Safety reassessment of Egyptian second research reactor post Fukushima accident

By

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Egyptian Second Research Reactor

INTRODUCTION

lessons learned from the Fukushima accident under several areas and topics such as:

1- the seismic design;

2- the tsunami effect;

3- the station blackout effect;

4- the station safety design;

5- loss of ultimate heat sink;

6- spent fuel storage pools design;

7- regulations and organization/crisis management.

REASSESSMENT OF THE FACILITY

- The main objective of this reassessment is to evaluate the robustness of the existing reactor protection, in terms of *design features* against the impact of extreme events, with an emphasis on fulfillment of the basic *safety functions* to avoid accidents like that happened in Fukushima.

ETRR-2 ACTONS AFTER FUKUSHIMA ACCIDENT

- Review and updating of the safety analysis after in-core irradiation for LEU targets to produce Mo-99.
- Ensure that the OLCs are maintained as they approved by the current operating license.
- Review the emergency power supply and Uninterrupted Power Supply System (UPS) .
- Review of the emergency preparedness and the emergency equipment.
- Study the interaction of the reactor associated facilities (ET-RR-2, fuel fabrication plant and Radioisotopes Production Plant).
- Review of the operator response to the design basis accidents and radiological emergency.

- Complete loss of all electrical power supply (off-site, on-site and batteries).
- Loss of ultimate heat sink .
- Review the off-site emergency response including management of severe accident.
- External Events (extreme earthquakes, extreme weather conditions craft crash, fire).
- Internal Events (internal flooding, fire).
- Security events.
- Review of the site accessibility.
- Existing communications means.
- Review the postulated initiating events covered by the safety analysis in SAR and IAEANS-R-4.
- Events with experimental devices.
- Analysis of the BDBAs and combination of events (extreme earthquake that leads to an internal event such as internal flooding and /or fire, station black out, source term calculations).

REASSESSMENT OF THE SITE

Requirements:

- Low probability of earthquakes and volcanoes.
- Low probability of radiation spread by wind.
- Enough distance from accommodations.
- Enough distance from seas and oceans.

* All the mentioned requirements are verified in ETRR-2

REASSESSMENT OF THE BUILDING

Requirements:

- Earthquake resistance
- Submarine doors
- Radiation spread resistance
- Air confinement
- Emergency doors

All the mentioned requirements are verified in ETRR-2, It is recommended to increase the submarine doors for electric components rooms.

REASSESSMENT OF RADIATION PROTECTION

- Advanced equipment for all type of radiation
- Periodically calibration
- Failure detectors for the components that may cause radiation release
- High level of training on radiation protection and safety culture

There is a variety of radiation protection systems and equipment in ETRR-2.

More training is recommended in ETRR-2 to increase the safety culture.

REASSESSMENT OF EMERGENCY PREPAREDNESS AND RESPONSE

Requirements:

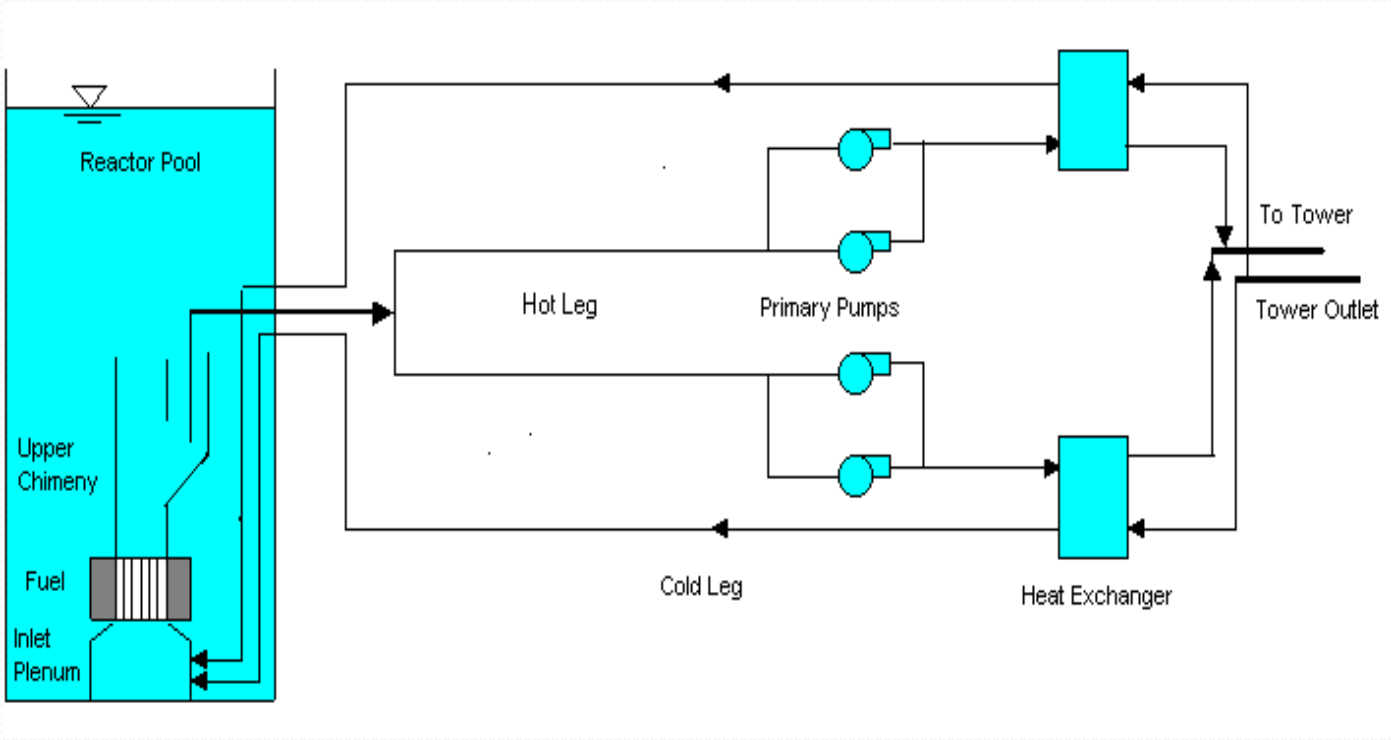
- Repeating the emergency plan training periodically.
- Verifying the good communications internally and between the reactor and the different centers and authorities to ensure a good coordination and rapid response in case of emergency.
- Good monitoring system.
- Manual and automatic fire detection.

* All the mentioned requirements are verified in ETRR-2

SAFETY FEATURES

Requirements :

- Redundancy (cooling pumps)
- Diversity (control rods and Gadolinium)
- Fail safe (control rods –Gadolinium- RPS)
- Physical separation (cooling pumps)
- Negative reactivity temperature coefficient


Reactor Pool
Upper
Chimeny
Fuel
Inlet
Plenum
Hot Leg
Primary Pumps
To Tower
Tower Outlet
Cold Leg
Heat Exchanger

DEFENCE IN DEPTH

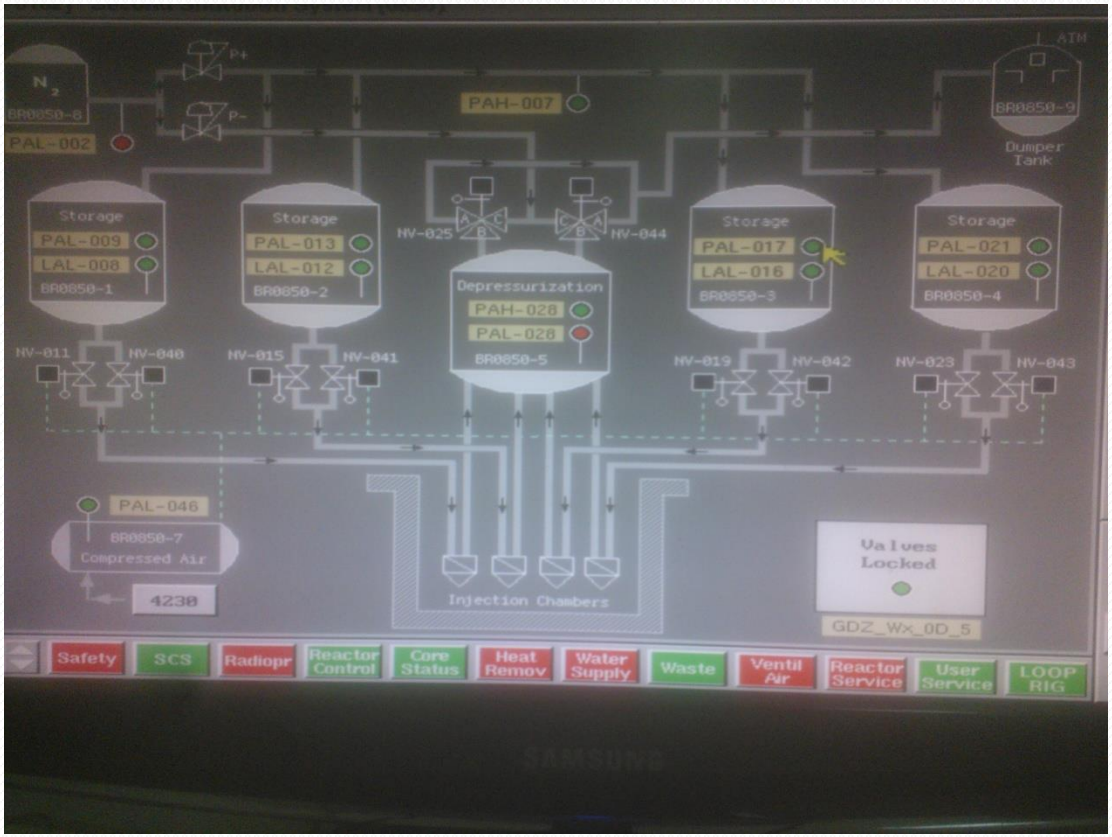
- Prevention of accident
- Protection against accident
- Mitigation of radiation consequences

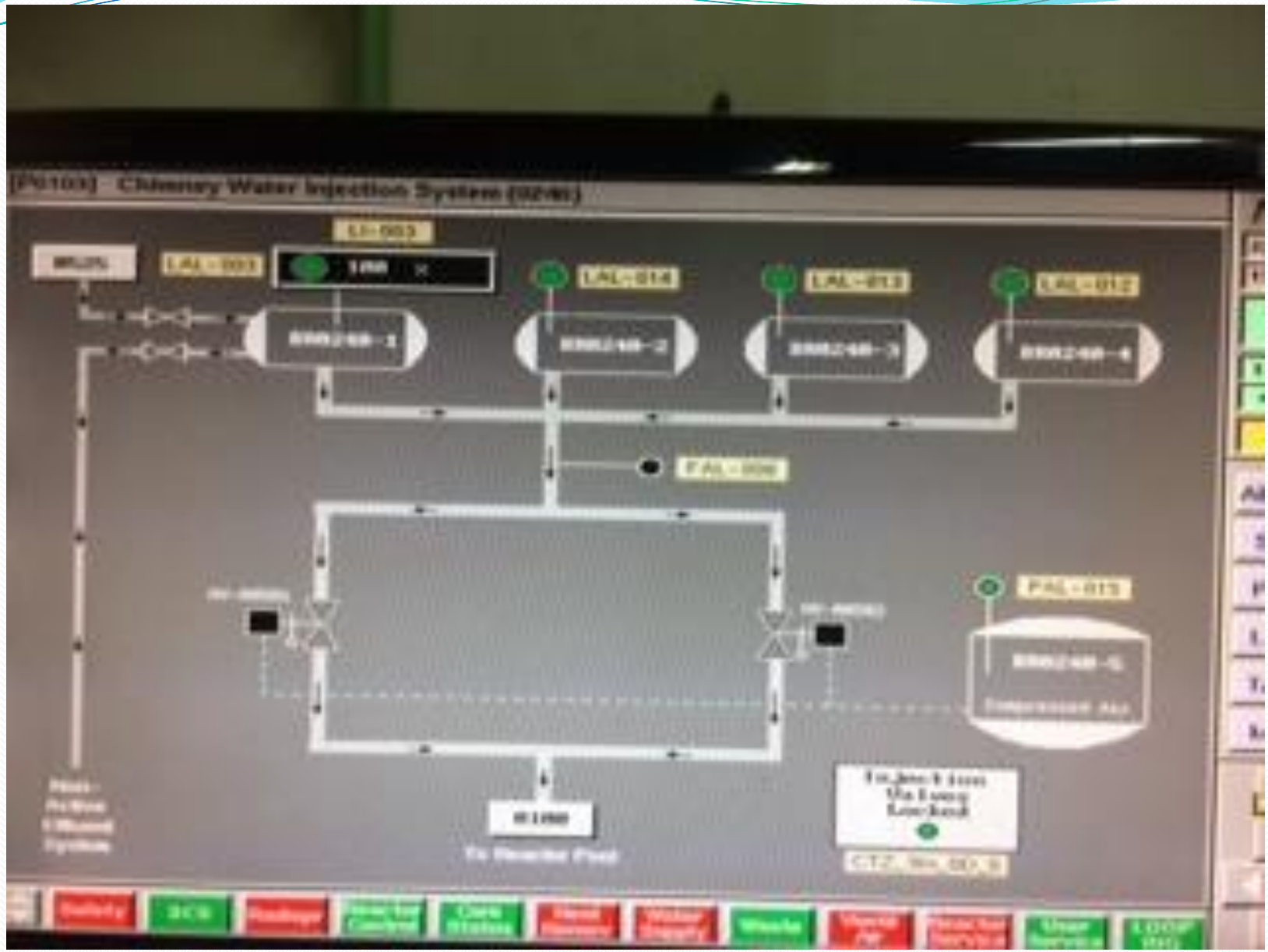
* The mentioned philosophy is strongly verified in ETRR-2

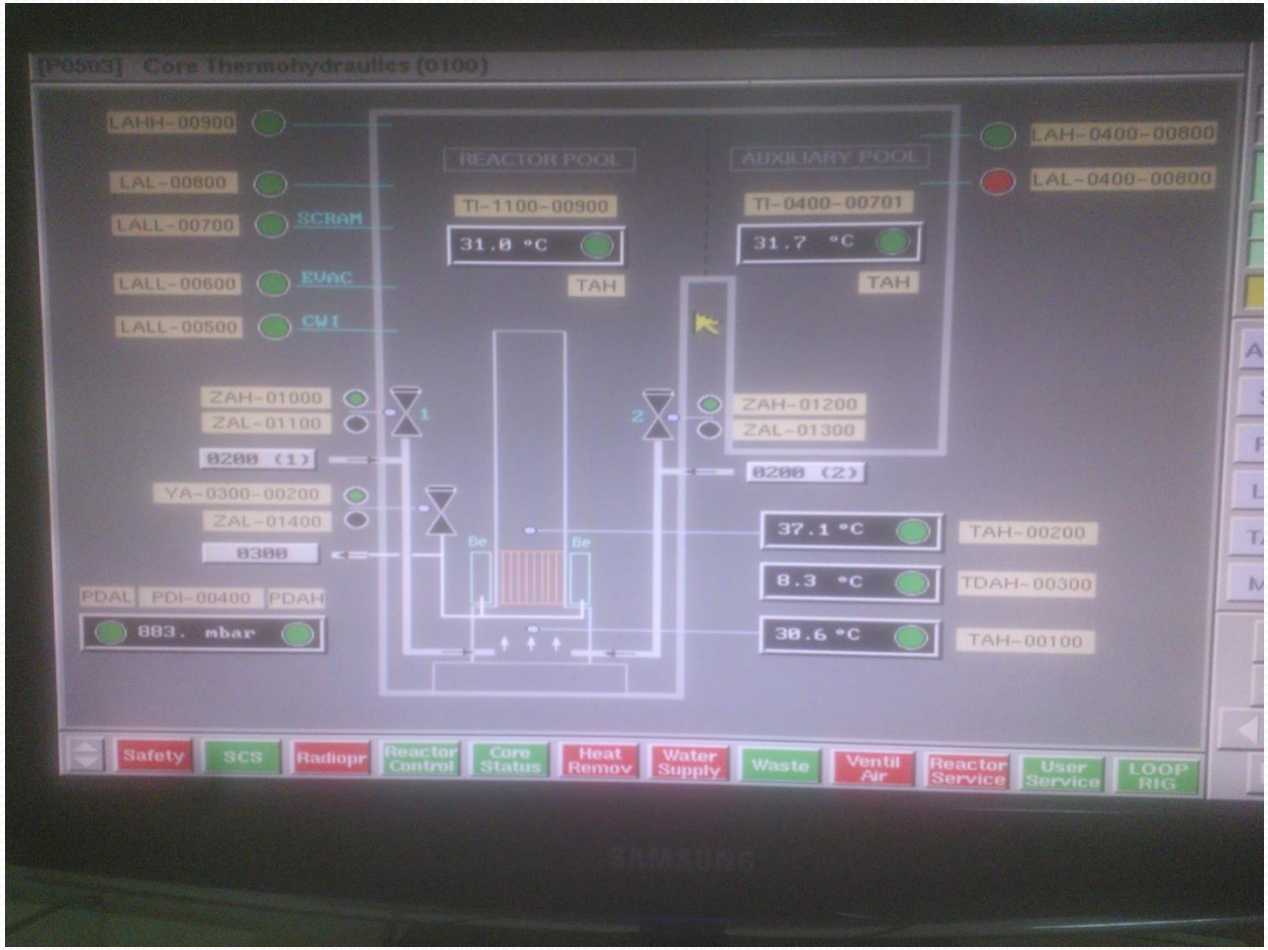
SAFETY SYSTEMS IN ETRR-2

- First shutdown system.
- Second shutdown system.
- Chimney water injection system.
- Evacuation alarm.


C1
C2
S1
C3
S2
C4
OPEN
CLOSE
96.6
98.6
99.6
73.2
99.9
73.7


N2
BR0850-8
PAL-002
P+
P-
PAH-007
ATM
BR0850-9
Dumper Tank
Storage
PAL-009
LAL-008
BR0850-1
Storage
PAL-013
LAL-012
BR0850-2
HV-025
HV-044
Depressurization
PAH-028
PAL-028
BR0850-5
Storage
PAL-017
LAL-016
BR0850-3
Storage
PAL-021
LAL-020
BR0850-4
HV-011
HV-040
HV-015
HV-041
HV-019
HV-042
HV-023
HV-043
PAL-046
BR0850-7
Compressed Air
4230
Injection Chambers
Valves Locked
GDZ_Wx_0D_5
Safety
SCS
Radiopr
Reactor Control
Core Status
Heat Remov
Water Supply
Waste
Ventil Air
Reactor Service
User Service
LOOP RIG


[P0103] Chimney Water Injection System (0240)
LAL-014
LAL-013
LAL-012
PAL-015


[P0503] Core Thermohydraulics (0100)
LAHH-00900
LAL-00800
LALL-00700
SCRAM
LALL-00600
EVAC
LALL-00500
CWI
REACTOR POOL
TI-1100-00900
31.0 °C
TAH
AUXILIARY POOL
TI-0400-00701
31.7 °C
TAH
LAH-0400-00800
LAL-0400-00800
ZAH-01000
ZAL-01100
0200 (1)
YA-0300-00200
ZAL-01400
0300
ZAH-01200
ZAL-01300
0200 (2)
37.1 °C
TAH-00200
8.3 °C
TDAH-00300
30.6 °C
TAH-00100
PDAL
PDI-00400
PDAH
883. mbar
Safety
SCS
Radiopr
Reactor Control
Core Status
Heat Remov
Water Supply
Waste
Ventil Air
Reactor Service
User Service
LOOP RIG
SAMSUNG

SAFETY FUNCTIONS

- Safe shutdown.
- Enough cooling for the reactor core.
- Mitigation of the radiation consequences.

* There is additional control room in ETRR-2. It is used in case of emergency to verify these safety functions.

AVAILABILITY AND SAFETY

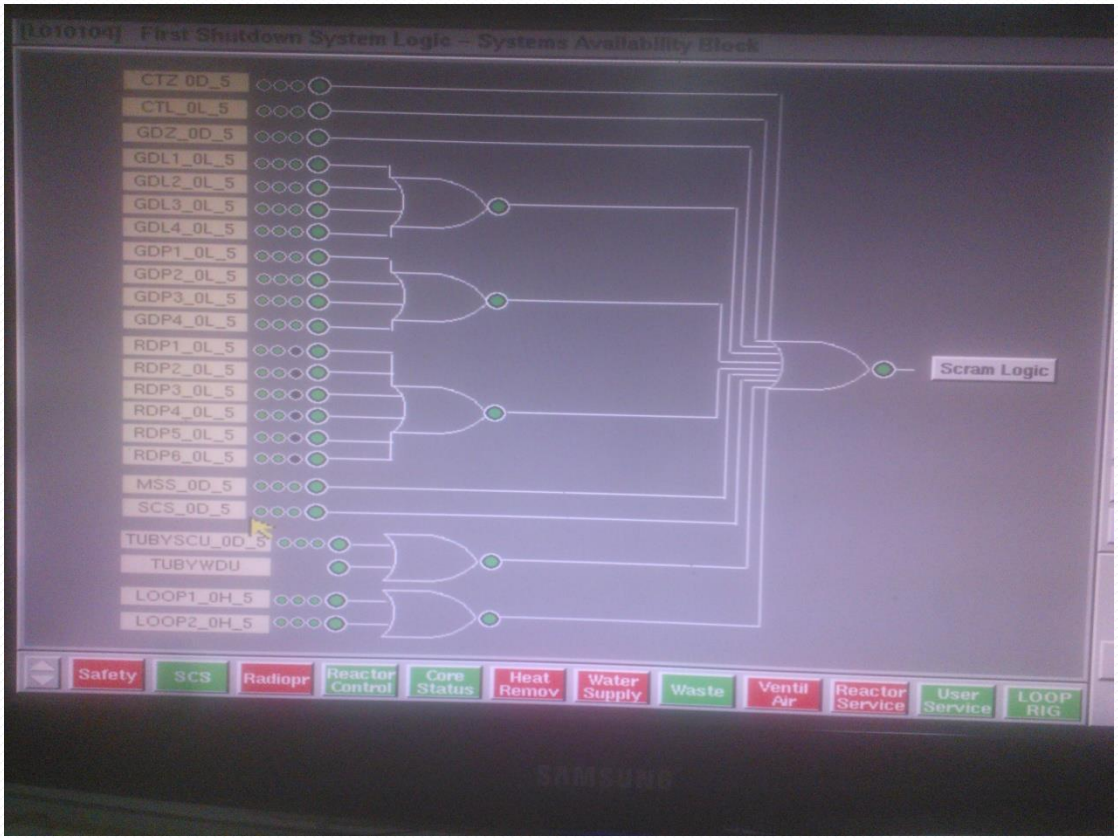
In spite of the importance of availability, it must be limited to levels that keep the reactor operation in safe mode. This limitation of the availability is very important to avoid the human errors.

This principle is very clear in the design of the logic systems of ETRR-2. It makes the reactor operation impossible without verifying all of the safety conditions.

DESIGN BASIS ACCIDENTS

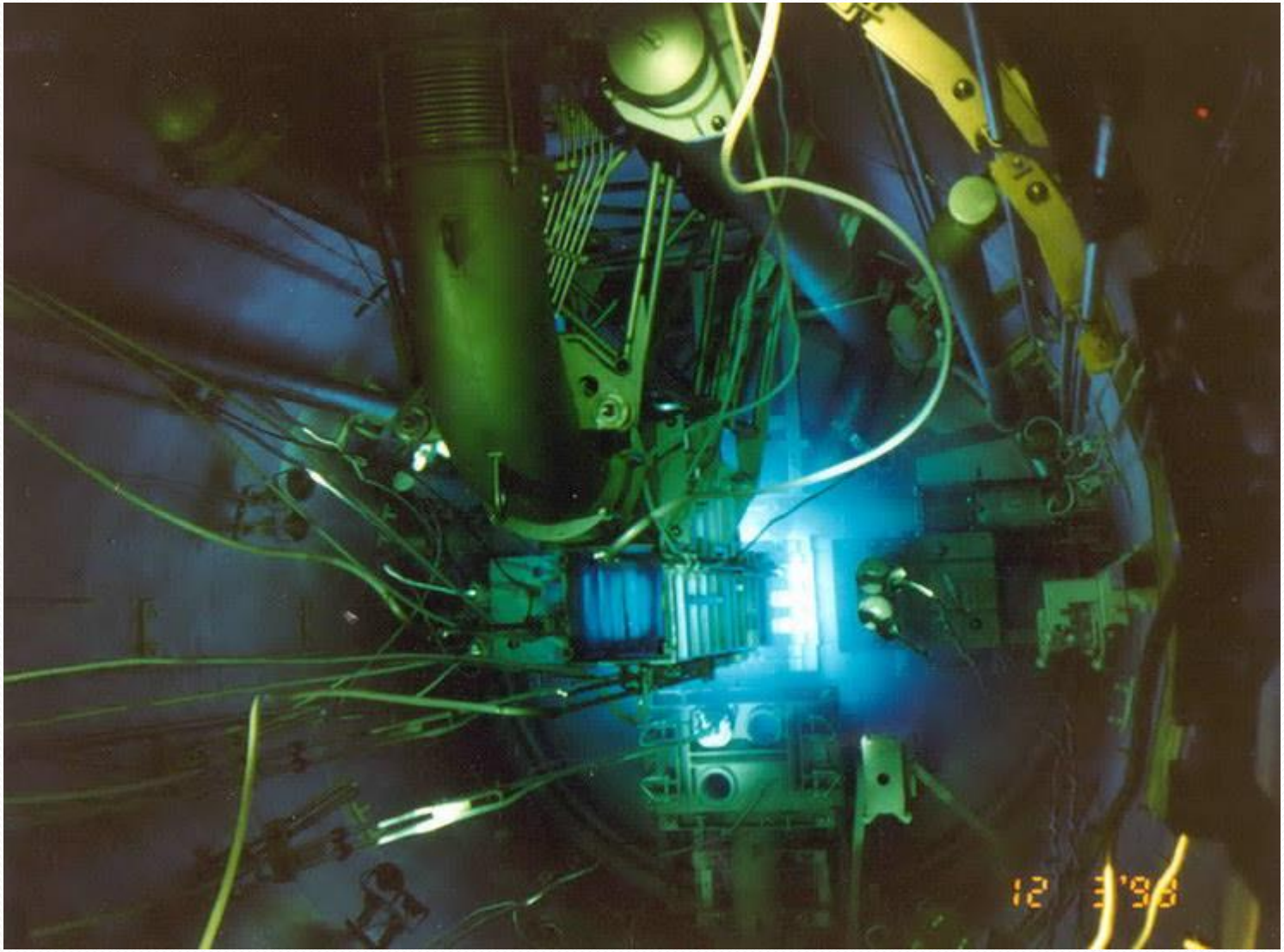
The reactor design must take all of the expected accidents and their scenarios into consideration to adopt the principle of defense in depth in the design.

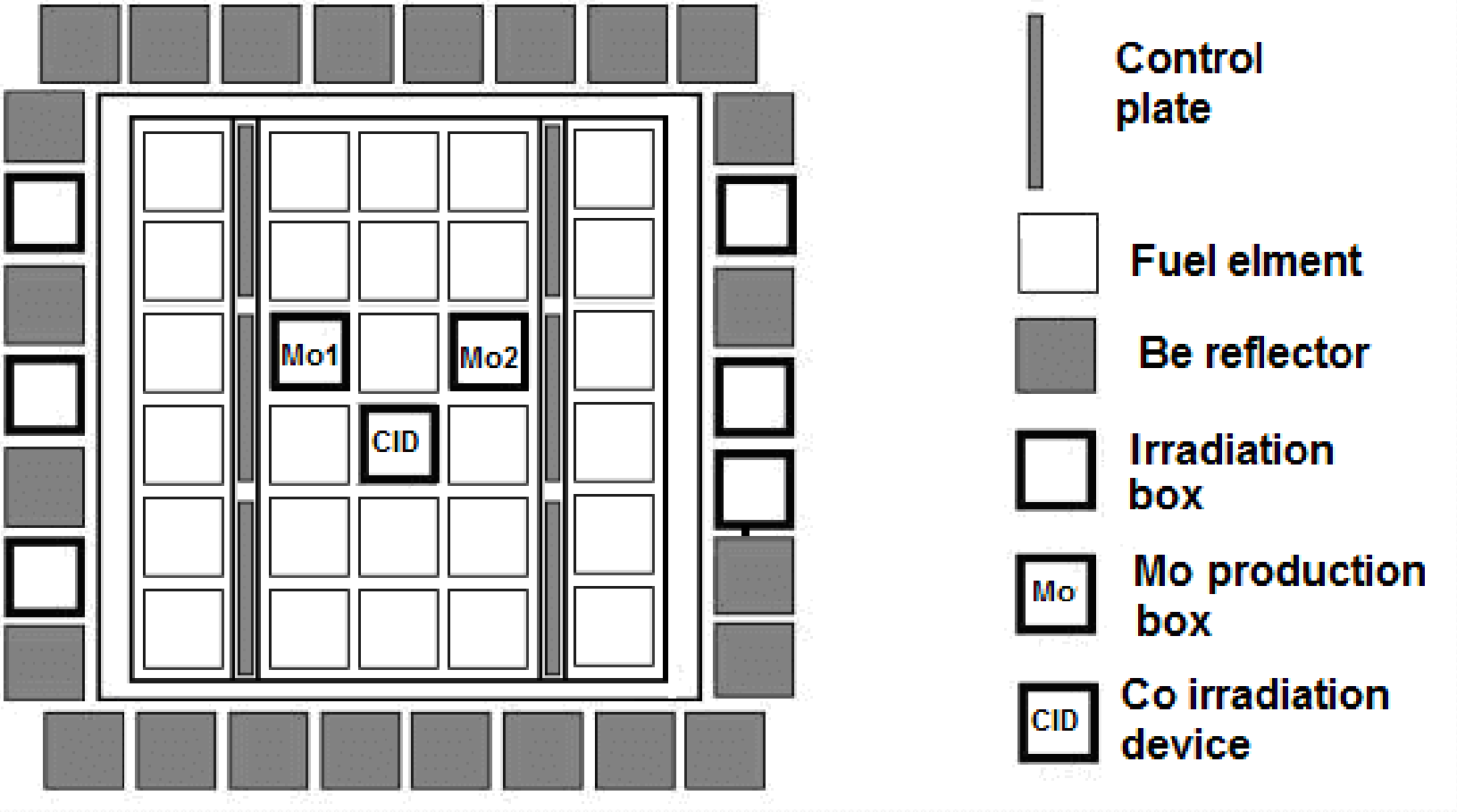
In ETRR-2, this principle is very clear and adopted with the higher levels of safety multiple barriers and recovery actions. There is a *quick reference emergency guide* that can be used by the reactor operation group to verify the safety functions easily and quickly in case of emergency.


[L010104] First Shutdown System Logic – Systems Availability Block
CTZ 0D_5
CTL_0L_5
GDZ_0D_5
GDL1_0L_5
GDL2_0L_5
GDL3_0L_5
GDL4_0L_5
GDP1_0L_5
GDP2_0L_5
GDP3_0L_5
GDP4_0L_5
RDP1_0L_5
RDP2_0L_5
RDP3_0L_5
RDP4_0L_5
RDP5_0L_5
RDP6_0L_5
MSS_0D_5
SCS_0D_5
TUBVSCU_0D_5
TUBYWDU
LOOP1_0H_5
LOOP2_0H_5
Scram Logic
Safety
SCS
Radiopr
Reactor Control
Core Status
Heat Remov
Water Supply
Waste
Ventil Air
Reactor Service
User Service
LOOP RIG

DESIGN BASIS ACCIDENTS IN ETRR-2

- Loss of offsite power supply accident (LOPS).
- Loss of flow accident (LOFA).
- Loss of heat sink (LOHS).
- Loss of coolant accident from pool (Pool LOCA).
- Core loss of coolant accident (Core LOCA).
- Fast reactivity insertion.
- Low reactivity insertion.
- Coolant channel blockage.

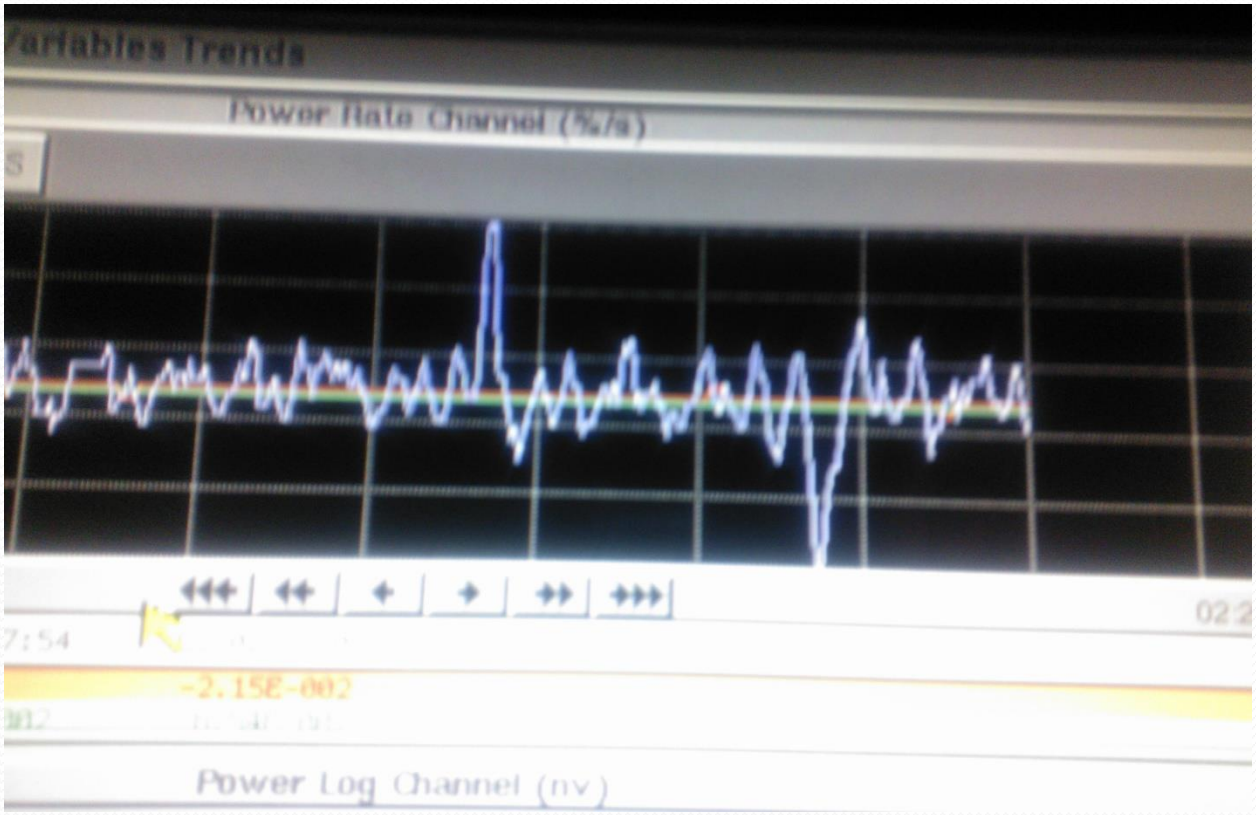

12 3'98


Mo1
Mo2
CID
Control plate
Fuel elment
Be reflector
Irradiation box
Mo
Mo production box
CID
Co irradiation device

Maintenance

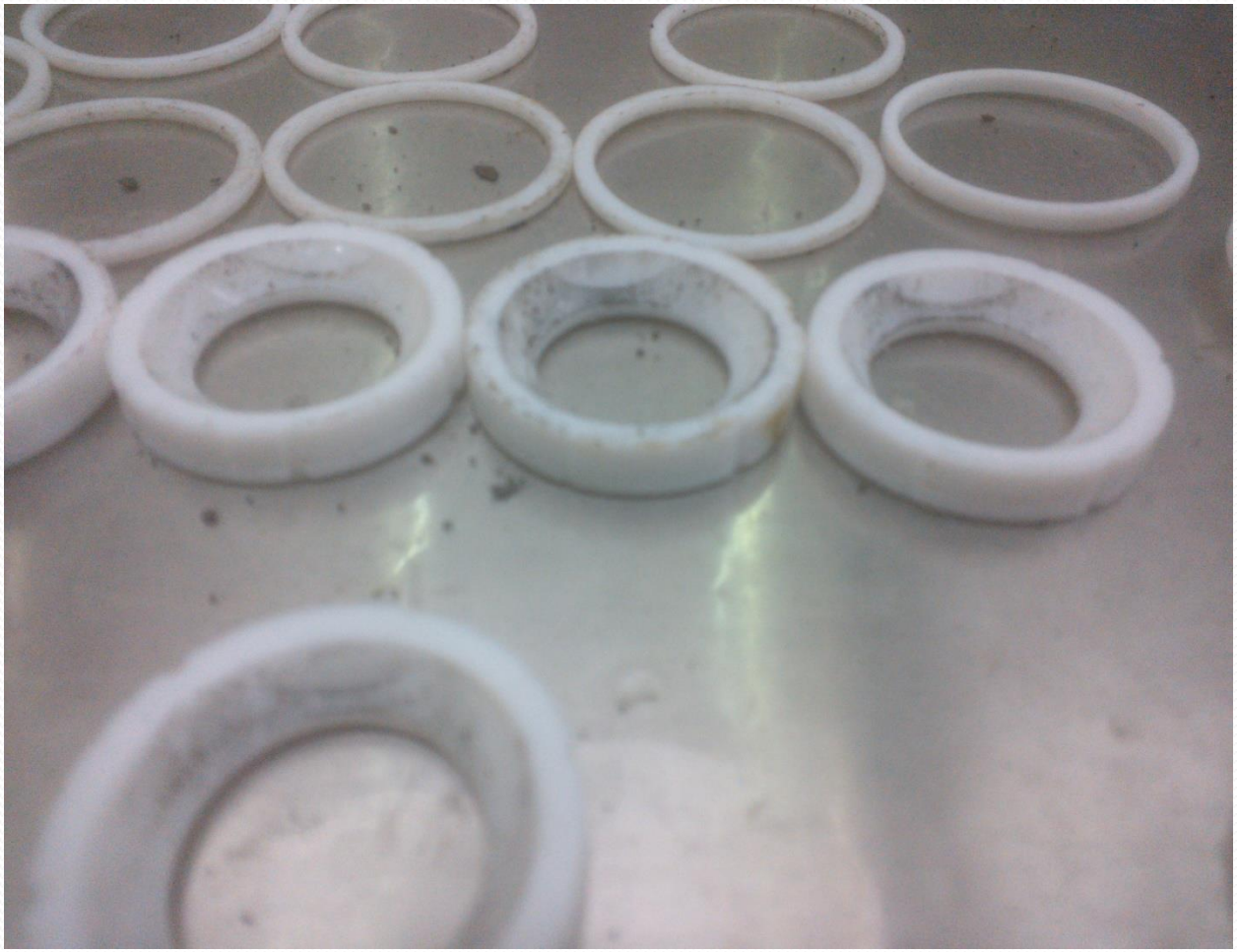
Preventive and corrective

CIC (NOISE)


Variables Trends
Power Rate Channel (%/s)
-2.15E-002
Power Log Channel (nv)

Changing cables and connection

Gadolinium valves



ELECTRIC SYSTEM

Requirements:

Multiple classes for the electric system:

Class A (UPS)

Class B (Diesel generators)

Class C (External power supply)

* All the mentioned requirements are verified in ETRR-2

reassessment recommendations are:

- shortage detected such as some area is out of the fire fighter car range (there is no paved road), and evacuation alarm does not work in some areas
- Periodic tests for safety and safety related systems.
- Ensure training and periodic retraining of the workers.
- Periodic emergency drills must be done and detecting the shortage and malfunctions in the emergency plan, equipment, communications and personal.
- Power of diesel generators should be increase from 500 K.W to 600 K.W to include the feeding of fire pumps in case of loss of site power supply.
- Pay attention to preventive maintenance for the safety systems and related equipments according to maintenance plan.

CONCLUSION

The reassessment of ETRR-2 shows that all of the basic safety functions are fulfilled during the extreme events.

Thank You