RADIOLOGICAL PROTECTION FOR SPENT FUEL DRY STORAGE AT EMBALSE NPP

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Abstract

Embalse NPP dry-stores used fuel elements in concrete silos inside the premises: The fuel elements are kept for at least 6 years in pools located in the controlled area , before being moved into the silos.
This paper describes the radiological protection for the different stages of the process, i.e., when the used fuel elements are moved from the pools into the silos, and while they are kept in the concrete silos.
The occupational exposure of the personnel operating this system at each stage is showed, as well as the environmental dose rates around the silos, and the dose rate in the shields used during the transfer.
These environmental dose rates are assessed with portable instruments and with TLD dosimeters placed around the silos.
This paper also describes the periodical routine control performed every two years in the atmosphere inside the silo, the moisture control and the detection of possible aerosols (in some cases, traces of krypton 85 were detected).
It is important to point out that the maximum equivalent environmental dose rate H* (10) detected at approximately 20 metres from the silos is overly low: (0.35 microsievert / hour)
Our experience demonstrates that dry storage is totally compatible with the environment and with the ALARA criterion for personnel's doses.

Introduction

The spent fuel dry storage system at Embalse NPP was designed, built and operated by INVAP SE between 1992 – 1993, and licensed to operate by the ARN (Regulatory Argentine Authority).
This system is surveilled by the IAEA, the ABACC, and the ARN , complying Safeguards Agreements.

The first silo was loaded on 18/03/93. The pre-operational assessments were performed prior to the first load, and several TLD dosimeters for environmental monitoring were installed in the perimeter fence. These dosimeters are replaced every year.
Figure 1 shows the position of TLD dosimeters , (see Nº 1, 2, 3, 4, 5, 6, 7 and 15).

Dry Storage Process

The process will work as follows:
After 6 years of storage in the pools, spent fuel elements can initiate the dry storage process, in order to end up temporarily stored in the silos for 50 years.

The spent fuel elements stored horizontally in trays, are carried to a tilting tray that turns them into a vertical position. Then, the operators move the fuel elements one by one, from the bridge crane located over the pool ,up to the lattice inside the pool's shield, which is also under water. The lattice is the bottom of the fuel storage canister that will store the fuel elements.

After 60 spent fuel elements are placed on the lattice, the shield cover is placed. Then, the fuel elements extraction begins.
Once they are extracted from the shield, they are decontaminated, hanging over the pool. The interior is drained and vacuum dried. Spent fuel elements are then moved to the hot cell where the shield lattice is taken off, and the fuel storage canister's cover is placed in order to dry them and weld the cover to the lattice. The compressed air is then conducted through activated carbon filters and HEPA filters.

After welding the fuel storage canister inside the cell, it is lifted and moved to the transfer shield placed on top of the hot cell. This transfer shield is then carried in a trailer to the silos, where it is lifted with a gantry crane and placed in the upper part of the silo. Once the transfer shield is placed on the silo, the fuel storage fuel storage canister carrying 60 spent fuel elements is placed inside the silo.

When the silo is complete, (9 fuel storage canisters), the silo is sealed. IAEA and ABACC Safeguards Inspectors seal the silo up.

The Embalse NPP Radiological Protection Department samples the silos' interior through pipes specially designed ,every two years, (free volume: 0.5m3)This sampling is useful to check possible leaks through the welds.
Should there be any leaks, radioactive noble gases in long disintegration period would be found (e.g., Kr^{85}.t1/2=10.7 years) an aerosols such as Cs 137 (t1/2=30 years; and Co 60 (t ½=5 years)

The assessment is performed either directly or indirectly, with a vacuum that samples air inside the silo. Prior to getting inside the vacuum, the air goes through high efficiency paper filters, that retain solid aerosols in suspension, and finally the air goes through an activated carbon cartridge, to confirm Kr^{85}. (energy 517 Kev) presence.
In case the Noble gases detector shows concentration values in the background, in Kr^{85}. the activated carbon filter is assessed through spectrometry. All paper filters are the assessed in the Multichannel, whether noble gas activity has been detected or not.

There are the 130 silos in Embalse NPP which were assessed, in some of the silos a maximum concentrations of [Kr^{85}.] . = 10^8 Bq/m^3 (1 DAC de Kr^{85} = 1,07 10^7 Bq/m^3)), was found; this means that the activity inside the silo = 5 x 10^7 Bq. The Embalse Operating license allows a release of 3 x 10^{13} Kr^{85}. Bq/day.

No radioactive aerosols were t found in the silos.

Conclusions

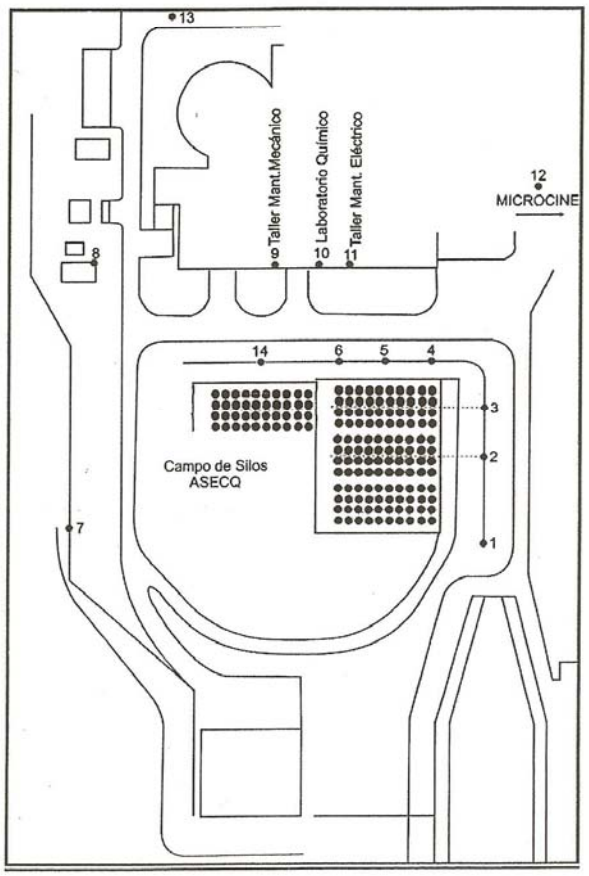
One hundred and thirty silos comprising 70200 spent fuel elements can currently be found at Embalse NPP.

It must be pointed out that no significant doses (external or internal) were assessed in the personnel; only 1.83% of the 2007 collective dose, and no radiological protection event was reported.

Another point to highlight is the process reversibility: a welded canister already stored in a silo can be moved back to the spent fuel storage pools. This process hasn't been used yet, due to the excellent operational status of the system.

CHARTS

Figura 1


13
Taller Mant.Mecánico
Laboratorio Químico
Taller Mant. Eléctrico
12
MICROCINE
8
9
10
11
14
6
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Campo de Silos
ASECQ
7

Radiological data of the process

Tritium water concentration in air (T_2O) in spent fuel storage pools, where the canister carrying spent fuel elements are loaded

Minimum : 0,3 DAC

Maximum: 0,9 DAC

Average: 0,6 DAC

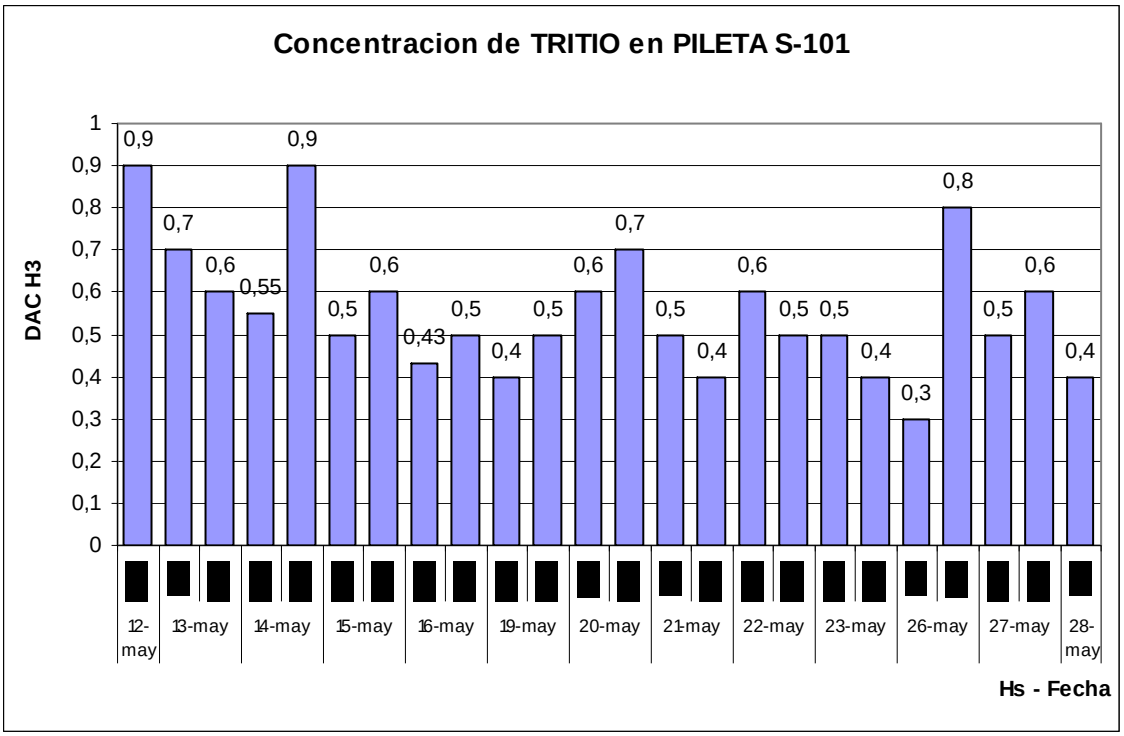
Dose Rate: H ≤ 10 µSv/h (external environmental radiation)

Dose Rate in transfer room (hot cell location)

H ≤ 10 µSv/h

Dose Rate in silos field

H ≤ 10 µSv/h



Collective dose uptake for personnel, during all the Dry storage process; 35 people in 2007

External Radiation: 3,394 mSv-man

Tritium water: 3,062 mSv-man

Total: 6, 456 mSv-man

The 2007 collective dose for all Embalse NPP personnel equaled 352 mSv / man . The collective dose percentage for dry storage personnel equaled 1.83%.

Annual dose exposure in internal sampling places in the silos field and surroundings.