



Ageing management program for Egyptian second
research reactor

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Operation head

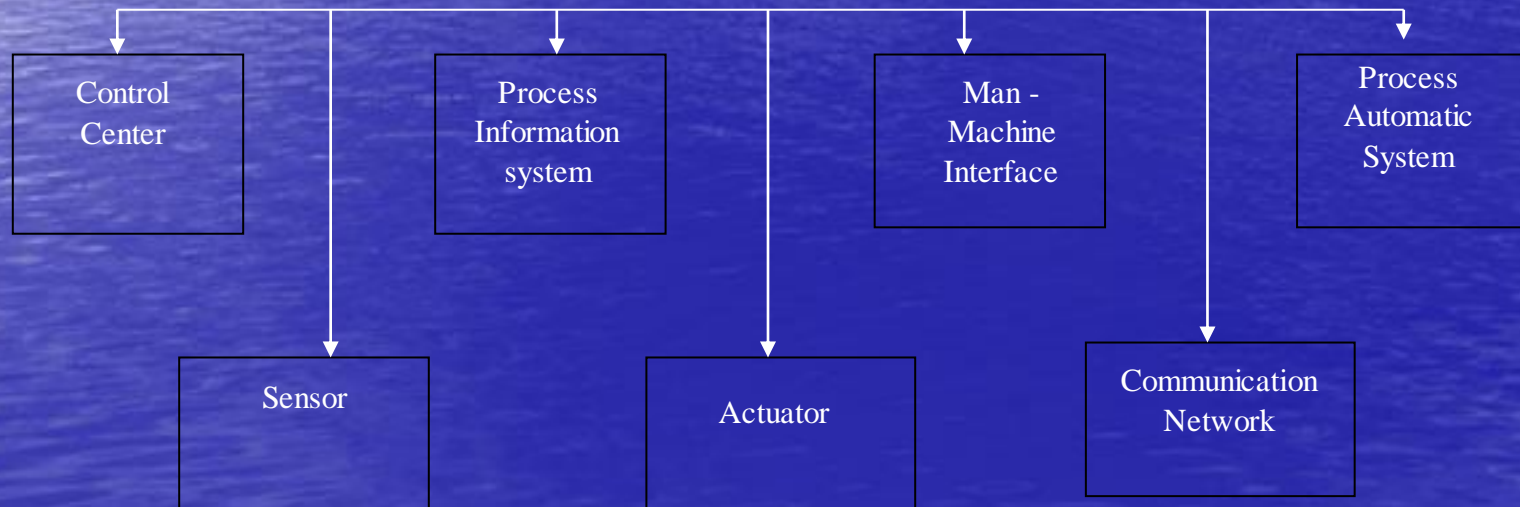
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<http://www.etr2-aea.org.eg>

- The Egyptian second research reactor (ETRR-2) is an open-pool type reactor, 22 MW, and in operation since 1998. Its main purposes are to produce radioisotopes, personnel training, research and development.
- Aging management of ETRR-II is based on a maintenance program that was planned to provide adequate preventive, predictive, and corrective maintenance according to surveillance, periodic, and in-service inspection.

Supervision and Control System SCS

- **DEFINITION:**
 - **The SCS includes all components required for reactor process control during normal operation and incidental plant operation.**



SCS

- **Distributed digital control system**
 - The SCS is physically distributed, where supervision, control and field units are distributed in different reactor rooms, according to process and supervision consoles
- SCADA type.
- OS. QNX real time OS.

SCS units:

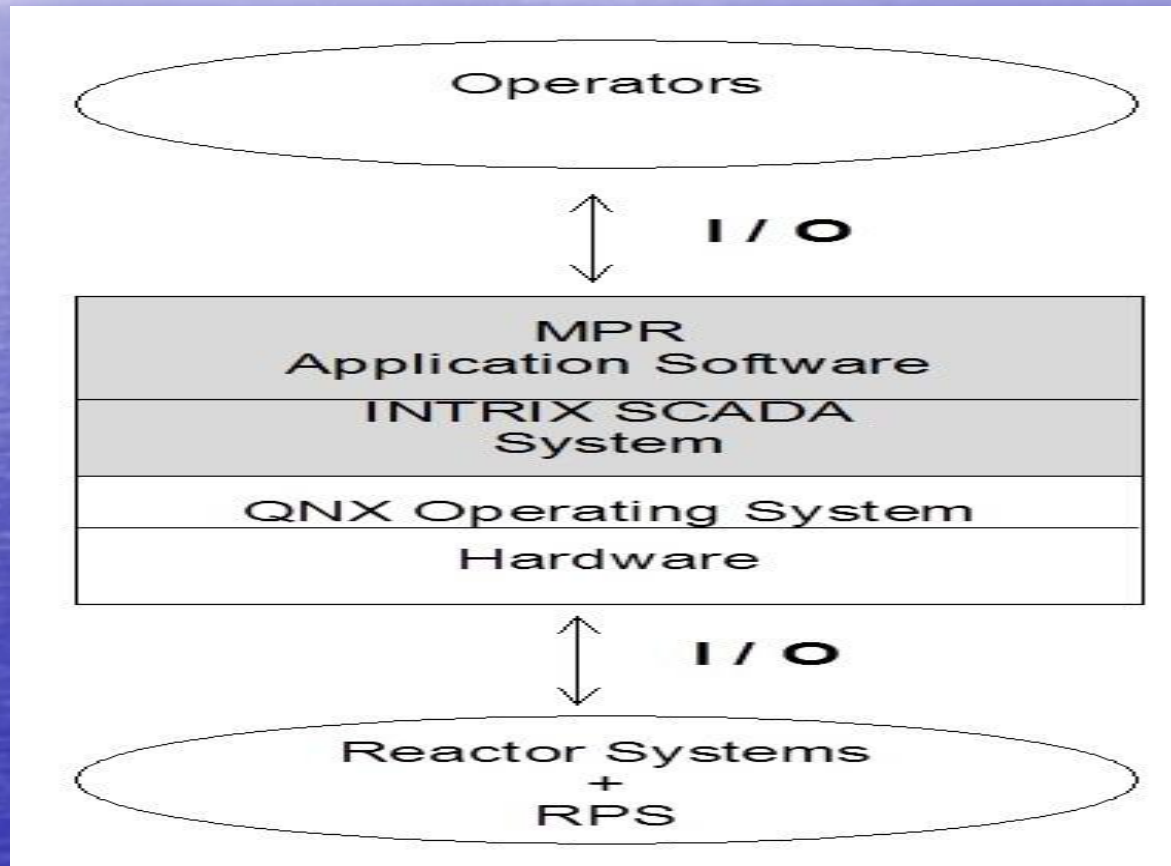
- **Field Unit FU**

- FU do the link between Control Unit and Sensor / Actuator devices. Input data are acquired from plant sensors and processed here before sending the information to upper level. Output data coming from Control Unit is sent to appropriate plant actuators.

- Field Units (FU) specification is :

- Industrial computer (rack mounted)
- STD BUS 32 bits
- Main processor Intel 486
- 8 Mb RAM
- 850 Mb HDD
- I/O cards

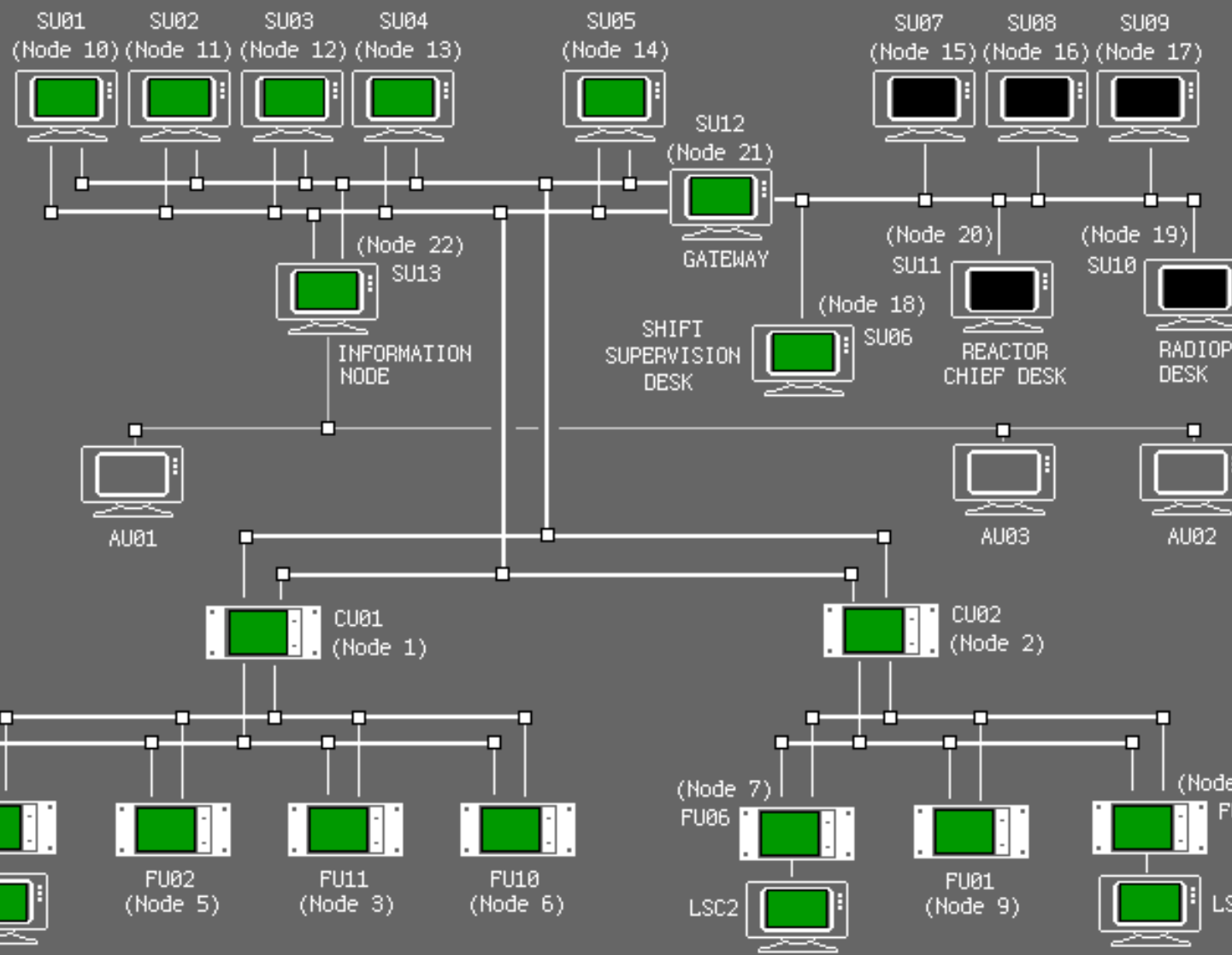
SCS INTERNAL STRUCTURE



MAIN CONSOLE

SECONDARY CONSOLE

TRAINING CONSOLE



Shutdown

-3.5 %/s

EVAC

ALARMS

STATE

PLANT

LOGIC

TASKS

MENU

Navigation controls including a square button, two upward-pointing triangles, and two left/right-pointing triangles.

System status bar with buttons for: Safety, SCS, Radiopr, Reactor Control, Core Status, Heat Remov, Water Supply, Waste, Ventil Air, Reactor Service, User Service, and LOOP RIG.

Handling Ageing in SCS

- It began from design stage by using a design criteria based on simplicity and expandibility (using modular design concept both in S.W. and H.W.) {prevention of ageing effect through design according to **IAEA-SSG-10**}
- The system has an online diagnostic routine and watchdog linked to reactor protection system (RPS). The RPS will initiate the first shutdown system if the SCS is not available {prevention of ageing effect though surveillance and testing according to **IAEA-SSG-10**}
- During construction stage, standardization in all units of SCS in term of H.W. and S.W was done (with minimum configuration according to **IAEA-SSG-10**)

Handling Ageing in SCS contin.

Software Ageing

- Software Ageing : in which the state of software degrades with time (not HW related). The primary causes of this degradation are:
 1. Memory leaks
 2. Unreleased file locks.
 3. Data corruptions
 4. Non- terminated threads

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Monitoring of the reactor service condition is one of the applied aging management strategies in ETRR-2, e.g.:

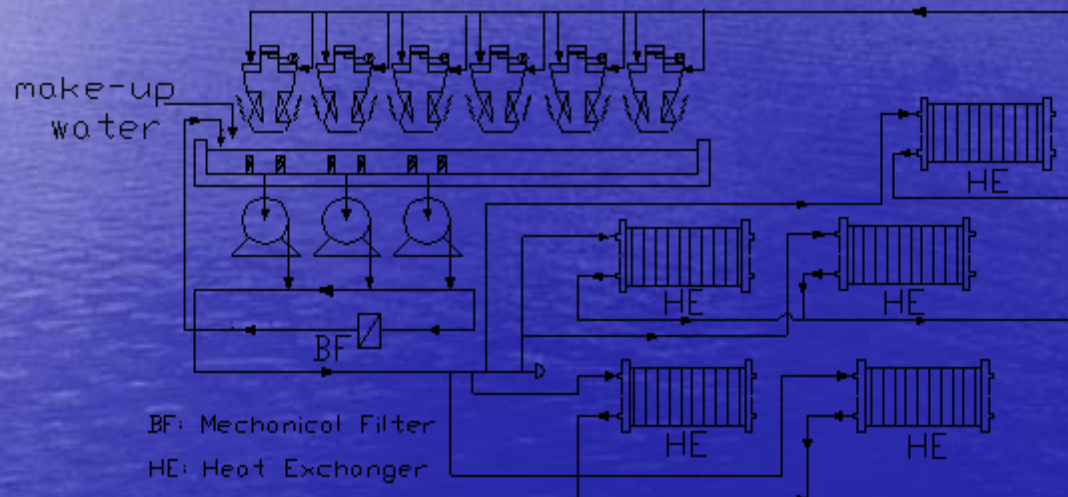
- Core pressure difference
- Heat exchanger pressure and temperature difference
- Cooling pump pressure
- Coolant flow rates and temperatures
- Vibration levels of primary cooling pumps
- Conductivity of primary water coolant
- Radiation dose over the reactor pool
- Water level of reactor pool
- Leak detection system
- Water radiochemical analysis
- Non-dissolved elements level in coolant water
- Control rod drop time
- Corrosion rate of piping



Aging management of the secondary water coolant system

- **This system is responsible for the final dissipation of the energy produced in the reactor. This energy is transferred as heat from the primary to the secondary circuit through heat exchangers. The energy is rejected to the environment through a cooling tower consisting of six separate cells; each cell is equipped with its own blower and its own water supply. The piping material of the system is carbon steel with different sizes (between 24" and 6").**
- **The tower basin has a water volume of $\sim 300 \text{ m}^3$.**
- **The cooling range is approximately $7 \text{ }^\circ\text{C}$.**

HE: 2 Core cooling system (CCS), 1 Reactor pool cooling system (PCS), 1 Auxiliary pool cooling system (APCS), 1 of the test loop cooling system





Do step

The **Do step** includes applying two programs:

- **A chemical program**
- **A biological program**
- The **chemical program** comprises dosing a **scale- and corrosion inhibitor**. In semi-open systems these chemicals are mostly based on low-zinc programs to be environmentally friendly. The discharge of zinc to the environment is restricted to 1- 2 ppm (mg/l). Beside zinc usually phosphates either organic or inorganic or mixtures of both types are implemented.
- A **general dispersant** is also added to disperse silt, mud, and iron particles that can then be removed through the blowdown.
- Due to new restrictive laws concerning the environment, all these compounds must be non-toxic and biodegradable.

Aging management of secondary cooling system by **chemical treatment**

The **check step** includes **1.) monitoring the water quality** by measuring

- the **pH value and alkalinity** to conclude if the water quality is suited for the chemicals to work properly.
- **chloride and sulphate** concentration as there exists an upper limits for their concentrations in the cooling water. Chloride promotes pitting of carbon and stainless steel. Chloride and sulphate come with the feed water and as side products due the addition of chlorine gas and sulphuric acid, respectively.
- the **electric conductivity** of both the coolant and feed water to calculate the **concentration number**. This number implies the concentration of salts in water due to evaporation of water leaving behind all the salts in the coolant water.

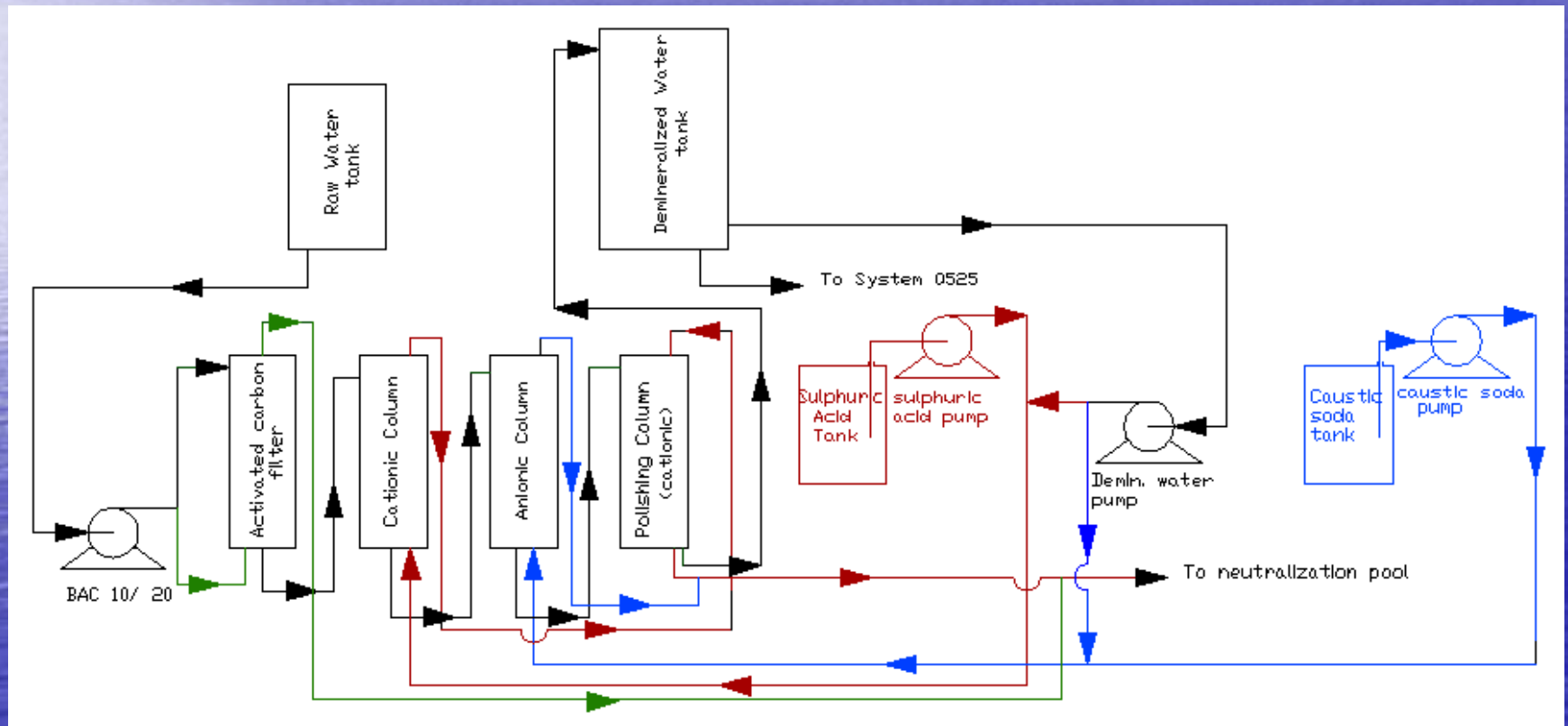
Primary Cooling System

Aging management of this system is achieved by:

1. Supplying it with demineralized water of conductivity < 1 $\mu\text{S}/\text{cm}$ and solid concentration < 0.5 ppm through the demineralization plant which provides water with a conductivity lower than 0.5 $\mu\text{S}/\text{cm}$. Regeneration of this plant is done with H_2SO_4 and NaOH .

→ the resins and activated carbon were renewed in 2007.

Demineralization Plant



Aging Management in Primary Circuits

- 2. Reactor and hot water layer water treatment systems that maintain the Reactor pool and Auxiliary pool water within required purity grade eliminating all corrosion, fission and radioactive traces.
- **These systems consist each of a mechanical filter, mixed-bed nuclear grade resin column, and a resin trap to retain resin particles from flowing with the water. Volume of each bed: 0.7 m³.**
- **These resins had to be renewed several times along the reactor lifetime**

Conclusion

The Egyptian second research reactor is operated for more than 20 years, so an ageing program is designed to monitoring the degradation rate to mitigate ageing effect. The ageing program includes the periodic inspection and defined both the preventive and corrective actions. Most of the systems are updated to be in optimum condition. Safety systems and safety related systems are updated to overcome the ageing effect. The program is based on the monitoring the systems performance and its failure rate. Due to the high failure rate of some systems or its components, those systems are redesign such as control rods. Renewal program is going for the systems according to the degradation rates. Ageing program also includes the health of the personal and feeding the reactor by new young personal.

- 1-Aging management in Supervision and control System of ETRR-2 was begun in design stage by using a design criteria based on simplicity and expandability.
- 2- During construction stage, standardization in all units of SCS in term of H.W. and S.W was done.
- 3- After the system was fully operated, a database for HW and SW and maintenance programs for all the components.
- 4- operational and safety procedures were issued to deal with software



THANK YOU