EXPERIENCE WITH THE INES SCALE IN EGYPT

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The Egyptian Atomic Energy Authority (AEA) has 4 research centers, the actives of the AEA run into four major fields: research and technological projects, radiation protection and safety, society services activities, regional and international cooperation. The AEA houses some major and research facilities, among them, Egypt' First Research Reactor ET-RR-1, the Hot laboratories Center at Inshas, and the Industrial Irradiator Facility (Egypt's Mega Gamma-1) at Nasr City. The major projects are Egypt's second Research (Multi - Purpose) Reactor (ET-RR-2) and the Cyclotron Accelerator.

The ET-RR-2 is an advanced swimming pool research reactor contracted with INVAP, Argentina in Sept. 1991. This is 22 Mwt reactor will be used in radioisotope production, materials testing research, reactor physics research and reactor thermal engineering research. The ET-RR-2 is to be constructed in the same site as the ET-RR-1, i-e at Inshas, 35 km, North-East Cairo. The Facility is owned and to be operated by the Egyptian Atomic Energy Authority.

The Staff of the National Center for Nuclear Safety and Radiation control (NCNSRC) evaluated the Safety Analysis Report for the application submitted by the Applicant for a construction permit. The staff concludes that the ET-RR-2 reactor Facility, owned by AEA, can be constructed by the Argentinean company INVAP without endangering the health and safety of the public and without causing undue harm to the environment.

The Cyclotron complex is based on a compact AVF cyclotron of Russian type MGC-20 with K = 20. The accelerator is intended to be used in a multi-dsciplinary way. The complex contains provisions for radioisotope production, fast neutron research and applications, use of cyclotron beams in nuclear analytical techniques, biomedical and nuclear medicine applications, and surface modifications and treatment, shielding design of walls, floors and ceilings are done in accordance with ICRP-60 recommendations with dose limit rates to non-occupational exposed individuals not exceeding 0.5m Sv/y.

Both the reactor and the cyclotron are to be commissioned by the end of 1997.

Egypt participated in the INES service since 1991, up till now the scale is applied only once when fire occurred at the Industrial Cobalt-60 Gamma Irradiator, Egypt's Mega Gamma I, on September 5, 1995. The event was rated below scale there was not any releases of radioactivity as a result of the fire, Also no one was injured due to fire or by any other cause.

Since 1991, the scale leaflet was translated to Arabic and issued coloured as the English version. The Scale was introduced in a number of Egyptian and Arabic conferences and meetings. Also articles was published in number of the daily and weekly journals and magazines. The people working in nuclear facilities especially in developing countries have to be encouraged to report any abnormal occurrence without the fear to be Punished.

In the following section thirty years experience with Egypt first Research Reactor (ET-RR-1) operation, was introduced focusing on the famous events that were initiated and the procedures that were taken for their recovery or mitigation is given. Four out of seven events can be attributed to human errors, the events if classified using the INES, some will be below scale and the rest level-1 events.

Event (1):

Partial blockages of coolant channels in some fuel bundles (1965).

Cause:

Melting of rubber seal of core illumination lamp due to residual heat after reactor shutdown.

Evaluation:

Human error due to leaving the lamp in its down position to the next day after some in-core operations.

Mitigation:

1- Unloading these bundles to the spent fuel storage.

2- Embedding them into special sealed stainless steel apparatus constructed and manufactured for cleaning these bundles.
3- The bundles treated chemically to dissolve these substances in acidic solution then using compressed air for agitation and cleaning.
4- Washing the bundles by distilled water and then reloading them into reactor core.

Event (2):

Partial damage in control rods supporting mechanism and deformation in the vertical reloading channel (1966).

Cause:

Release of the loading mechanism wire during reactor cover rotation.

Evaluation:

Unexpected event.

Mitigation:

Welding control rods supporting mechanism and repairing other parts.

Event (3):

Deformation of some fuel bundles during core unloading, (1967).

Cause:

Rotating the large cover before reaching the upper limit of the loading mechanism.

Evaluation:

Human error due to rush in evacuating all core fuel bundles simultaneously.

Mitigation:

Those bundles are barred in special container in the spent fuel storage. The core is cleaned by picking up all residuals and changing reactor water inventory.

Event (4):

Ejection of automatic control rod out of the reactor core, and damage of control rod channel (1979).

Cause:

In this event the motor pulled out the control rod and the ejection was stopped by the failure of the wire connecting the rod with the servo-drive.

Evaluation:

Human error due to undocumented maintenance work.

Mitigation:

1- The control rod channel was repaired.
2- The wire tying the rod with the servo-drive was replaced.
3- Maintenance work in the servo drives and indicator were done. The system was tested before operation.

Event (5):

Severe reduction in water level in the central tank. [i.e. from 580 cm to 300cm] (1986) . No damage because the reactor was not in operating mode.

Cause:

Leakage in drainage valve (no. 20) under central tank.

Evaluation:

Human error due to un-tightly closing the valve.

Mitigation:

Closing the valve tightly and refilling the tank.

Event (6):

Deformation in loading mechanism of irradiated samples in core, (1988).

Cause:

The head of the loading mechanism was broken and release of its spring action.

Mitigation:

Maintenance procedures have been done.

Event (7):

Neutron collimator damage inside channel No. (8).

Cause:

This collimator was 90 cm length. It was extended through the opening of three discs of its gate. It was damaged during channel closing.

Evaluation:

Collimator length was bigger than channel discs length.

Mitigation:

A great mechanical effort has done to remove the damaged collimator from this channel in September 1992. In order to continue the research programme on this channel, a small collimator of length 35 cm which not exceed the length of the first disc is constructed.

MECHANICAL MAINTENANCE PROBLEMS

Some of the most frequent maintenance problems arise in the following parts of the reactor plant:

1- Cooling Tower and Heat exchanger.

Due to the relatively long idle intervals and exposure of-the cooling tower to the environmental climatic' conditions, the wooden frame of the cooling tower is subjected to be ruined. Mud, sand and ashes are deposited on the basement pool and sucked into the heat exchanger tubes causing their blockage. This results in a pressure increase and a decrease in the secondary circuit flow rate and hence less cooling efficiency. Flow rate and pressure before and after carrying out maintenance processes to the heat exchanger, cooling tower and pumps are as follows:

	Flow rate, m3/hr	Pressure, bar
Before maintenance	300	6.5
After maintenance	400	5.0

2- Pumps and valves.
   Due to forces on pump seals, they are frequently subjected to torsion and shear that cause damage to them. Gate valves in the system have many problems on their desks and spindles. Repairing process of suction gate valves are difficult since they are directly connected to the suction pipe from the core.

REACTOR SYSTEMS MODIFICATION

1- The Surface area of the outer concrete shield of the reactor body was covered by three adjacent layers of iron plates in 1967. The thickness of each plate was 15 mm. Machining on plates to form radial shape was done by heavy rolling machines. Horizontal channels shielding configuration as well as ventilation grids in concrete shield were accurately measured and properly appointed by a die on the plates then they were cutout by oxygen. The iron plates were welded vertically and horizontally at their edges and corners. About 50 tons of iron plates were mounted around the concrete shield. The costs were about 10,000 L.E. Project management and daily problems were the experience obtained during that time.
2- Since reactor technology have been developed during the last decades, it was necessary to up-grade the aging control, radiation, protection and measuring systems of ET-RR-1 to achieve safety requirements. A plan was carried out in three stages:

First Stage:

Modernization of nuclear devices, safety and control instrumentation of the reactor through technical assistance from west Germany, 1984.

Rabbit system irradiation facility through the IAEA technical assistance program in 1986.

Second Stage:

Modernization of radiation measurement equipment with a new system from Hungary through IAEA contract No.(EGY/09/15) in

1987. The system contains 30 measuring points distributed in different areas in the reactor building to monitor the radiation levels.

- Installation of a TV monitoring system for continuous observations of working people.
- Installation of a new water treatment equipment to produce demineralized water according to the required quality. The system realizes economy of the exploited power, and reduces the time of demineralized water production.
- Renewal of the cooling tower by adding new steel and peach-pine wooden structures.

Third Stage:

Modernization of ET-RR-1 measuring system. The system performs measurements of coolant flow rate, pressure, temperature and water level inside the reactor core. The project was carried out by the company in Hungary through the IAEA technical assistance program (contract No. EGY/ 04/ 28) in 1989.

Installation of an automatic compensation system for water level replacement inside the core.

Installation of Computerized Safety Logic system, CSIS, (project EGY/09/025). which increases safe operation of reactor and enable continued system check up.

Data acquisition system, DACQUS.

IN- SERVICE INSPECTION PROGRAM (ISI)

Inspection of the ET-RR-1 main components were carried during September 1992 for : reactor vessel, shielding vessel, part of the horizontal channels, spent fuel storage vessel and some parts of the primary circuit piping. The following equipment were used for inspection:

1- Television video system comprises:
   - Closed circuit television camera with the cable.
   - Camera control unit.
   - Display.
   - Video cassette recorder.

2- Ultra device for measuring thickness.
3- Several aluminum pipes having 50 meter length and 60kg weight approximately.

The results show that the reactor vessel surfaces are in good condition and the reactor can work safely.

CONCLUSION

Full implementation of INES in Egypt is delayed. The safety staff at the nuclear facilities have to be encouraged to use the INES scale in classifying the abnormal occurrences take place at their facilities. To facilitate assessment of event INES ratings, a training seminar has to be conducted by the IAEA for the nuclear safety staff at the different nuclear facilities responsible for reporting events.