Decontamination and dismantling of nuclear and radioactivity facilities in Research Centres.

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Abstract

Currently, research projects on dismantling and decontamination (D&D) of some of the CIEMAT nuclear and radioactivity facilities are being performed. The main goal of these projects is to actualise obsolete facilities to the new necessities of CIEMAT in R&D, which are focussed principally on industry requirements. In this presentation, also a brief description of the studies performed in order to minimise the radiolytic impact on human and environment due to these activities are discussed.

Objective

The main objective of this presentation is to describe briefly the state of the art of the decommissioning activities that CIEMAT is developing with the aim of updating obsolete radioactive and nuclear facilities

1 Introduction

In the last twenty years, nuclear research centres devoted to radioactive and nuclear studies have begun decommissioning activities of old nuclear facilities built during the 1950s and 1960s, at the time of high intensity in nuclear R&D activities.

Motivation for decommissioning are very different, but they could be summarised in three points:

1. Old facilities unusable for the new requirements of R&D projects.
2. Excessive cost to maintain a facility in a safe enclosure with surveillance during long period of time.
3. Public perception of hazards.

CIEMAT (formerly JEN) is a Spanish R&D national centre located at Madrid (Spain) devoted principally to studies about energy, technology and environment.

In 1982, CIEMAT had 39 radioactive facilities and 5 nuclear installations dedicated to nuclear fuel cycle and technological applications of nuclear energy. The most important nuclear facility was the JEN-1, an experimental nuclear reactor of 3 MW thermal power. This reactor was used mainly for personal training of the incipient Spanish nuclear industry (it reached its first criticality in 1958), for irradiation of materials and for medical radioisotope generation. This facility worked until 1984. In 1987 began the pre-decommissioning strategy studies of JEN-1 together with other nuclear facilities associated with the reactor: metallurgical hot cells (IN-04), a plant for nuclear fuel fabrication (IN-03) and an experimental plant for nuclear fuel reprocess (M1). Irradiated fuel generated at JEN-1 was sent to USA for final waste management.

Related to radioactivity facilities, in 1985, CIEMAT shutdown operations in 14 installations, which most of them are currently used as conventional laboratories and others are still in a safe enclosure period

Decommissioning strategy and planning

Decommissioning is the final phase in the life-cycle of nuclear and radioactivity facilities. It is a complex process involving operations such as decontamination, dismantling and in same case demolition of building and structures. All of these processes can bring associated risks into health and safety of workers and members of the public and any implications for the environment.

According to IAEA [98IAE], there are three basic stages of decommissioning, in which removal of spent fuel, process fluids and operational wastes are usually pre-decommissioning activities. In the case of non-reactor facilities, the definition are summarised as follows:

Stage 1: Safe enclosure with surveillance

Stage 2: Extensive plant decontamination, partial dismantling and removal of plant systems. Limited release of the site for non-nuclear use.

Stage 3: Decontamination and dismantling of the plant up to free release of the site for non-nuclear use.

The decommissioning of non-reactor facilities is usually achieved in three main phases that may involve intervening periods of safe enclosure depending on the options chosen for the particular project.

Phase 1: Initial cleanup and preliminary decontamination where necessary;

Phase 2: Dismantling and removal of the systems and equipment as appropriate;

Phase 3: Demolition or reuse of buildings and structures.

Previously to begin decommissioning activities, the Spanish regulatory organisation (CSN) requires a complete mandatory documentation for ensuring that work is performed safely and that hazard to workers, the public, and the environment are minimised, mitigated and controlled. This documentation includes detailed information about the institutions and personnel operating that will manager and perform the different D&D activities, collection of relevant information on the facility and related potential hazard (security study and radiological evaluation), volume of waste and quality assurance of the process.

Brief description of emblematic CIEMAT nuclear facilities

Nuclear reactor JEN-1

The JEN-1 was an experimental research, pool type, moderated and cooled by light water with a thermal power of 3MW. As was aforementioned, the experimental nuclear thermal reactor, JEN-1, reached its criticality on 18 October 1958. JEN-1 was designed and built with a very high neutron flux with the aim of it was versatile, easy to handle, and safe. The pool of the reactor was divided in two areas. In the area in which the reactor was located the average neutronic flux was of $1.75 \cdot 10^{12}$ $n.cm^{-2}.s^{-1}$and a fax flux of $5.9 \cdot 10^{13}$ $n.cm^{-2}.s^{-1}$. The second area of the pool was designed to store spent fuel elements. The nucleus of the reactor was formed by a rectangular aluminium base hosting the fuel elements, the neutronic source, the graphite reflector and irradiation baskets. The fuel elements were type Material Testing Reactor (MTR) with initial enrichment from 20% to 90% of ^{235}U. Initially the fuel elements were supplied by General Electric and Babcock and Wilcox, but since 1964 they were manufactured by JEN (currently CIEMAT).

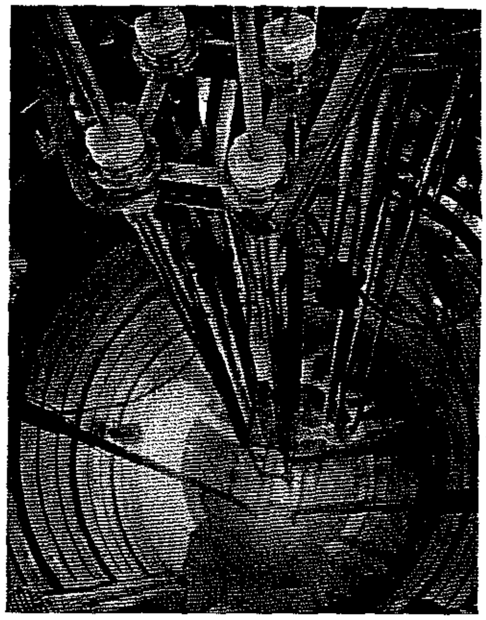

Fig. Error! Unknown switch argument. **Experimental nuclear reactor JEN-1.**

Metallurgical hot cells IN-04

This nuclear facility has four hot cells shielded by lead and barite concrete. This facility was designed and built to study irradiated nuclear fuel behaviour from JEN-1 reactor and also from commercial Spanish nuclear power plants. Metallurgical studies of irradiated metals in these hot cells were performed as well.

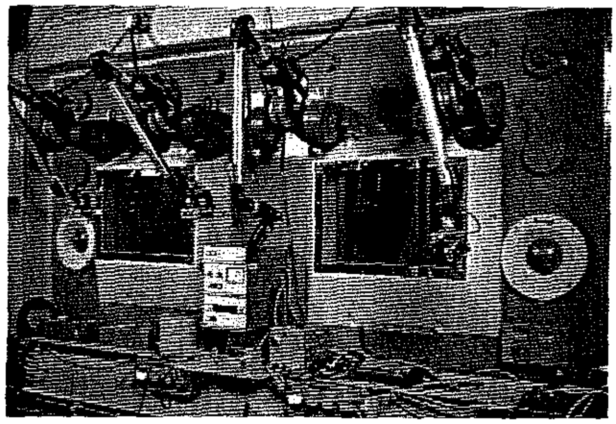

Fig. Error! Unknown switch argument. **Detail of the metallurgical hot cells (IN-04).**

Decommissioning and reclassification of the metallurgical hot cells (IN-04).

The strategy for decommissioning is characterised by removing and reducing the internal parts, followed by a decontamination of the internal surfaces. These actions were carried out hand off until the radiation field of the cells allowed entering for fine cleaning.

The different steps to perform the decommissioning of the metallurgical are summarised as follows:

Elaboration of the mandatory documentation

Radiometric studies

Elaboration of the operating procedures

Selection of operating personnel

Management of radioactive wastes

Radiological control of the operating personnel

Performances of the ventilation system, floors and walls

Recovery of equipment's

Although the main parts of the hot cell, ventilation systems, metallurgical devices, manipulators, etc. remained operatives, because it was retired from service, the technical and radiological information was limited.

For decommissioning studies this facility was divided into 6 areas:

Load area (materials and equipment reception)

Shielding cells area (4 HOT CELLS)

Handling area

Liquid wastes area

Workshop

Auxiliary services

To get a clearer view on the radiological problem, the dose, the activity and the isotopes needed to be determined on the entire surface of the cell. The in situ measurements and the analyses of samples allowed to put the *pollution* in charts:

Loading area:

Superficial β-γ contamination level:

1.84 to 600 $Bq.cm^{-2}$

Environmental contamination level:

^{137}Cs: 2.5 to 33.0 $Bq.cm^{-3}$

^{241}Am: 0.01 to 0.15 $Bq.cm^{-3}$

Shielding cells area (Base Cell):

Superficial β-γ contamination level:

1.80 to 460 $Bq.cm^{-3}$

Environmental contamination level:

^{137}Cs: 0.4 to 2.4 Bq.cm^{-3}

^{241}Am: 0.04 to 0.20 Bq.cm^{-3}

Handling area:

There was not radiological contamination

Due to this nuclear facility will be reused as radioactive facility, recovery of devices an equipment's is an important task from an economical point of view. Main operative devices recuperated were: manipulators (master and slaves), cranes, metallurgical tools and devices, TV circuit, system for recovering liquid wastes, etc.

Decommissioning of the JEN-1 nuclear reactor

In 1989 pre-decommissioning activities: removal of spent fuel, process fluids and operational wastes were begun. JEN decommissioning was integrated in the framework of the European Atomic Energy Community's research programme on the decommissioning of nuclear installation (1989-93). Special efforts were put into the study of under water cutting techniques of irradiated materials and aluminium decontamination [95MAÑ/VIL]

According whit IAEA basic stages of decommissioning, nowadays JEN-1 reactor is in the stage-1.

In situ measurements and analyses of samples of several defined zone of the reactor are summarise as follows:

1. reactor building: 0.1 µSv/h
2. reactor structure: 1.7 µSv/h
3. pool: 2 to 30 mSv/h
4. irradiation channels: 3 to 5 mSv/h
5. engine room: 2 to 5 µSv/h
6. ventilation room: Background

The main elements that have to be still dismantle are:

1. Pool
2. engine room
3. Purification room
4. Ventilation room, filters and chimney stack

5. Liquid effluents system

Nowadays R&D studies are ongoing in order to define properly methods and equipment for dismantling activities. The main techniques to be considered are:

1. Underwater cutting equipment (by plasma).

2. Equipment for cutting contaminated concrete.

3. Equipment for demolition of non-radioactive concrete.

4. Decontamination equipment for metals and concrete.

Discussion and conclusions

Project health and safety took precedence over any other aspects of the projects performed.

It is important to point out that the availability of members of the original operation crew has been a great help during the decommissioning operations, and without the knowledge of them the work would have been far more costly and complicated. One lesson learned is that conservation of all essential written information, drawing, etc. is an obligation that must be recognised by plant management during the operation phase, and that strict control of this material is essential when decommissioning is dallied for a longer period.

Other important aspect for all decommissioning projects is to have a formal agreement with the burial site for all waste forms and containers prior decommissioning. In Spain, low and medium radioactive wastes are definitive stored in the centralised repository located at El Cabril, Cordoba.

At present decommissioning work of metallurgical hot cell have been already performed. Nowadays, the facility is waiting for total decontamination certification that has to be emitted by Spanish Nuclear Regulatory. After that, some conventional tasks are already provided in order to reclassify the old nuclear installation as radioactive facility.

JEN-1 reactor is still in the stage-1 of decommissioning. The main reason of the delay is the high cost of the works.

References

[98IAE] "Decommissioning of nuclear facilities other than reactors". Tech. Rep. Series No. 386. IAEA. Vienna, 1998.

[95MAÑ] "Decommisioning of the JEN-1 experimetal reactor", L.Mañas et al., EUR 16899 EN.