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ELECTRICAL SYSTEM REGULATIONS OF THE IEA-R1 REACTOR

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ABSTRACT

The IEA-R1 reactor of the Nuclear and Energy Research Institute (IPEN–CNEN/SP), is a research reactor open pool type, designed and built by the U.S. firm "Babcock & Wilcox", having, as coolant and moderator, deionized light water and beryllium and graphite, as reflectors. Until about 1988, the reactor safety systems received power from only one source of energy. As an example, it may be cited the control desk that was powered only by the vital electrical system 220V, which, in case the electricity fails, is powered by the generator group: "no-break" 220V. In the years 1989 and 1990, a reform of the electrical system upgrading to increase the reactor power and, also, to meet the technical standards of the ABNT (Associação Brasileira de Normas Técnicas) was carried out.
This work has the objective of showing the relationship between the electric power system and the IEA-R1 reactor security. Also, it demonstrates that, should some electrical power interruption occur, during the reactor operation, this occurrence would not start an accident event.

Key words: IEA-R1 Reactor, Electrical System, Reactor Security.

1. INTRODUCTION

The IEA-R1 reactor of the Nuclear and Energy Research Institute (IPEN–CNEN/SP) is a research reactor open pool type, designed and built by the U.S. firm "Babcock & Wilcox", having, as coolant and moderator, deionized light water and beryllium and graphite, as reflectors.

The main purposes of the IEA-R1 is the radioisotopes production used in medicine, materials testing, fundamental research in areas such as: physics, radiochemistry, radiobiology and activation analysis, besides human resources training at postgraduate studies and training of personnel for the position of reactor operators.

2. REACTOR DESCRIPTION

The IEA-R1 reactor of the Institute of Energy and Nuclear Research (IPEN) is a research reactor type open pool, built and designed by the American firm "Babcock & Wilcox", having, as coolant and moderator, demineralised light water and beryllium and graphite, as reflectors. The main purposes of the IEA-R1 are the production of radioisotopes for use in medicine, materials testing and nuclear fuels and neutron irradiation of samples. There, it is also conducted fundamental research in various fields, such as physics, radiochemistry, radiobiology, activation analysis and aid to human resources at post-graduate training of specialized personnel for operating reactors.

The first reactor criticality occurred in September 1957. Originally, the reactor was designed for operation at 5 MW, but most operations occurred at 2 MW, until 1997. Between 1995 and 1997, the reactor received a series of modifications to adapt it for security operation at 5 MW. In 1997, the reactor received a temporary authorization for operation at 5 MW.

The reactor pool is located inside the reactor building. It has a total volume of 272 m3 and is divided into two compartments: (a) operating chamber and (b) the storage compartment of irradiated fuel elements. The two compartments can, optionally, be isolated using a gate.
The core of the IEA-R1 is basically constituted by a set of MTR type fuel elements which is submerged in the pool and suspended by a metal frame. The reactor is moderated and cooled by light water.

The control of the reactor power is performed by moving neutron absorbing elements (AE) into the reactor. Each absorbing element contains two Ag-In-Cd alloyed, Ni coated, blades. The start of the absorbing elements, to control the reactor, is done by electromechanical mechanisms, independent by an absorbing element. These absorbing elements have, also, the role of ensuring the safe shutdown of the reactor, when necessary ("SCRAM"), through the free fall of all absorbing elements, by de-energizing of the electromagnets that support these elements. The reactor has only this means of reactivity control with the two functions (control and security). An absorbing element exerts control and safety functions and the other three only exert security.

3. ELECTRIC POWER SYSTEM OF THE IEAR -1 REACTOR

Designed to meet the demand of electric power required by the charges of the reactor (security systems and systems not related to security), the different situations in which the plant can be found, such as during startup, normal power operation, shutdown, maintenance, exchange of fuel elements and accident situations. The system also supplies the Laboratory of Nuclear Experimentation (LEN) and nuclear physics experiments (experimental benches).

It is appropriate to highlight that the information contained herein is directed to show the functional suitability of the system to the plant, as well as to indicate the degree of compliance of the projects with the standards applicable to industrial facilities, basically, the Brazilian Association of Technical Standards (ABNT) rules.

The Electric Energy System is usually supplied by the utility electricity grid (ELETROPAULO) via Jaguaré substation. This extension is connected to IPEN underground distribution network, which is configured with two interlocking rings. In case of electricity supply failure, the charge that should maintain the continuity of the reactor operation, including the experimental benches, which start to be fed by local sources of power (diesel generator group, no-break set or uninterrupted power module).

Configuration

The Electric Power System is divided into three (3) distribution systems. Each system takes into account the desired level of availability in the supply of the electrical power charge of the reactor, in order to maintain the continuity of the operation. Such delivery systems are presented at 3.1, 3.2 and 3.3.

3.1. Normal Electrical Distribution System (NEDS)

Main cargoes:

Air conditioning;

Pumps of the retention tank;

Table of Nuclear Physics (QFF-N-13);

Outdoor illumination.

3.2. Essential Electrical Distribution System (EEDS)

It can tolerate short interruptions in the electricity supply and, so, it is essential to the security and continuity of operation. The EDDS is powered by a normal network: in case some failure occurs in the supply, the system is powered by a conventional group of generators.

-Main charge

220V

-Normal illumination of the reactor building

- Exhaust system and normal ventilation

-Crane

440V

Secondary pumps;

Fans of the towers;

Air compressor;

Valves Insulation System Pool.

3.3. Vital Electrical Distribution System (VEDS)

It can not tolerate interruptions in the electricity supply; therefore, it is essential to the security and continuity of the operation. The SDEV is powered by a normal network in case a failure occurs in the supply system: it is powered by a group of no-break generators and Uninterruptible Power Modules (MPI´s).

Main charges:

220V

Control desk;

Fire Fighting System;

Framework of nuclear physics;

440V

Primary pumps

Exhaust System Emergency

Valves of the Emergency Cooling System (SRE)

The components of security systems of an industrial plant should have low probability of failure, especially if there is a high risk of accidents that could cause environmental damage. In nuclear plants, the presence of robust security systems is not only a technical specification, but also a requirement for license and operation [2].

4. CONCLUSIONS

By the late 80s, the safety systems of the reactor were supplied only by a source of electrical energy, namely, as an example, the control desk was supplied only by the 220V vital electrical system, that in case there is electric energy failure, it is powered by the 220V “no-break” generator group.

In the years 1989 and 1990, a reform of the electrical system upgrading was carried out, upgrading it and adapting it to the changes made to increase the reactor power and, also, to meet the technical standards of the ABNT.

In this reform, were made electrical interconnections between the various security systems were made, causing these systems to have redundant power supply: taking the previous example of the control desk, in addition to being supplied by the vital electrical system, should there be a failure, the power supply can come from the 220V essential electric system, thus increasing the system's security.

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