IAEA-SM-310/31P

IAEA - INTERNATIONAL SYMPOSIUM ON RESEARCH REACTOR SAFETY-OPERATION AND MODIFICATION

CHALK RIVER, ONTARIO, CANADA 23-27 October 1989

SECURITY DEVICES AND EXPERIMENT FACILITIES AT ENEA TRIGA RC-1 REACTOR.
MODIFICATIONS OF EQUIPMENTS.

AUTHORs: PIETRO BIANCHI (ENEA TIB TRIGA - ROMA)
ARMANDO FESTINESI (ENEA TIB TRIGA - ROMA)
EMILIO SANTORO (ENEA TIB TRIGA - ROMA)
GABRIELE TARDANI (ENEA - ROMA)
MAURO MAGLI (TEMAV - BOLOGNA)
GIANLUIGI REIS (COMEC NUCLEARE - CASALE M.)

INSTITUTE LOCATION: ENEA C.R.E. CASACCIA
DEPT. TIB-TRIGA
VIA ANGUILLARESE 301
00060 ROMA (ITALY)

ABSTRACT

RC-1 TRIGA operating exercise staff has realized some auxiliary security devices as follows identified:

a) - Neutron source automatic handling device.

b) - Irradiated samples "Rabbit" connection rotating rack

c) - Auxiliary equipment hot-fuel elements transferring

a) - Neutron source automatic handling device.

The reactor electronic control instrumentation system comprehends various instrumentation channels, which operating capability must be verified by licensee as per italian regulations.

In order to obtain automatic and repeatable operations, TEMAV designed and constructed an equipment with remote drive to transfer neutron sources, on basis of requirements, performances and technical data requested by ENEA-TIB dept.

b) - Irradiated samples "Rabbit" connection rotating rack

Pneumatic radiating system for short lived materials allows an extration of radiated samples in a time no longer as 4 seconds.

For system optimizing, both sides operability and sanitary protection, has been realized a specific rotating rack for connection of irradiated samples with pneumatic transfer (RABBIT).

c) - Auxiliary equipment hot-fuel elements transferring

Actually to permit 1 MW hot fuel elements storage into pits it is necessary to remove hot 100 KW fuel elements and transfer them to re-treatment plant.

The feasibility studies brought evidence the impossibility of use heavy truck inside Reactor Hall.

To avoid all problems it results the opportunity to leave truck outside Reactor Hall and to move only PEGASO container with a special equipment rail running. Rail-truck translation is assured by electromotor driving pull device and security cable.

1. FOREWORD

The ENEA 1 MW REACTOR RC-1 is a modified TRIGA MARK II reactor realized by the Gulf General Atomic (San Diego - California, USA). It is an etherogeneous-homogeneous type, totally reflected and water cooled. Reactor itself is placed at the bottom of an aluminium vessel, of cylindrical shape, open on the top, about 7 m high. This vessel is placed inside the biological shield.

The fuel elements which constitute the reactor core, are cylindrical and made of a ternary alloy of HZr-U, containing H and Zr in the ratio 1.7 to 1.

This alloy contains 8.5 wt % of U enriched to 20 % in U^{235}. These fuel elements have small graphite cylinders at the top and the bottom, and are placed inside a stainless steel sheet.

The reactor incorporates various facilities for a basic nuclear research and training as well neutron and γ radiation studies, isotopes production and sample activation.

RC-1 TRIGA operating exercise staff has realized some auxiliary security devices to permit safe, accurate and quick reactor facilities utilization.

This paper includes a description of three of those security auxiliary devices as follows identified:

- Neutron source automatic handling device.

- Irradiated samples "Rabbit" connection rotating rack.
- Auxiliary equipment hot-fuel elements transferring.

The design of equipments herein described has been based according to specific regulations and standards for nuclear reactor plants as well italian general security dispositions and technical requirements.

All activities relevant to security were executed in compliance with ENEA - RC-1 TRIGA Nuclear Quality Assurance Program Manual and specific prolicies and procedures to be applied for such design and realization.

Enclosed figures show mechanical features, main assemblies and installation of above mentioned devices.

2. NEUTRON SOURCES AUTOMATIC HANDLING DEVICE

2.1 - Basic problem outlines

Reactor electronic control instrumentation system comprehends, as following detailed, a set of instruments for neutron flux measurement and control, a channel for start-up, two linear channels with a large range of survey, a logarithmic channel and also a safety channel.

The licensee, on basis of thechnical italian exercise regulations, is obliged to verify the operating capability of above mentioned channels before start-up and reactor running conditions.

To this purpose, in control schedule, before start-up it is foreseen to admit a signal the nearest as possible to the sensing elements of channel for verifying operating capability itself.

In the past this operation was practically executed fishing with a special electromechanical equipment the start-up source (Am-Be of 5 Ci) settled in a hole of reactor core, and positioning subsequently itself near to the above channel counters. Troubles with such operations were essentially:

a) Big difficulties in positionning neutron source in front of various detectors. Different measurements, effected in different times, with same detector, resulted difficult to compare.

b) System, to much hard-working, because of source coupling up and disconnecting.

c) Caution to be observed in all handling situations, for maintenance and reparation, because of high activity of electromechanical device itself.

d) The possibility to take up radiological doses because of operating on top of reactor and consequently, in a position to touch demineralized water of nuclear process (operation made by protected staff).

e) The waste of time referred to the above mentioned problems.

In order to obtain automatic and repeatable operations, TEMAV designed and constructed an equipment with remote driving to transfer neutron sources, on basis of requirements, performances and technical data requested by ENEA-TIB Dept.

The device so realized is admitting of important developments and with any modifications, may be identified like a standard equipment necessary to all TRIGA type reactors erected in different research institutes.

2.2 - Components

2.2.1 - Electrical supply board and control panel

Electrical supply is low voltage type (24 Vdc) and allows an indipendent driving of linear actuator. Both electrical equipment fixtures are located in Control Room and permit operation from main Control Panel Board (Console).

2.2.2 - Derivation box

This box is located in top reactor area and feeds the linear actuator separately.

2.2.3 - Supports with linear actuators

Aluminium support assembly are fastened to steel beams, installed at top of reactor tank itself. A single support allows a single installation of source, drived by a single linear actuator by relevant source support rod. The linear actuator, commercial type, consists of a motor device with reduction gear, worm type, with a helical gear ball bearing screw, which allows, with a high grade of precision and repeatibility, linear movements.

Limit switches with magnetic proximity sensors allow predeterminated operation selection (translation).

2.2.4 - Source support rods

It consists of a 7 m straight aluminium tube of ø=22 mm composed by single tubes, end screwed and pin fixed, with box ending who contains the neutronic source (0.5 Ci) of Am-Be. Adjustable locking shaft connects tubes to actuators to allow source correct positioning.

2.2.5 - Detector tube containers

The aluminium ion chamber container structure is realized by two tubes ø=120 mm and ø=40 mm diameter with 1200 mm lenght and 90 mm center distance fastened to reflector structure. Each tube respectively permits ion chamber location and rod source driving during translation operation, all without modification of mutual distance itself.

2.3 - Operating features

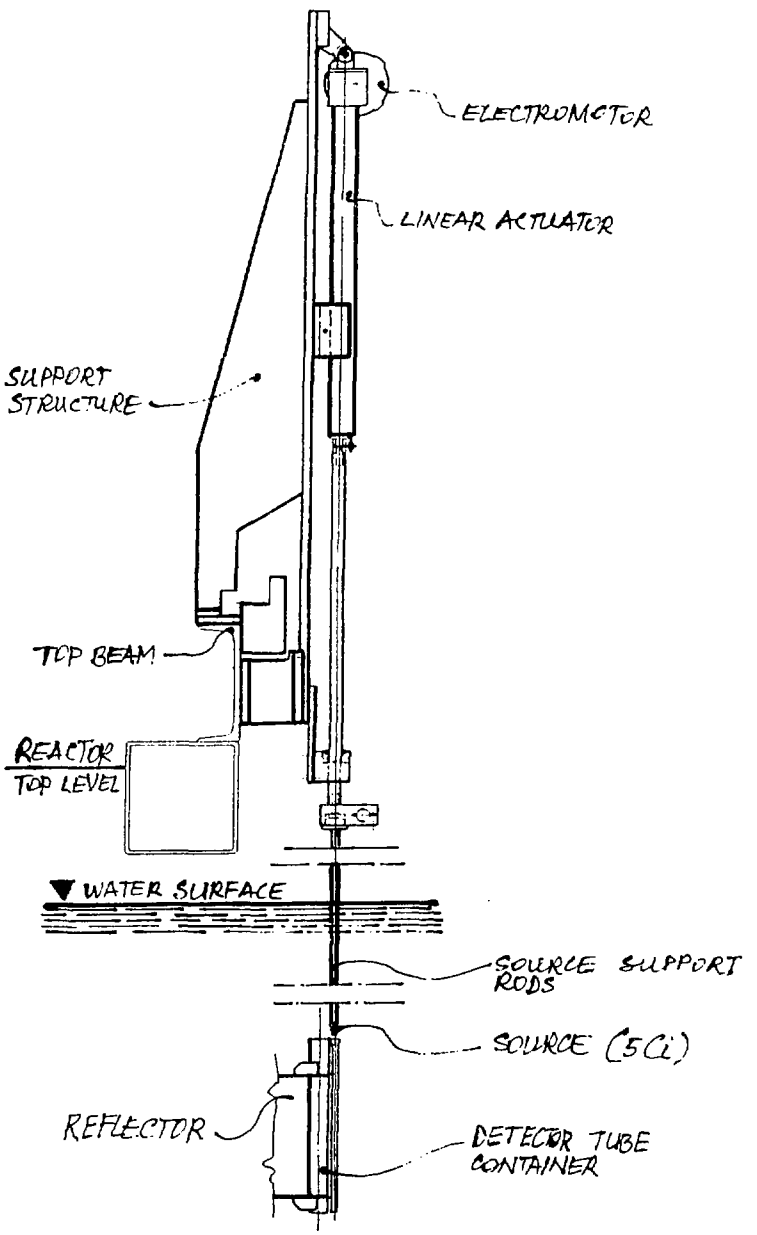
Limit switches set-up is performed referring to neutron source location relevant to max sensibility of detector area.

All reading instrumentation operation, control and comparison, are standard performed to verify daily values validity.

Start-up channel $\log_n$ and power level 1 and 2 channel reading instrumentation are Control Panel Board (Console) performed with relevant meters located in Control Room. The device Control Panel Board contains all information for system operability with up-down level yellow flashing, red and green light indicating source translation and also top-down position for each instrumentation channel.

Fig. 2.4

- NEUTRON SOURCE AUTOMATIC HANDLING DEVICE



3. IRRADIATED SAMPLES RABBIT CONNECTION ROTATING RACK

3.1 - Basic problem outlines

Triga type reactor involves a research plant with some in pile radiation facilities such as a pneumatic radiating system for short lived materials and the pneumatic transfer system (RABBIT) itself allows an extration of radiated samples in a time no longer as 4 seconds. Sample positioning into reactor core is obtained by a tubing system from blower to shielded cell located in the plant Radio-chemical Laboratory, where the "sample introduction box" finds housing, and from here runs up to the hole of grid peripheral ring of reactor core.

For system optimizing, both operability and health physic protection, has been realized a specific rotating rack for irradiated samples connection with pneumatic transfer.

3.2 - Components

3.2.1 - Shielded cell

Cell assembly consists of a lead shielded box of overall dimensions about 1000x1000x1500 mm which contains in-out rack connection samples.

3.2.2 - 10-positions shielded rack

The lead shielded rack with rotating top plate is assembled on bearing supports and anticorodal aluminium housing and elements.

It contains 10-position ring plate opening for samples capsule holders located on peripheral circumference, also totally shielded, each opening accessible by single hole on rotating top plate who contains 10-positions indicator.

A removable plug completes top plate.

3.2.3 - Basic structure

Basic structure consists of a step by step rotating electromotor drived circular plate. Empty rack is manually moved to loading circular plate operating position. Rotation is controlled by electromechanical and electronic system which working conditions are indicated on Panel Board and, in case, provocates rotation block in situation of simultaneous two samples insert, with relevant alarm in Control Room.

Rack system slides on appropriate guides allowing left position, all over rotating plate for loading, and right position for unloading or decaying.

Empty rack slides from guides derivation to rotating plate with box housing alignement.

3.2.4 - Control Panel Board

Control Panel Board of 24 Vdc electrical supply is located in Radio-chemical Room with remoting control in Reactor Control Room.

3.3 - Operating features

Rabbit connection rotating rack allows short lived isotopes irradiated samples use with automatic handling and operability.

Reactor operator checks all operations because of remote control in Control Room.

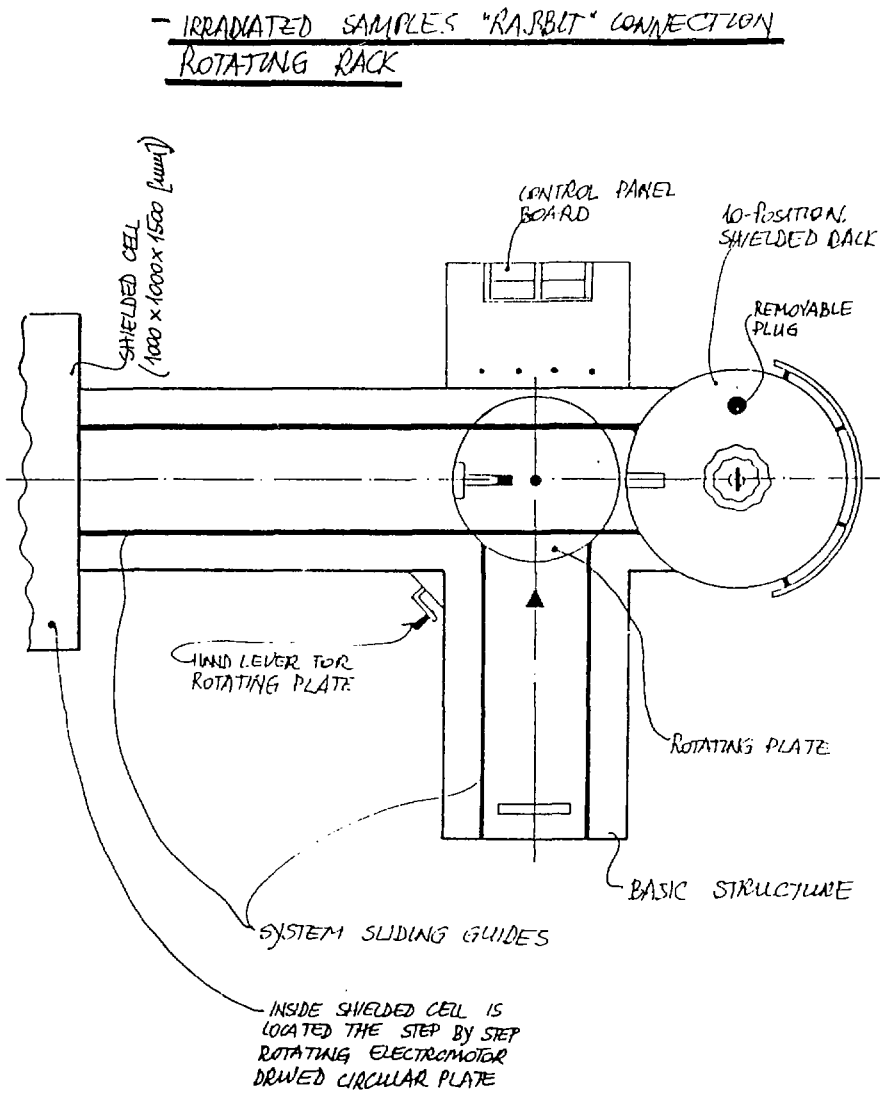
Automation device consists of filling sequence selection possibility for different samples to irradiate and automatic sequence execution.

All switches and control lights of main supply and equipment Control Board, located in Radio-chemical Room, have three lights indicating main operational situations:

- rack arrival missing in samples connection box;
- sample request indications in assigned opening;
- rack full and rack empty changing request indication.

Filling sequence is indicated on Control Panel Board by digital displays.

Fig. 3.4


- IRRADIATED SAMPLES "RABBIT" CONNECTION
ROTATING RACK
SHIELDED CELL (1000 x 1000 x 1500 [mm])
CONTROL PANEL BOARD
10-POSITION SHIELDED RACK
REMOVABLE PLUG
HAND LEVER FOR ROTATING PLATE
ROTATING PLATE
BASIC STRUCTURE
SYSTEM SLIDING GUIDES
INSIDE SHIELDED CELL IS LOCATED THE STEP BY STEP ROTATING ELECTROMOTOR DRIVED CIRCULAR PLATE

4. AUXILIARY EQUIPMENT HOT FUEL ELEMENTS TRANSFERRING

4.1 - Basic problem outlines

The ENEA RC-1 TRIGA reactor is a more than 20 years old installation originally of 100 KW, actually 1 MW power after structure modification.

Because of power upgrading 100 KW fuel elements were stored in pits located inside Reactor Hall. Fuel transfer from tank to pits is by "Coffin" realized.

Actually, to permit 1 MW hot fuel elements storage into pits, it is necessary to remove previous hot 100 KW fuel elements and transfer them to re-treatment plant. Special PEGASO container of 20000 Kg weight, loaded on special truck, performs transfer itself.

The RC-1 plant is a research installation not allowing industrial fuel handling as usually by PEGASO container performed.

The feasibility studies brought evidence to:

- RC-1 floor slab structurally not designed for heavy loads
- access door and Reactor Hall not designed for big dimension equipment
- bridge-crane working area not covering access door zone
- any case impossibility to engage main access door and run-way because of operational long time and security of TRIGA itself.

To avoid all above mentioned problems it results the opportunity to leave road-truck outside Reactor Hall and to move only PEGASO container with a special equipment rail running. Rail-truck translation is assured by electromotor driving pull device and security cable.

4.2 - Components

4.2.1 Rail

Rail-way 14 m lenght runs 8 m inside Reactor Hall connecting bridge-crane working area to access door, and extends outside Hall others 6 m.

Rails are installed on transversal steel mainframes of different hight, to obtain min 2 % slope for assuring constant cables tension in pulling and security. Anchor bolts, heavy type, assure frames to slab foundation.

Rails structure section inside Reactor Hall, in access door zone, is allowed to rotation till vertical position by shaft electromechanical motor driving, connected with rotating section itself. This facility permits free access to Reactor door during all fuel transfer operations.

Pull device is constitued by electromechanical equipment and gear box at low revolution number. Security cable is also installed and hand operated by winch. Both devices are fastened on special headframe located near Reactor tank.

4.2.2 - Rail-truck

Grid of steel shapes, with loading surface to compensate rail slope, constitues the rail-truck structure restoring original PEGASO road-truck fastening, to road truck. On front transversal beam, both pull and security hooks are installed.

4-axis (8 steel wheels), able to transfer total weight to railway structure, support the system and assure PEGASO container verticality to connect "Coffin" hot fuel elements with perfect security operation.

4.3 - Operating features

To perform transfer of hot fuel elements from pits to PEGASO rail-truck system is operating as following:

- transfer of PEGASO from road-truck to rail-truck outside Reactor Hall
- rail-truck with PEGASO pulling in Reactor Hall at Reactor tank proximity and fastening in operating position
- vertically rail section rotation assuring access to Reactor Hall door
- Reactor Hall door closing to assure negative pressure in ambience.

- hot fuel elements transfer by "Coffin" and bridge-crane, and cyclic operation till end of hot fuel transferring itself
- equipment assembly outside building sliding after railway restoration
- PEGASO road-truck loading.

Fig. 4.4

- AUXILIARY EQUIPMENT HOT FUEL ELEMENTS TRANSFERRING