per month laboratory sample
Turbidity (**)	(See note below)	
Al, Zn, Sr, Ba, Pb, Cr, Co	< 50 ppb	Monthly laboratory sample
Radiation level	3000-5000 Bq/mL	Each Two Weeks laboratory sample

Maintenance and Periodic Testing

The reactor staff is performing the required maintenance and periodic testing of the systems.

- **Instrumentation and control (I&C) systems are checked twice a year and detected failures are repaired.**
- **The cooling systems are put into operation 20 hours every week**
- **Ion exchanger filters run daily, and water samples are taken weekly for analysis**
- **The performance of electrical systems components such as contactors, uninterruptible power supply (UPS) is checked periodically**

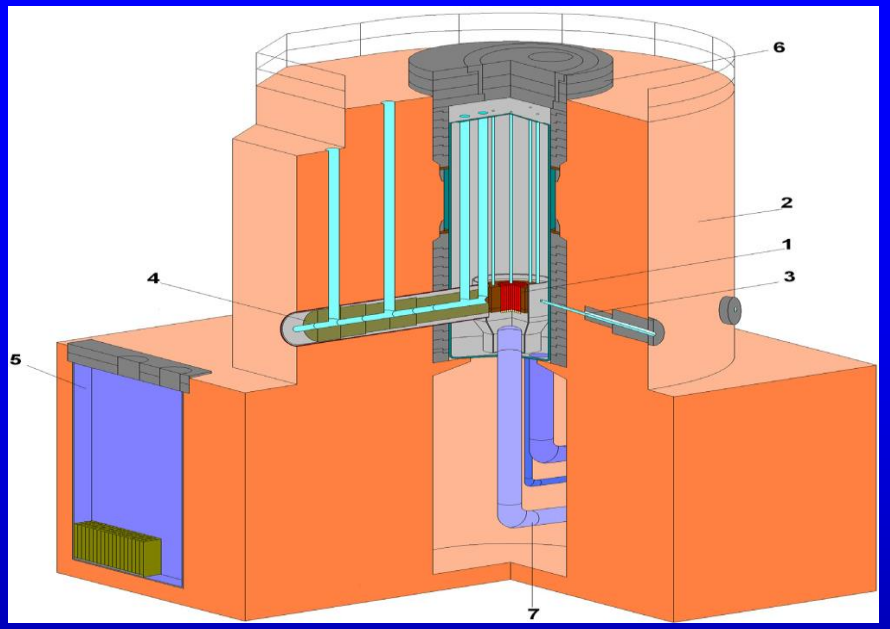
Periodic Inspection Program

Make all inspections that could indicate degradation of mechanical and electrical systems and components

- a visual inspection for Spent Fuel Assembly each SFA go through a visual inspection of physical condition (check for scratches, cracks, examine if it is swollen or has mechanical deformations due to heavy radiation etc.).

- visual and other inspections if needed for mechanical parts, electrical parts, electronic parts, etc..

Defueling of ETRR-1 Reactor Core & Decay pool



Physical security system:

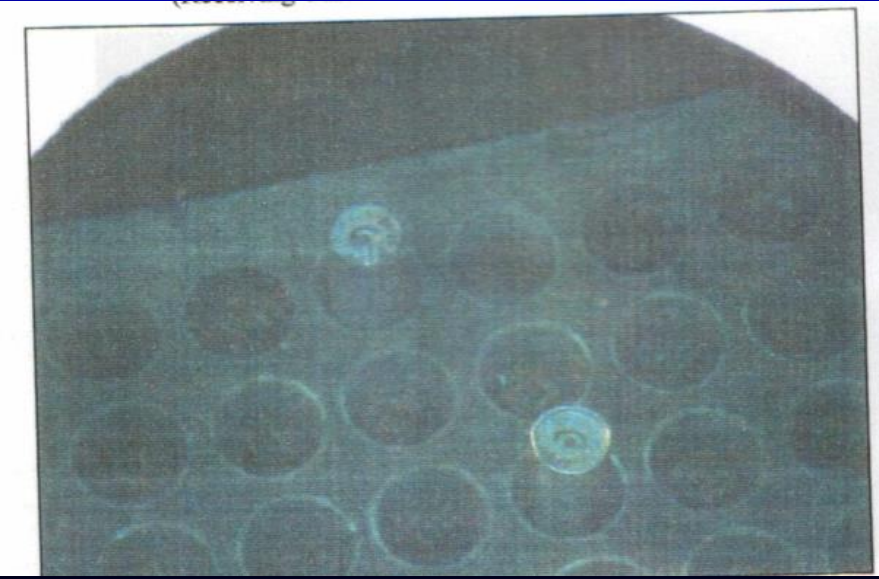
This project includes modernization and refurbishment of the reactor physical security system in collaboration with the International Atomic Energy Authority (IAEA).

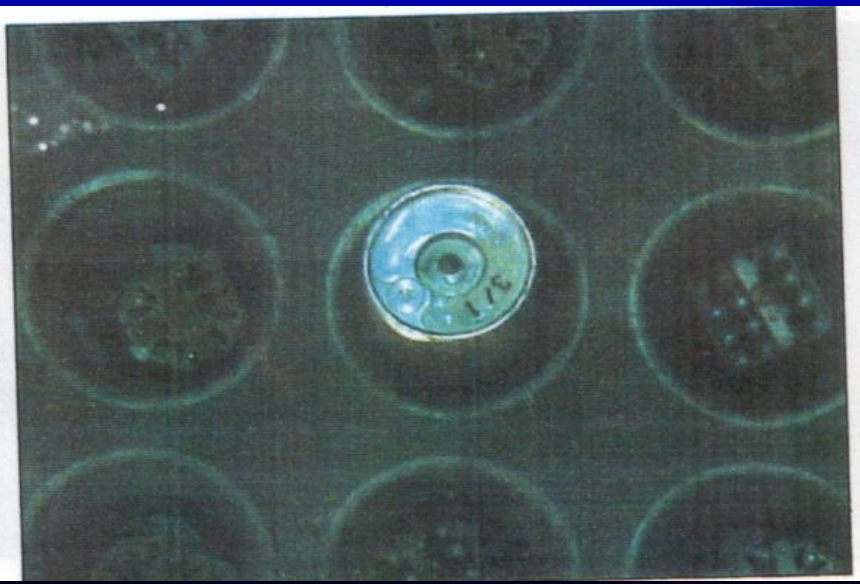
- **Safety analysis report:**

It is an internal project to issue a new and complete and update ETRR-1 SAR.

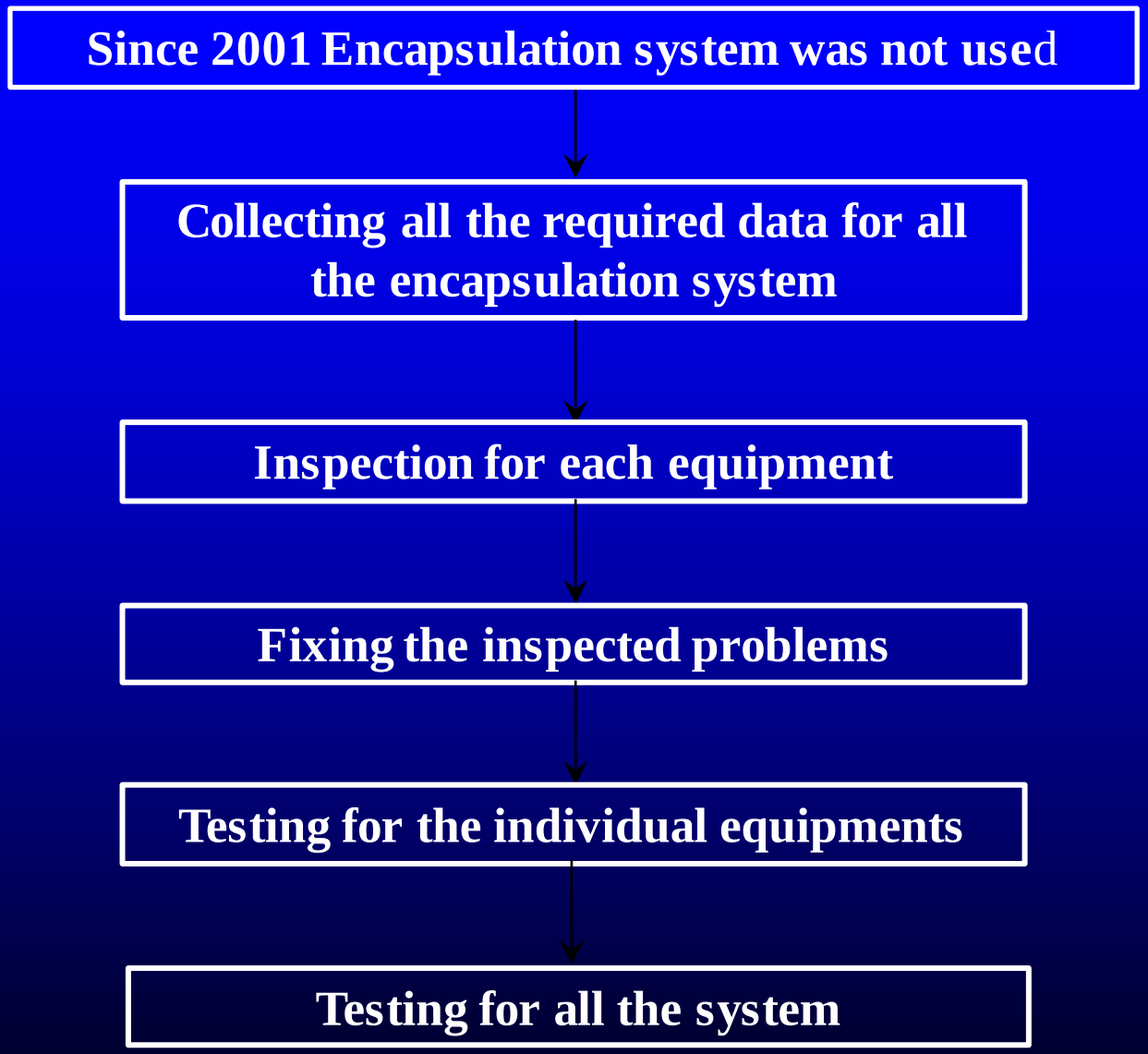
Encapsulation Activities

- Fuel transportation from the old tank to the new one Hungarian/Egyptian
- Encapsulation of 2 spent fuel assemblies Hungarian/Egyptian
- Encapsulation for other spent fuel assemblies Egyptian



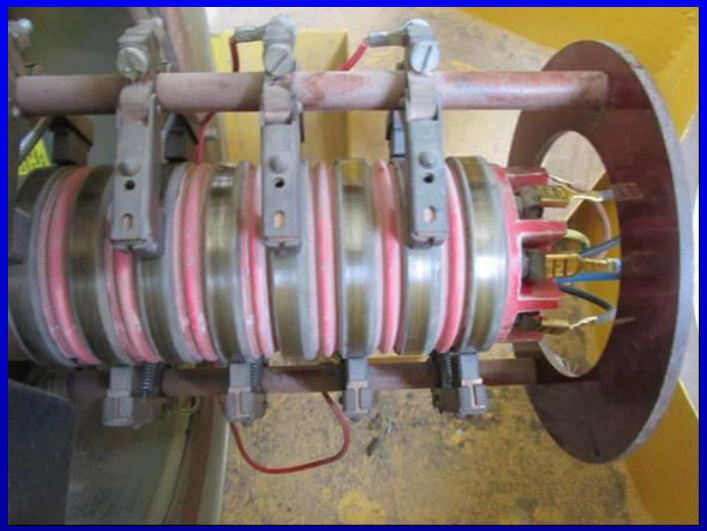


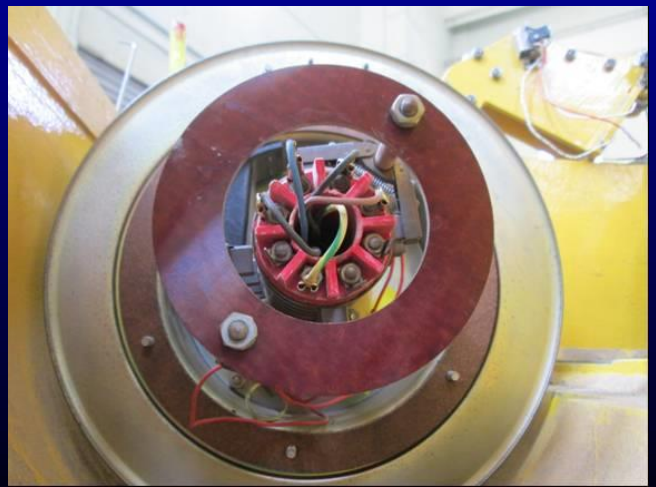
Recent Arrangements for ETRR-1 Spent Fuel Encapsulation



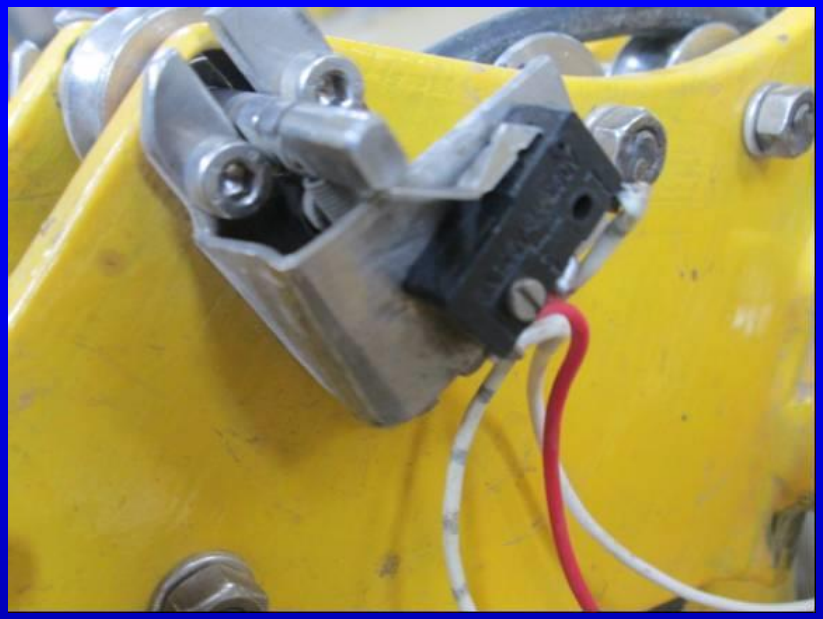
Fixing the Inspected Problems

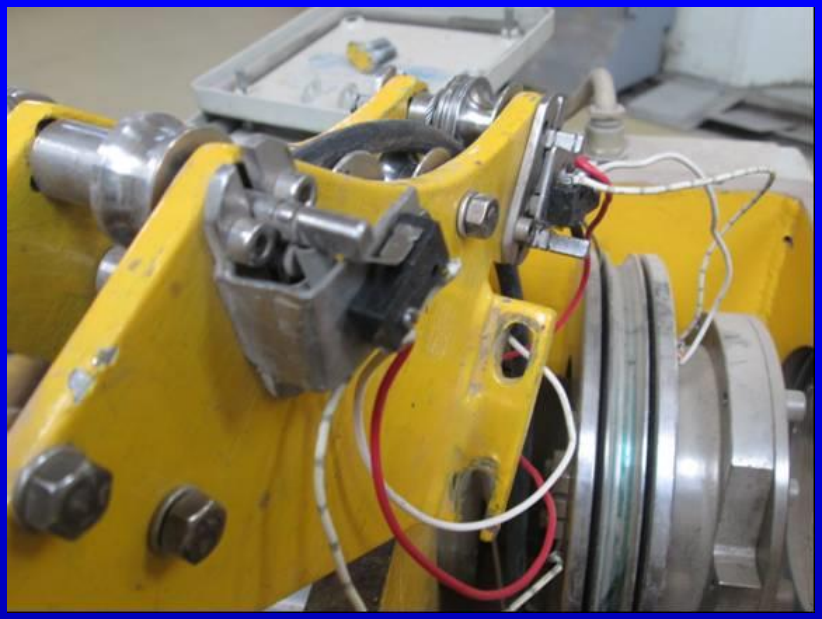
1-Transfer trolley





2-Transfer cask





3-Welding head

Dry Test

Layout of Encapsulation Process

Spent Fuel Transportation from Old to New Storage Tank

Spent Fuel Draying Process

Pressing Process (inserting fuel assembly into the tube)

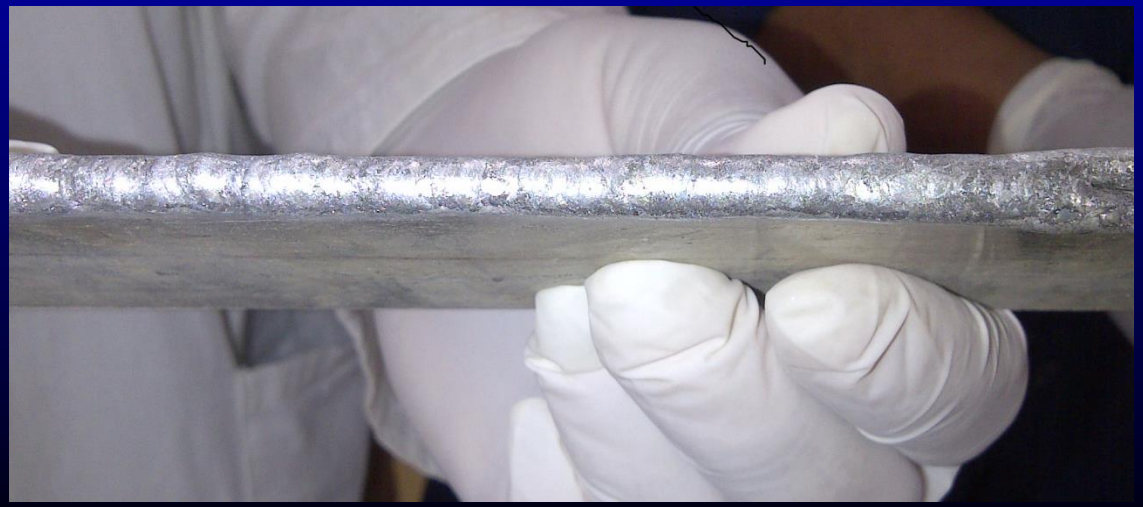
Welding Process

Vacuuming and Gas Filling for Welded Tube

Leak Test – Helium Detector

Encapsulated Tube Transportation to the Storage Pool

Test Results



Drainage Liquid Waste at ETRR-1

- *Primary loop*
- *Spent Fuel Storages.*
- *Heat exchanger*
- *Drains*

- *Filtration*
- *I.Ex. Filter*
- *Mobil Filter*

Drainage through special sewage systems

Storage in two waste tanks each 300 m^3

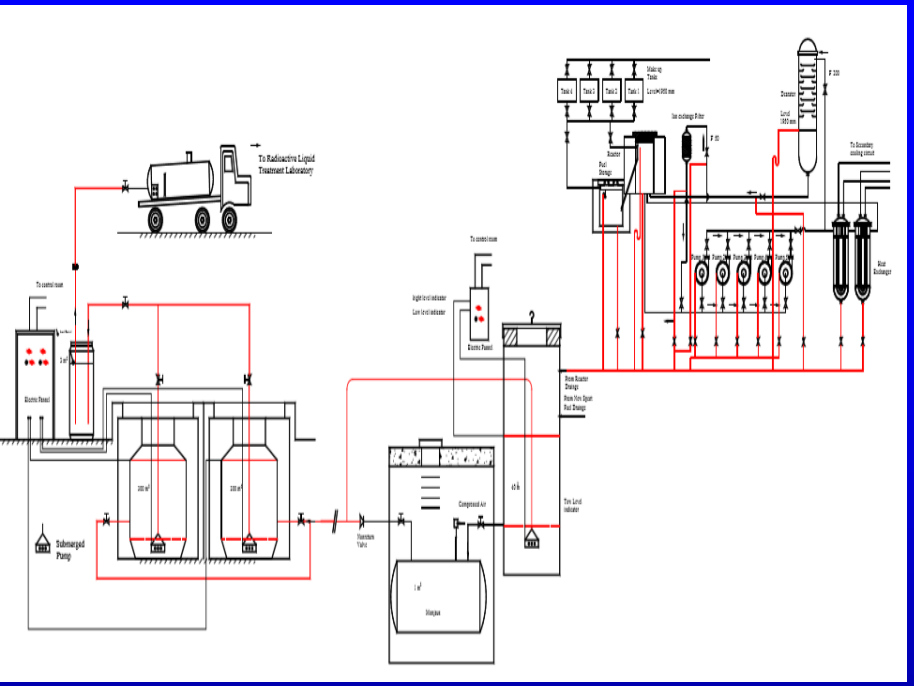
Sampling Analysis

Transport by mobile car for WMC

Liquid waste treatment at WMC

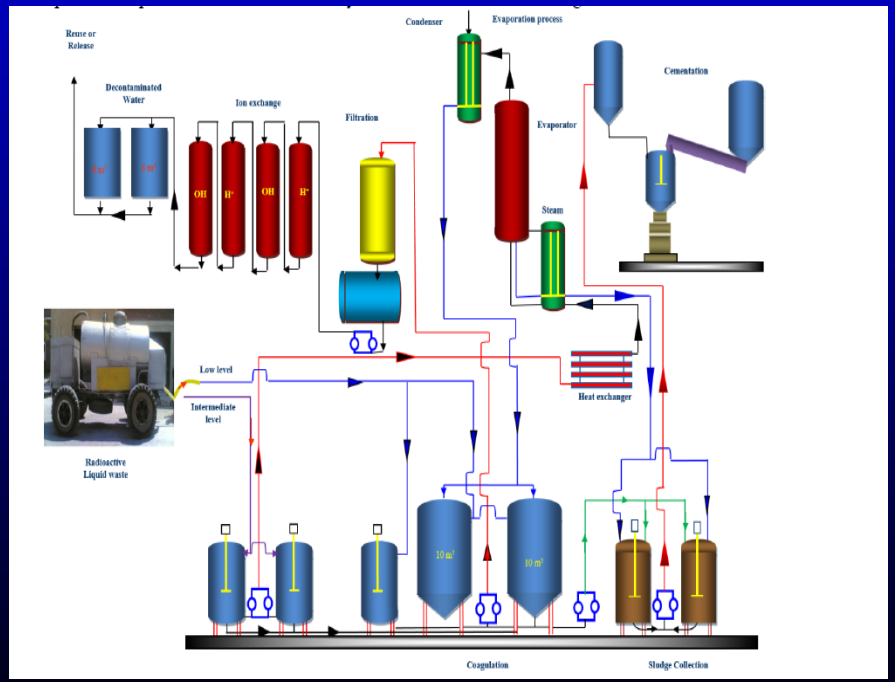
Liquid Waste Management at ETRR-1

WMS



Hot Laboratories and Waste Management Center

- Radioisotope Production
- Nuclear Fuel Research
- Radioactive Waste Management
  - Treatment, Conditioning Storage Disposal



3.3 Future Ageing & Modernization Activities

The reactor needs a program for modernization and refurbishment of many safety systems and components in the future. This program should consider the possibility of upgrading the reactor to a higher power. The program could include the following systems:

- **The primary cooling system:**

I. Three primary cooling pumps are available for operation; the other two pumps are out of service.

II. Many of the heat exchangers tubes are plugged.

III. The control valves are very old design and need to be replaced by new design.

Therefore, the system needs replacing its main components like pumps, heat exchangers and control valves.

- **The secondary cooling system:**

  The cooling tower could also replaced by a new smaller size and more efficient tower.

- **The water treatment system:**

  It also needs modernization and/or refurbishment. The ion exchange filter has a difficult mode of operation and maintenance.

- **The ventilation system:**

  The system needs refurbishment and installing new chiller units as its units are out of service and the system is used to circulate air without cooling.


Thank you for your attention