National Report: [Algeria]

[A.Ameur & A.keffaz]

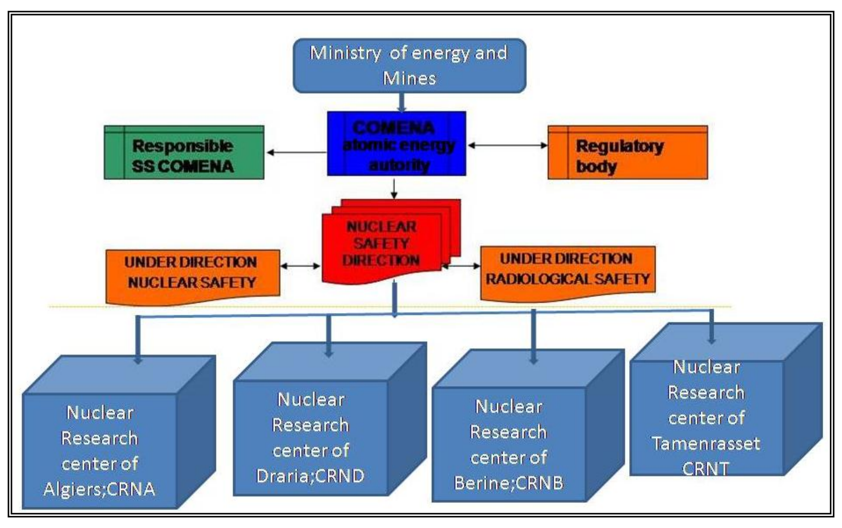
R²D²P: Workshop on "The Review of a Decommissioning Plan under the Research Reactor. Magurele-Bucharest, Romania 4 - 8 July 2011

Research Reactors in Algeria

Algeria has two research reactors

01 Mw reactor located at CRND
- criticality 24-03-1989,
- light water as moderator and coolant ,
- U-235 enriched 19,75%,
- Main utilization: NAA, SANS, Neutron radiography, Reflectometry, Training and code validation

15 Mw, MHWRR reactor located at CRNB
- criticality 17-2- 1992,
- heavy water moderator and coolant,
- Reservoir type with reflector on graphite,
- Vessel — aluminium alloy
- UO2 —fuel, U-235 enrichment 3% max,
- Main utilization: NAA, DNC, Neutron Diffraction, Neutron Radiography, Material Testing, Training and code validation.



Algerian National Atomic Energy Authority

The COMENA (Commissariat à l'Énergie Atomique), belonging to the Ministry of Energy and Mining, is the National Atomic Energy Authority which governs the nuclear safety in Algeria. It regulates and controls nuclear activities as far as radiation & nuclear safety, physical protection and nuclear non-proliferation issues are concerned.

COMENA acts as:
- ✓The Direction of Nuclear Safety;
- ✓Regulatory body: composed by representatives of several ministries, experts in the field and public organizations;
- ✓Body of scientific and technical supports for the nuclear installations under its supervision.

The Operating organizations (operators)

COMENA has four research Centers under its authority. it is about :
- ➢The nuclear research center of Birine (CRNB) operates Es-Salam research reactor (15MW) and acts as the Es-Salam's licensee;
- ➢The nuclear research center of Draria (CRND) operates NUR (1MW) research reactor and acts as the NUR's licensee;
- ➢The nuclear research center of Algiers (CRNA);
- ➢The nuclear research center of Tamanrasset (CRNT)

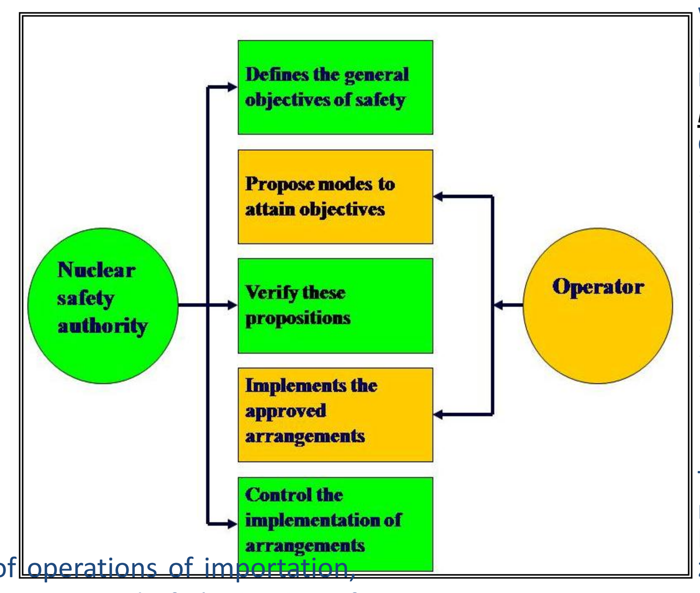
An Independent regulatory body

The relationship between the operator and the authority of Safety is clearly defined; The operator is responsible for the safety of research reactor over its lifetime; at all stages, he must present the technical documents which give evidence of the sure character of his facility.

whereas the Authority of Safety carries out the checks and inspections envisaged in the regulation to validate and deliver the related authorizations.

Safety committee

- The NUR and Es-Salam reactors are respectively operated by the CRND and CRNB which are parts of COMENA organization;
- Each Center is fully responsible for the safe operation of its reactor;
- To assume this responsibility, each Center has an appropriate organization which is based on the existence of two hierarchically independent structures and a safety committee:
- ✓ A structure in charge of the operation and maintenance of the reactor in accordance with the approved procedures;
- ✓ A structure in charge of nuclear safety and protection against radiation;
- ✓ A Safety Committee placed under the Director General authority's of the Center;
- ✓ All safety issues are also reviewed by a Central Safety Committee placed under the COMENA.



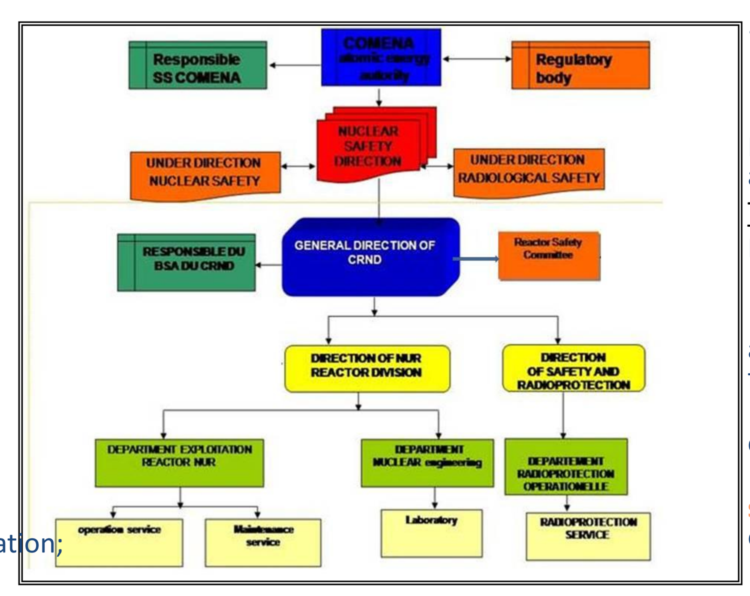
Legal and regulatory framework

- A New Promulgate Regulation in April 2005: It is about the update of Decree 86/132.
- ➢Decree Presidential N° 05/117 relating to the protection measures against the ionizing radiations:
- Scope: *General rules of protection against the risks of the ionizing radiations in particular due to radioactive substances;*
- ➢Decree Presidential N° 05/119 relating to the management of the radioactive waste.
- Scope: *Define the rules relating to the management of the solid, liquid radioactive waste and gas effluents generated by any activity using nuclear materials or radioactive substances;*

Article 1 — this decree has the aim of fixing:

— General rules of protection against the risks ionizing radiations, in particular at the time of operations of importation, transit, manufacture, of transformation, of use, handling, of transport, of storage, storage, evacuation and of elimination of the radioactive substances and very other practical which implies a risk resulting from: Professional exposures; Potential exposures; Medical exposures; Exposures of the public; Situations of emergency exposure

- ➢ Decree Presidential promulgate in September 2007 :
- *Scope: creation, organization and operation of atomic energy authority (COMENA).* Art. 4 (a): the atomic energy authority is charged:
- ✓ To deliver, modify, suspend or withdraw the authorizations for activities using radiation sources;
- ✓ To takes a national inventory of radiation sources and a nuclear matters;
- ➢A draft of Nuclear Law, which includes provisions for decommissioning, was prepared and submitted to Algerian government for review this year. This draft law is expected to approve by our National Assembly next year.



International regulatory framework

➢International Engagements:
- ✓ Convention on Nuclear Safety;
- ✓ Convention on the Physical Protection of the Nuclear matters;
- ✓ Convention on earlier notification of nuclear accidents;
- ✓ Convention on the assistance in case of nuclear accident or emergency radiological situation;
- ✓ Code of conduct on the Safety and the Safety of the Radioactive Sources;
- ✓ Code of Conduct on the Safety of Research Reactors;
- ✓ IAEA INFCIRC/153 The Structure and Content of Safeguards Agreements relating to NPT.
- ✓ Official declaration of intent of adhesion to the additional protocol; etc…

License / authorization

The (tow) research reactors have an initial authorization for Initial Operation;

A periodic safety review and assessment is performed for both Nur and Es-Salem reactor, by the safety committee. It is decreed in the nuclear law proposed:

Nuclear facilities shall submit safety analysis reports when applying for permit for construction, modifications of operation, termination of operation, operating research reactors and operating nuclear power plants.

Decommissioning planning / implementation

Nur reactor has been in operation since 1989 and Es-Salam since 1992. In the immediate future, there is no foreseeable intention to shutdown definitively the facilities. Quite the contrary, the COMENA is firmly engaged to refurbish Es-Salam to carry out an ambitious national programme for producing industrial and pharmaceutical radioisotopes. Whereas, Nur manages its ageing. But by now, the COMENA is strongly concerned with the preparation of sound decommissioning program for the two reactors

•In 2007, the Safety assessment committee of both reactor Nur and Es-Salam recommends the preparation of decommissioning plan for Nur reactor and its other relevant facilities. But the overall national decommissioning strategy isn't clearly stated. What makes that the general options and aspects of decommissioning are always being studied. Whereas, the National Policy on Waste Management is in progress; a national plan for radioactive waste management is in preparation.

Considerations during Design and Construction of Nur Reactor

During the design and construction phases of Nur reactor, the aspects which allow easy decontamination and minimization of the occupational exposure have been considered. such as selection of material, use of modular for easy dismantling and an appropriate design which avoid the contamination. Besides, the liquid reactor treatment station, the spent fuel storage, the shielding for spent fuel transfer from the reactor pool to the spent fuel storage and the solid radioactive disposal facility were designed.

Considerations during Design and Construction of Es-Salam Reactor

Es-Salam reactor is of reservoir type. The reactor complex is doted with many shields: graphite reflector, surrounded biological shielding, sand and, heavy concrete which form the skeleton of reactor complex.

•Reactor complex is also surmounted by the top water shielding (top-cabine) which form a shield space used when we withdrawal the spent fuel assembly or other activated components from the reactor core.

•Spent Fuel assembly and other activated components are hoisted by remote control operation. The fuel activate section remain in the top-cabine during operation, transferred then to receipt cell, then conveyed towards the water pool storage by wet itinerary;

•The pool storage is built very close to reactor complex; there are a working wet pool (cutting process tube to recover the fuel assembly), a wet storage pool and dry storage pool.

•Reactor building well shielded: all technological rooms (which shelter all the reactor systems) and reactor hall (which shelter the reactor complex) forms a well shielding (built by a thick concrete);

•Ventilation system doted with 04 filters by cell (Pre-filter, HEPA, iodine, HEPA) then high chimney; forms with the reactor building the third barrier of the reactor.

The waste management inside NUR reactor Building

Designed for temporary storage of low and medium level solid and liquid radioactive waste. Solid wastes- includes spent ion-exchange resins, contaminated clothing, tissues, glassware, etc- are segregated by disposing it in appropriate containers. For long-life contaminated waste, it will be sent to cemetery sec.

Decay radioactive liquid waste, is stored in tow pools of 100 m3 volume.

The waste management inside Es-Salam reactor Building

•Temporary low level Liquid storage pit in reactor building;

•Temporary Intermediate level Radwaste system: inside the reactor building there 02 reservoirs with capacity of 1.3 m^3. This system is used to collect the waste liquids and waste resin coming from the purification system, heavy water concentration system, and test loops to send them to the liquid waste storage tank and spent resin storage tank outside the reactor building;

•Temporary storage of low and medium level solid. Solid wastes- includes, Contaminated pieces from maintenance, contaminated clothing, tissues, glassware, etc- are segregated by disposing it in appropriate containers. For long-life contaminated waste, it will be sent to the solid waste storage building outside the reactor building.

Means of handling and transport available in Nur Reactor

The facility is designed in the form of open pool-type with in-core structures of modular shape. Provision of overhead crane to transfer heavy and contaminated or activated components and adequate space and entrance door for direct entry of heavy transport vehicles for loading of heavy loads. Wide and smooth access road allows for heavy transport vehicles to reach the reactor building.

Means of handling and transport available in Es-Salam Reactor

Crane of the reactor hall: 03 lifting capacity :20/5/0.32 Tons;

Crane of the pool storage: 03 lifting capacity :05/1/0.5 Tons;

transfer spent fuel or activated wastes from the pool : 02 ways: wet and dray

Adequate space and entrance door for direct entry of heavy transport vehicles for loading of heavy loads. Wide and smooth access road allows for heavy transport vehicles to reach the reactor building.

The main materials used in the core of Nur reactor

The main materials used in the reactor core components are made of stainless steel 304. This alloy is used in the main structures such as reactor pool tank, beam tube, coolant system piping, the grid supporting the reactor core etc..; reflector: aluminium housing, thermal column: graphite-filled aluminium, specimen rack, detectors (fission chambers, ionization chambers The other 5 control rods: regulating, control and safety rods are made of sealed type of 304 Stainless Steel.

Reduce contamination and to allow easy decontamination, in-core structures of simple design with smooth finishing, the floors of the reactor hall, the corridor and laboratories for activation analysis with floor smoothes. Meanwhile, the primary and secondary cooling system that consists of pump, heat exchanger, temperature probes, N-16 decay tank and associated valves & piping are made of and coated by stainless steel and aluminium alloy. Furthermore, existing active ventilation system is available **and can be used to facilitate control of airborne** contamination that may arise during decommissioning work.

The main materials used in the core of Es-Salam reactor

- reactor vessel: aluminium alloy(LT21);
- Coolant material : D_2O
- Socket in Lower plenum of vessel: zirconium alloy (Zr4);
- Fuel assembly : UO_2
- Cladding of fuel : zirconium alloy (Zr2);
- Process tube (which shelter fuel assembly): same as vessel;
- Vertical experimental channels: same as vessel;
- Aluminium plug (upper vessel) : aluminium alloy (LD2);
- Absorbing material of control rod (14 control rod): Cd;
- Cladding material of control rod: Stainless steel;
- Reflector : nuclear pure graphite;
- Envelope (which shelter vessel and graphite): A3 steel;
- Biological water tank shielding (surrounding envelope) : A3 steel
- Upper water tank shielding (top-cabine, upper reactor complex):A3;
- Material of Pipes cooling of graphite reflector : LT21
- Material Coolant Heat exchanger of biological shielding :A3
- The Main material for reactor coolant system (pipes, primary heat exchanger and primary pumps) : Stainless steel;
- Cover material of Storage pool: Stainless steel.

Considerations during Operation

The environmental impact study, a public received dose, was done in safety analysis rapport of the two reactors for the normal and for accidental cases.

All relevant operational records stipulated in chapter 17 "safety specification" are kept in reactors and specially the records which deal with doses.

For decommissioning activities, the same study must be done. it should be noted that around the Es-Salam reactor, there is no significant density of population;

History of Operational events: It should be noted that during the lifetime operation of both Nur and Es-Salam reactors, we did not have events which led to high levels of contamination such as:
- ✓Fuel cladding damage;
- ✓Fuel dropping during discharge;
- ✓Contamination resulting from leakages in the primary circuit;
- ✓Contamination resulting from leakages or flooding in storage of radioactive effluents and wastes;
- ✓Contamination in beams or capsules melting;
- ✓Contamination due to maintenance and repair activities; etc…

Characterization of the facilities:

To provide necessary data for the implementation of the decommissioning strategy , it is important to collect all the radiological data and information. Contamination Measurements is used for radiological characterization of the reactors. Particularly in the zones which shelter the activated systems of the reactor, places of radioactive material storage and the zones where is performed the research activities.

Outline of the facilities survey:-
- .. Measurement of the neutron flux and gamma spectrum
- .. Evaluation of the activated radioactivity/contaminated radiation/fission products
- .. Evaluation by the analysis code
- .. Estimation of the amount of waste based on the evaluation results

Suggested decommissioning option for Es-salam

In the safety analysis report of Es-Salam we find a suggested option: Remove the fuel assemblies, the easy-removed activated components as well as the larger components. The remains are partially sealed off or confined in use;

The main steps of decommissioning :

Remove all the fuel assemblies from the reactor core;
- ➢Hoist all the fuel assemblies to storage pool for a proper time storage and then transfer them to fuel reprocessing factory;
- ➢Remove the control rod assemblies, the control rod guide tubes and the vertical experimental channels from the reactor and transfer them to waste storage pool for a proper time storage, then transfer to storehouse (out of reactor building) for future treatments;
- ➢Drainage of heavy water from the whole loop and vessel (before, make a water mixing to make sure that activated corrosion products are drained) then transferred to waste liquid processing factory for farther treatment;
- ➢**Hoist the reactor vessel and the aluminium plug into the buried well in the reactor hall and seal them up, keeping the storage for at least 50 years.** Then almost all fission products sediments on the surface of the vessel would decay to the level enabling the vessel and the plug to be transferred to another place for cutting or burying;
- ➢Dissemble the decontaminated heavy water loop components by mechanical cut using a electro-saw. Heavy water pumps can be disintegrated for further cleaning and treatments, heat exchangers, valves and tubes can be treated as solid wastes.
- ➢Because of less contamination of the helium loop, the disintegrated equipments and tubes can be used for other purposes;
- ➢Because no fission product contamination, shield cooling loop can be disassembled and cleaned for father treatments;
- ➢After complete surface decontamination, top water tank can be dismounted for other use;
- ➢All fission product contaminated components within the reactor complex are so far removed, and now concrete can be poured into the reactor complex, making it a concrete column;
- ➢After a complete surface contamination, the whole space radioactive dose of the reactor hall approaches the background;
- ➢After the waste liquid is cleaned away, concrete is poured into the liquid waste pit is sealed up.

Lacks and weakness : In Es-Salam reactor: We haven't neither waste liquid nor waste solid processing facility; Problem of spent fuel reprocessing; problem caused by high activated materials; Manipulation of highly activated Large components; The graphite reflector have a high radioactivity and wigner energy stored in the life of reactor.

If we adopt this option : The vessel must be stored for 50 years: this option poses more problems in view of : efficiency of hall crane and electric systems after 50 years, changes in policy, loose of knowledge with the departure of initial staff, etc…

Development of reactor decommissioning technology

Nur and Es-Salam Reactor will continue to follow progress in the field of decommissioning technology available in the world. A program will be set up to make assessment of this technology and make recommendations as to select the most appropriate technology to be used in the future decommissioning program of these reactors.

Decommissioning cost calculation / funding

- ➢Cost calculation for decommissioning of the Two Research Reactors has not been made.
- ➢The Algerian system of financing the decommissioning process are not set up yet.
- ➢Funs may be available from government when needed.

Previous experience

With Nur Reactor a Small experiment realized during the operation of cleaning of the oxidation in irradiation beam, some dismantling activities were carried out according to a Plan presented to the Safety Authority. The operator fulfilled other requirements concerning responsibility assignments, tasks chronogram and description, quality assurance program, personal training, commissioning program, etc. The arisen wastes were considered radioactive, and disposed of in the Reactor hall.

The scientific personnel of both reactors have sufficient skills in the radiological domain:

Radionuclide inventory assessment and characterization:
- ✓Calculating the neutron distribution within structures, systems and equipment of the reactor (such as graphite reflectors, stainless steel tank, concrete structure…) using MCNP computer code;
- ✓Determining the activation activity of radionuclide (maximum and average levels) present in the structures, systems and equipment of the reactor based on the reactor operating history and using ORIGEN2 computer code;
- ✓Carrying out the sampling when necessary for the analysis.

THANK YOU