RAF1011- Workshop on application of IAEA Safety Standards on Operational Radiation Protection and Radioactive Waste Management for Research Reactors, Kinshasa, Democratic Republic of the Congo, from 9 to 13 September 2024

Operational Radiation Protection Program and Radioactive Waste Management of NUR Nuclear Research Reactor

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Presentation outline

- Organizational structure & regulatory framework
- NUR Nuclear research reactor

NUR Operational Radiation Protection Program

1. Radiation protection principles
2. Dose-Source control and physical controls
3. Administrative control: work planning, area classification and local rules
4. Monitoring system: workplace and individual monitoring, instruments..
5. Radiation protection aspects of emergency situations

NUR Radioactive Waste Management

1. Radioactive waste generation.
2. Radioactive waste treatment and storage
3. Discharge control and environmental monitoring

Organizational structure

•**Operating Organization:** CRND, Responsible for the safe management and operation of the nuclear facility.

•**Safety Committee:** Assists the Director General in safety-related aspects of reactor operation.

•**Reactor Manager:** Ensures safe operation and utilization of the reactor, approves system modifications, and coordinates emergency operations.

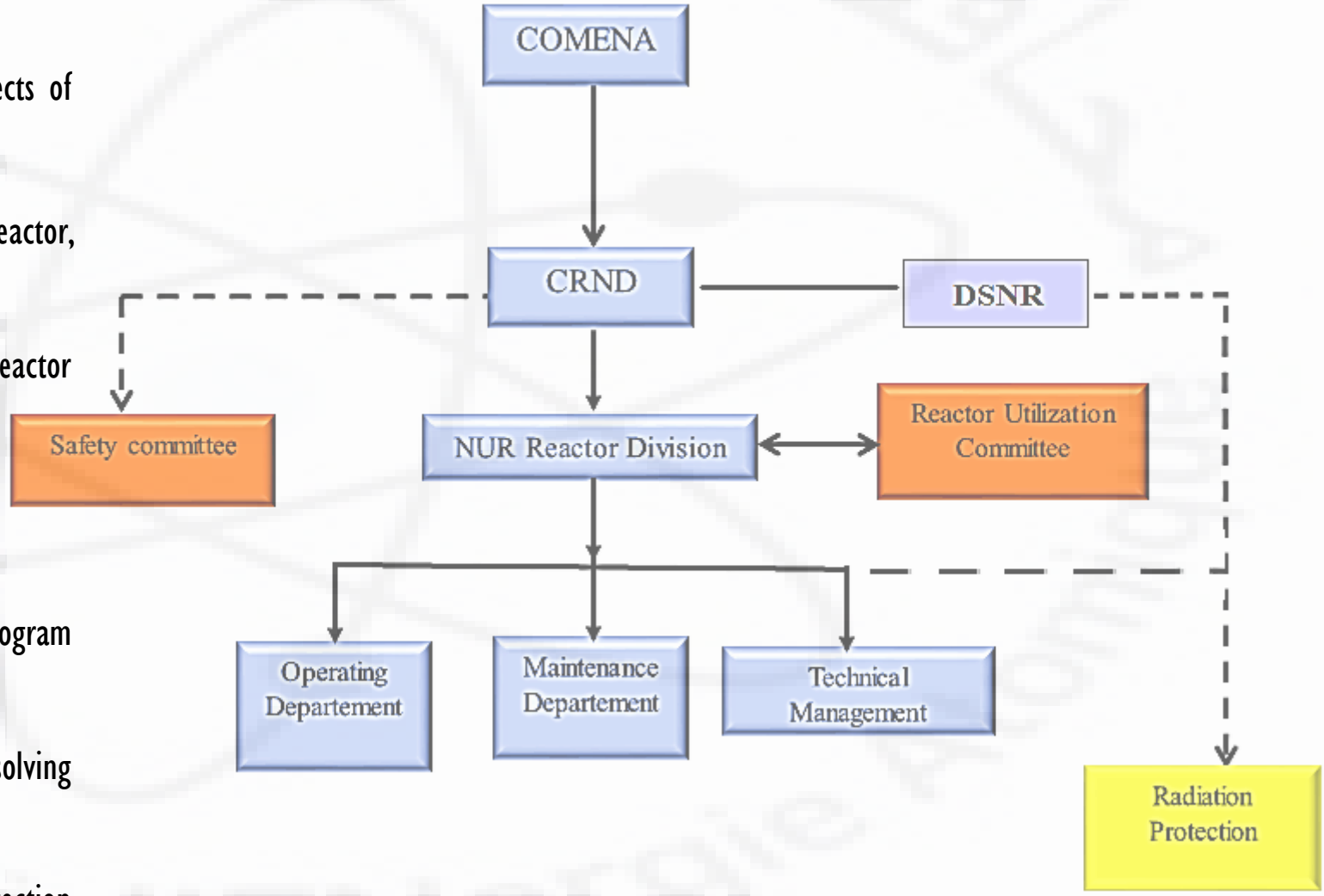
•**Reactor Utilization Committee:** Reviews experiments and oversees reactor system modifications.

•**Operations Staff:** Implements the reactor operation and utilization program.

•**Maintenance Staff:** Executes the reactor maintenance program in consultation with operations staff.

•**Technical Management Staff:** Assess the experiments, Assists in resolving designs and issues.

•**Radiation Protection Staff:** Implement the facility's radiation protection program to ensure the personnel and the facility safety.



REGULATORY FRAMEWORK

- Presidential Decree No. 96-436 of 01/12/1996, establishing, organizing and operating the Atomic Energy Commission
- Presidential Decree No. 99-86 of 15 April 1999 establishing nuclear research centers
- Presidential Decree No. 05-117 of 11 April 2005 on protective measures against ionizing radiation
- Presidential Decree No. 05-118 of 11 April 2005 on the ionization of foodstuffs
- Presidential Decree No. 05-119 of 11 April 2005 on the management of radioactive waste
- Presidential Decree No. 06-183 of 31 May 2006 amending Presidential Decree No. 96-436 of 1 December 1996 establishing, organizing and operating the Energy Commission atomic
- Presidential Decree No. 07-170 of June 2, 2007 amending and supplementing Presidential Decree No. 99-86 of April 15, 1999 establishing nuclear research centers
- Presidential Decree No. 07-171 of June 2, 2007 amending and supplementing Presidential Decree No. 05-117 of April 11, 2005 relating to protective measures against ionizing radiation
- Presidential Decree No. 07-279 of September 18, 2007 amending and supplementing Presidential Decree No. 96-436 of December 1, 1996 establishing, organizing and operating the Atomic Energy Commission
- Presidential Decree No. 14-195 of July 6, 2014 establishing the nuclear security provisions applicable to the physical protection of nuclear installations, nuclear materials and the security of radioactive sources
- Decree Presidential Decree No. 14-195 of July 6, 2014 establishing the nuclear safety provisions applicable to the physical protection of nuclear installations, nuclear materials and the security of radioactive sources
- Order of 27 Moharram 1437 corresponding to November 10, 2015 relating to the medical monitoring of workers exposed to ionizing radiation
- Executive Decree No. 17-126 of 28 Joumada Ethania 1438 corresponding to March 27, 2017 specifying the system for preventing radiological and nuclear risks as well as the means and methods of combating these disasters when they occur
- Law No. 19-05 of 14 Dhou El Kaâda 1440 corresponding to July 17, 2019 relating to nuclear activities.

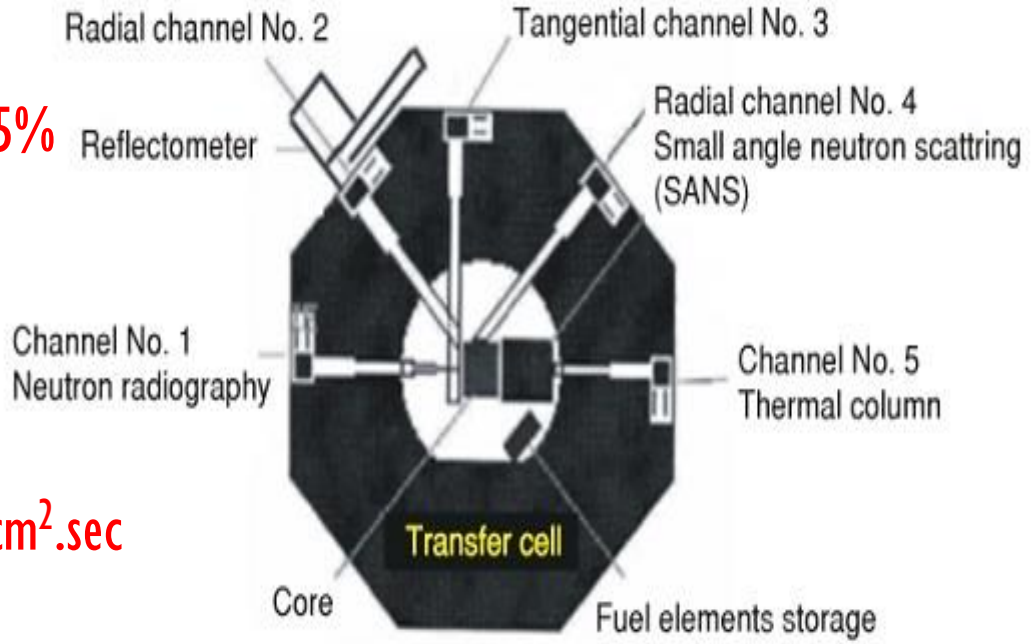
NUR Nuclear research reactor

- NUR is a 1 MW reactor designed, constructed, and commissioned by INVAP for the Algerian government and located in the site of Draria, 15 Km from the city of Algiers.

- Owned by the Algerian Atomic Energy Commission (COMENA) and operated by the Nuclear Research Centre of Draria (CRND)

- Obtained its first criticality on 24 March 198

- This open-pool reactor is Cooled and moderated by light water, It consists of a core with MTR-type fuel elements enriched to 19.75% and graphite reflector blocks providing flexible configurations,



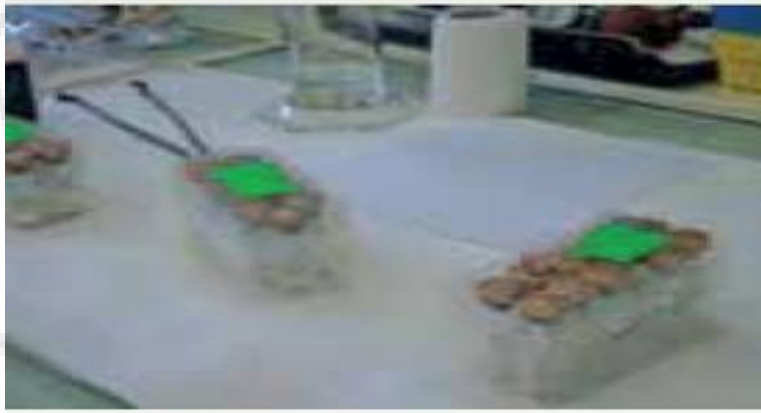
- Four radial and one tangential beam channels, Two vertical irradiation positions with Max thermal neutron flux $\approx 2x10^{+13}$ n/cm^2.sec
- Two fast pneumatic transport systems , One hot cell and one transfer cell
- A shutdown system consists of a set of control plates arranged by pairs and moving inside modified fuel assemblies. This arrangement is known as "fork type" control plates and the absorber is Ag-In-Cd.

Reactor core

- the reactor is a valuable tool for training and education purposes, but this is not the most relevant purpose. it provide many irradiation facilities to conduct advanced Scientific and Applied Nuclear Physics Research.

- NUR Reactor is mainly used for: Training of operators and nuclear engineering students ; Neutron activation analysis ; Neutron reflectometry ; Neutron Imaging ; Small angle neutron scattering (SANS), and Production of radioisotopes and radiopharmaceuticals at laboratory scale.

Universal cell



Technetium kits

NUR Operational Radiation Protection Program

- The NUR reactor's radiation protection policy follows the guidelines defined by the responsible authority, and CRND/COMENA, which is the holder of the operating license for this nuclear installation.

- The radiation protection policy adopted for the facility is based on its safety report, national and international regulations and therefrom on all resulting standards and requirements: “NUR Code of Good Practice for Radiation Protection”.
- Operational radiation protection and radioactive waste management programme of the facility establishes a practical and precise radiological protection system for the safe operation of the installation, defining all the procedures for controlling work areas, protecting workers and respecting safety principles, during all operational states.

I. Radiation protection principles

- The operational radiation protection program include The policy statement of operating organization which includes the radiation protection objectives and commitment to the radiological protection principles.

- The objectives of radiation protection are to: Ensure the effective control of doses to the workers and public, and of releases to the environment; Ensure conformance with all regulatory requirements; and Enable further optimization of operational practices.

- The three basic principles that underpin radiation protection, are expressed in Safety Principles

1. **Justification :** Facilities and activities that give rise to radiation risks must yield an overall benefit.

2. **Optimization :** Protection must be optimized to provide the highest level of safety that can reasonably be achieved..

3. **Limitation :** Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm..

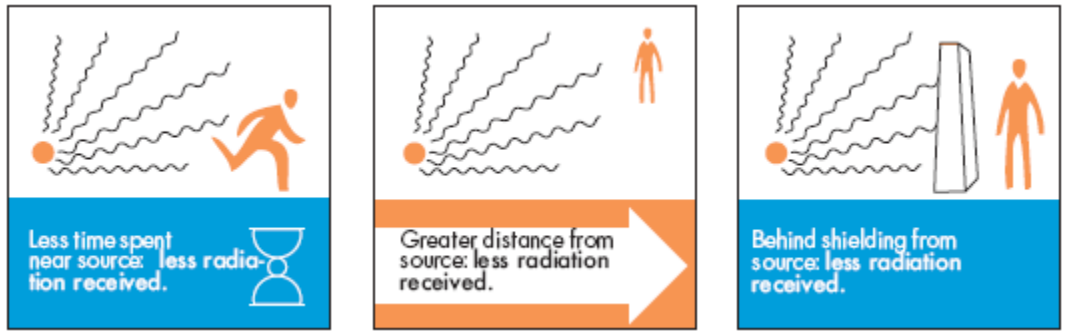
2. Dose-Source control and physical controls

- **Source Control**

In the field of radiation protection, the term source is the set of radionuclides contributing to the dose rate at workplace. In case of a research reactor, there is three kind of sources: Reactor Core and Beam tubes, Activation Products (primary cooling circuit, activation analysis samples, RA wastes..) and calibration sources in the laboratories.

To ensure effective Source control, many considerations in design and operation are taken place: Material selection, Quality of reactor coolant, Irradiated fuel and Beam tubes, Minimization of gaseous material and RA Wastes, Assessment of Neutron activation samples…

- **Physical Control:** Considerations in the design and operation



Distance, Time, Shielding , Decay …

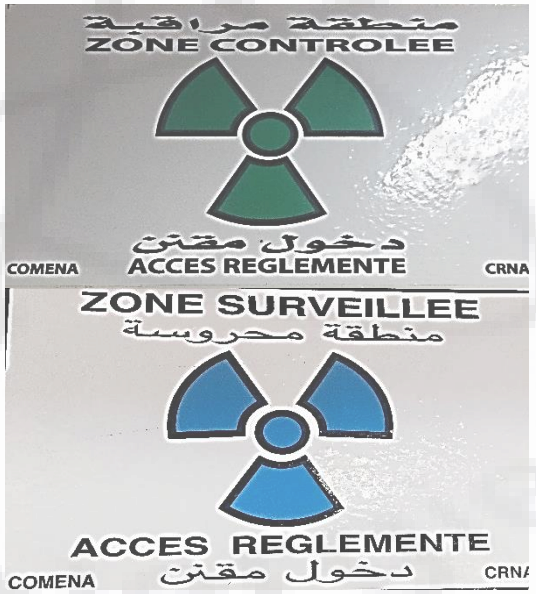
Personnel protective Equipment, Ventilation and decontamination procedures-facility…

3. Administrative Controls and Procedures

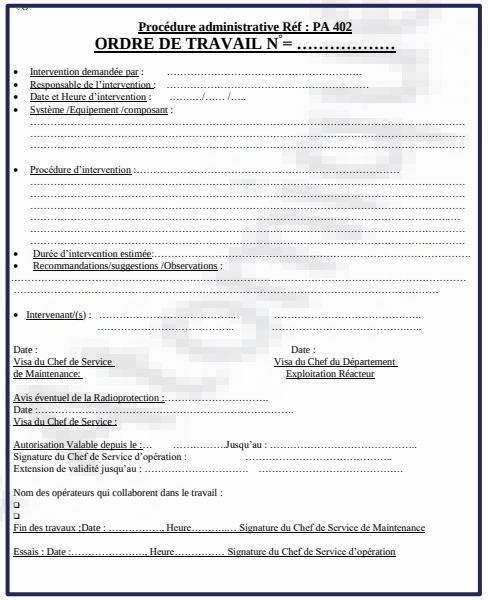
The Aim of RP Controls is to ensure the effective implementation of the radiation protection program. This includes all routine and non-routine controls and inspections necessary to ensure the integrity and safety of personnel and the facility. these controls are translated into procedures to effectively manage activities. These procedures should be developed and approved for all activities of radiological significance and for all activities for radiation protection purposes.

Radiation protection procedures are to be enforced and followed by all the reactor staff, transient personnel and visitors.

- **Procedures and controls include** :
  - ✓Radiation Work Permits
  - ✓Working Area Classification and access control
  - ✓Experiment approval;
  - ✓Sources discharge
  - ✓Archives and inventories



Working Area Classification



Procédure administrative Réf : PA 402

ORDRE DE TRAVAIL N° = ……

- Intervention demandée par : ……
- Responsable de l'intervention : ……
- Date et Heure d'intervention : ……/……/……
- Système /Equipement /composant : ……
- Procédure d'intervention : ……
- Durée d'intervention estimée : ……
- Recommandations/suggestions /Observations : ……
- Intervenant/(s) : ……

Date : Visa du Chef de Service de Maintenance:

Date : Visa du Chef du Département Exploitation Réacteur

Avis éventuel de la Radioprotection : ……
Date : ……
Visa du Chef de Service :

Autorisation Valable depuis le : …… Jusqu'au : ……
Signature du Chef de Service d'opération : ……
Extension de validité jusqu'au : ……

Nom des opérateurs qui collaborent dans le travail :

❑
❑

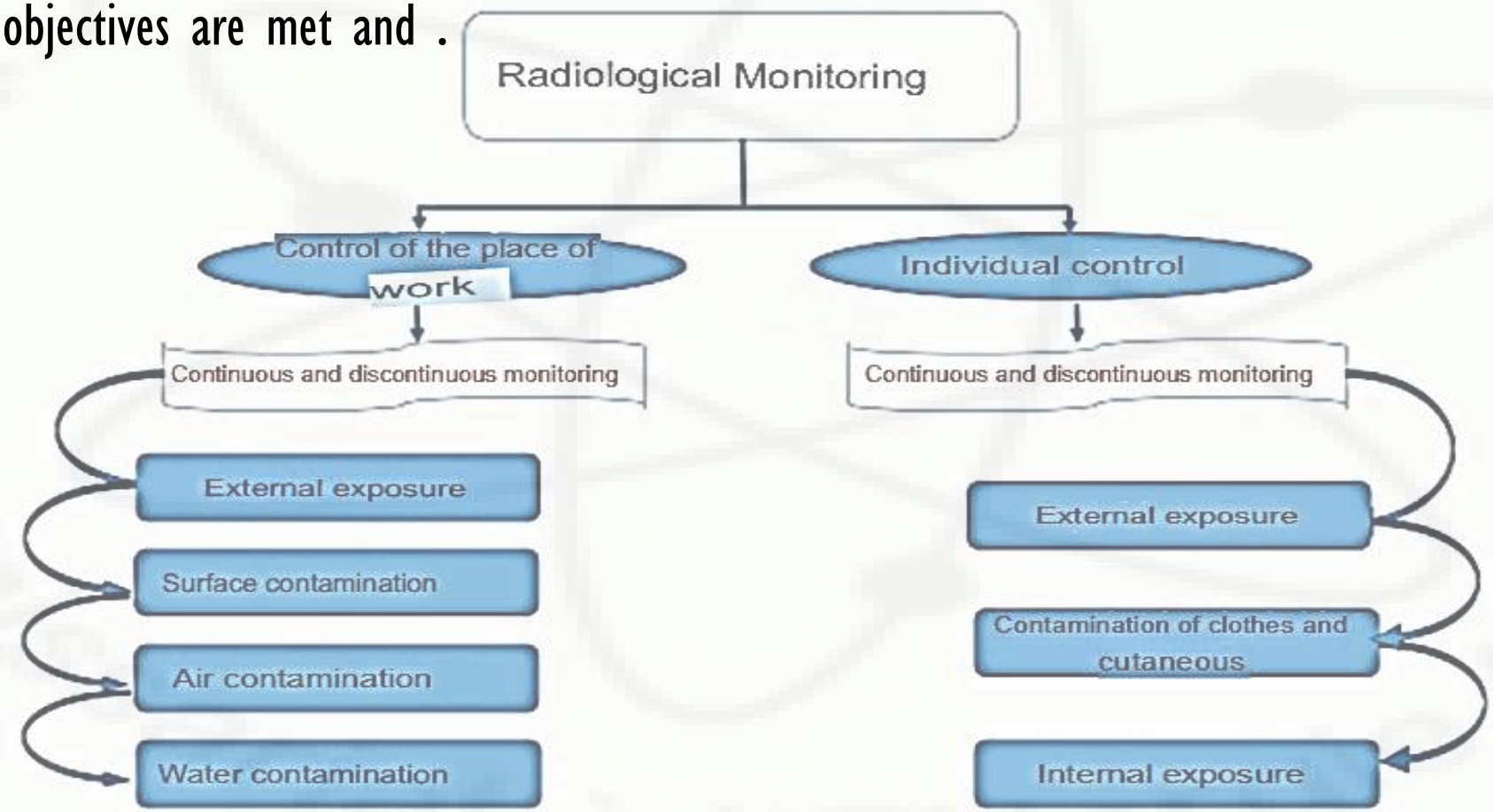
Fin des travaux :Date : ……, Heure…… Signature du Chef de Service de Maintenance

Essais : Date :……, Heure…… Signature du Chef de Service d'opération

Radiation Work Permits

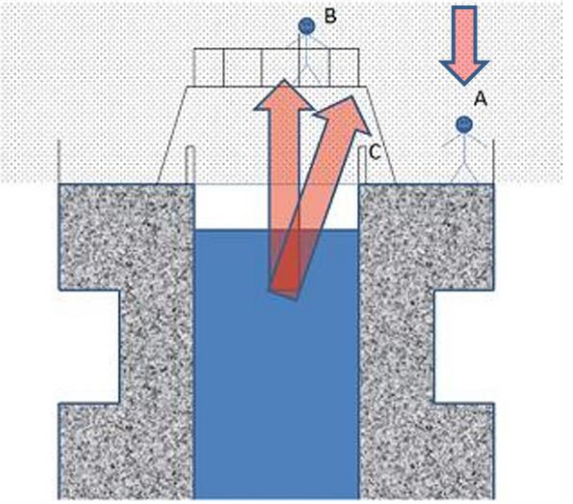
4. Monitoring system: workplace and individual monitoring, instruments

The radiation protection monitoring system at NUR research reactor guarantee that all the activities that could lead to exposure are planned, supervised, and executed in a way that ensure that the radiation protection objectives are met and .



Discontinuous radiological monitoring

All activities in the program shall be performed using written approved procedures, This include:



- monitoring of external dose to personnel and radiation levels in areas,
- monitoring of contamination of personnel, areas, surfaces and objects;
- Environmental monitoring;
- Monitoring of operation and maintenance tasks,
- handling of fuel irradiated samples and use of radioactive sources
- handling of ventilation filters, primary cooling circuit and working with ion-exchange resins, etc.
- Calibration and test of radiation protection equipment.
- RA Waste monitoring and management;
- Control the transport and movement of radioactive materials as irradiated samples and radioactive sources.

Example of some RP routine procedures

Discontinuous monitoring controls are carried out by radiation protection officers using portable equipment. The measured values are recorded on checklists and archived. Some routine procedures include:

Procedures	**Frequency**
Monitoring of the reactor facility.	Daily
Monitoring of surface contamination in the reactor building and laboratories	Weekly
Sampling and analysis of air in the reactor hall, laboratories and reception hall.	Weekly
Sampling and analysis of water from the primary and secondary circuit.	Weekly

Continuous radiological monitoring

The NUR reactor has :

- Continuous monitor of gaseous effluents related the ventilation system allows to control the effluents discharged to the environment.
- fuel cladding rupture detection monitor (MRG). It is located at the inlet of the decay tank.
- heat exchanger rupture detection monitor (MSEC). It is located in the pump room connected to the exchanger outlet to the secondary circuit
- 24 Geiger-Müller type area monitors that allow the measurement and continuous monitoring of gamma exposure rates at the most representative locations.
- Neutronic control-detection system of the reactor

The measured values by those systems are displayed at the measuring devices and/or at the control room level and related with NURSAO system, to reflect the overall radiological situation of the installation in real time.

Instruments and Equipment

In addition to the administrative controls and procedures, and to enable its effective implementation, NUR radiation protection program includes Sufficient and appropriate instrumentation and equipment for facility and personnel monitoring and protection.

As described in the NUR facility monitoring system, there is a two kind of radiological instruments and equipment: fixed and mobile.

Contaminamètre de surface
RadEye AB100 Alpha-beta

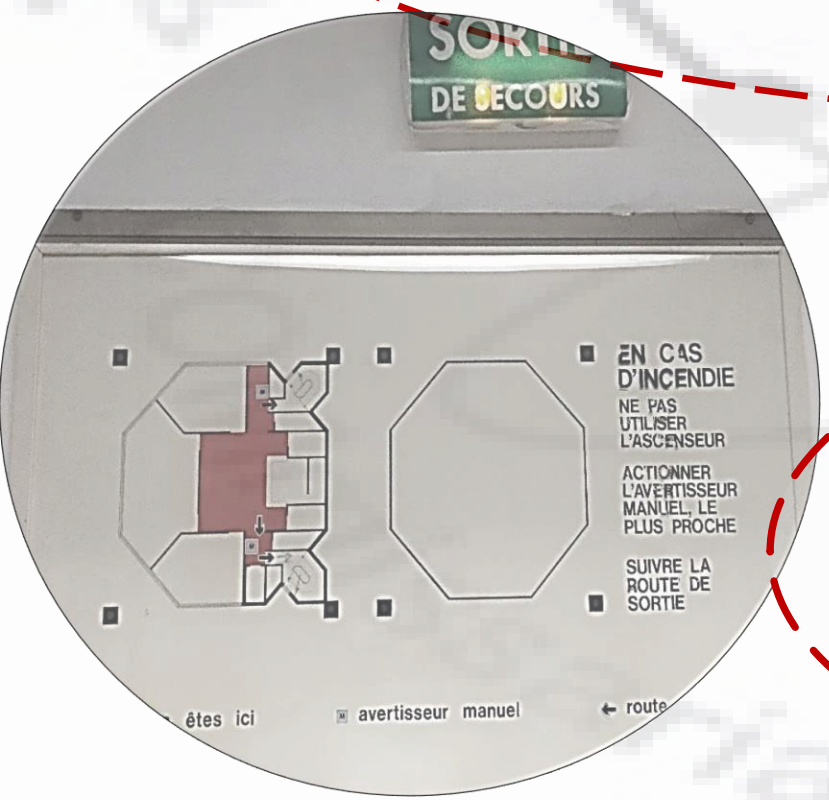
All instruments and equipment in the reactor are tested and calibrated regularly as required by regulations.

5. Radiation protection aspects of emergency situations

What is an Emergency ?

It is a situation of exposure that arises as a result of an incident, a malicious act or any other unexpected event, and requires prompt action in order to avoid or to reduce adverse consequences.

[GSR-7,Décret executive n° 17-126]



What Radiation protection to do ?

- Arrangements must be made for emergency preparedness and response
- Communicate and Evaluate the situation constantly
- Radiation protection procedures for evacuation and decontamination

NUR Radioactive Waste Management

All the parties concerned by radiation activities shall ensure that management of radioactive waste in the facilities and discharges of radioactive material to the environment are managed in accordance with the authorization and regulations [GSR-5,Décret executive n° 05-119]

Licensees Shall ensure that :

- Any radioactive waste generated is kept to the minimum practicable in terms of both activity and volume;
- radioactive waste managed and disposed in accordance with the requirements and Standards
- maintain an inventory of all radioactive waste that is generated, stored, transferred or disposed

I. Generation of radioactive Wastes at NUR facility

Radioactive Waste in the NUR reactor are mainly generated from

- The reactor operations : Primary system drains (primary pump), Gaseous radioactive elements or compounds from the pools, demineralization coolant systems..
- Laboratories activity : gazes generated in the activation laboratory, decontamination liquids, Irradiated samples, Al target capsules, solid wastes as gloves and paper..
- Maintenance and operation activities : Ventilation filters, Washbasin and shower liquids, Demineralized waste water recovered from the drainage of large equipment in maintenance operations, contaminated items and equipment.

No used fuel element is moved from the reactor core since its first criticality, the reactor core is perfectly managed by the reactor staff.

2. Radioactive waste treatment and storage

The collection procedure of radioactive waste in the various premises of the installation (Laboratories, Pumps room, pool surface area, Washbasin area…) is carried out regularly by putting in place the necessary material and human resources, and then a selection procedure for this waste was carried out by the radiation protection team according to wastes nature and activity and their packaging before the storage and disposal procedure.

3. Discharge control and environmental monitoring

- Gaseous radioactive wastes are treated by the ventilation system of the facility, the release of the this wastes is controlled by the MCEG system integrated to ventilation in accordance with the regulations limits
- Liquid radioactive wastes are stored in a storage pool of the facility (reactor storage facility) underground the cooling system, samples and spectrometric analysis are made by RP officer and an "approved radio isotopic laboratory" before the discharge to the environment (discharge control measures)
- Solid radioactive wastes including dismantled contaminated equipment are store and disposed in the reactor storage facilities (dry cemetery, used fuel cemetery, wastes shed of the reactor). After specific time, some of this wastes are transferred by the radioactive wastes department/DSNR to more convenient storage place.

All the radioactive wastes generated by the facility activities are managed, registered and controlled in compliance the regulations and standards.

Presentation Summary

- The reactor NUR is a valuable tool for Scientific research, training and education purposes.
- COMENA's organizational structure and regulatory framework for its centers establish a clear radiation protection in compliance with AIEA safety standards and regulatory requirements.
- Operational radiation protection programme of NUR reactor establishes a practical and precise radiological protection system for the safe operation of the facility, defining all the procedures for controlling work areas, protecting workers and public, respecting all safety principles during all the operational states.
- Radioactive waste generated by the facility activities are managed, registered and controlled in compliance the regulations and standards
- The successful safe operation of the NUR reactor for over 30 years underscores the effectiveness of the facility's radiation protection program and the important role of the radiation protection team in establishing a strong safety culture, with a strong dedication of the reactor Staff.

THANK YOU FOR YOUR ATTENTION !