GUIDELINES TO UPGRADE AND CONVERT THE ARGENTINE´S RESEARCH REACTOR RA6

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ABSTRACT

It is been considered a proposal in order to define a project oriented to modify and to convert the argentine´s research reactor RA6 of 500 KW of thermal power.

Its main guidelines are presented here.

This reactor is in operation from 1982 in the Bariloche Atomic Center and was designed and constructed by CNEA and INVAP SE.

Original core is composed by 25 old design RA3´s fuel elements partially burned, that means containing high enriched uranium (HEU).

The strategic objective of the project is to allow the use of this facility to produce radioisotopes as auxiliary alternative to the RA3.

For these, it is proposed:

-to adapt the facility in order to be able to increase the thermal power or neutron flux to adequate level enough to the mentioned use and regarding the compatibility with the general specifications and requiring a minimum of modifications.

-to change the core, these implies:

-to convert the reactor from HEU to LEU fuel opening the possibility to return spent fuel elements to USA through the RERTR previsions.

-to include new high density LEU fuels in developing in the country.

-to complete the facilities to handle radioactive material in the RA6 building.

Not major problems are expected considering our long experience acquired with the RA3.

Some preliminary studies are already under way

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INTRODUCTION

We are considering modify and convert the argentine's research reactor RA6. The strategic objective is to upgrade it in order to use as one alternative to the RA3 reactor for some radioisotope production during few periods of the year and, to convert it to LEU fuel on face of to use national fuel and to return HEU fuel to USA in the frame of the acceptance program.

So, a special project must be developed including a deep analysis of this problem, where all the aspects should be considered (technical, economical, safety and security, timing, environmental and social impact, etc…).

This project is just starting, so I will present the information gathered up to now.

THE RA6 REACTOR

It was planned as a complete tool for: teaching, training, some experimental exercises and research, tests, services, non destructive testing, neutron activation analysis, etc, activities, mainly associated to the Nuclear Engineering School of the Intituto Balseiro, /1/, /2/ and very good results have been obtained in these sense.

RA6 is a low thermal power, 500 KW, facility, it is located at Bariloche Atomic Center, and was designed and constructed by CNEA and INVAP SE from 1977 to 1982.

It is a very versatile machine, with some special characteristics as safety features designed as if it were an experimental reactor with a higher power, and a secondary control room to permit teaching and training activities.

It was complemented with annex laboratories, which permitted a large variety of uses.

Recently, on October 26, it has commemorated 20 years of successful operation, with very good results. The main results and present capabilities are, among others, training for nuclear engineers and national reactor personnel, participation in IAEA courses, assessment for overseas experimental reactors, NAA, BNCT project, Silicon doping capabilities, and irradiation services.

ORIGINAL CORE

The reactor was originally designed to be operated with national LEU fuel.

Difficulties to obtain uranium finally drove to the decision of using partially spent HEU fuel elements from the RA-3 reactor, applying adequate tests.

So, original core was composed by 25 old design RA3´s fuel elements partially burned (in the order of 14 %) and with 8.8 years decay. Containing high enriched uranium (HEU) in the order of 90 to 93 % U235

As the power of the reactor is very low, standard use of this fuel imply very low burn up, so if the decision of not changing the core is taken, these fuel elements could stand in the reactor for more than ten more years if present conditions are maintained.

As was told before, we were recently asked to analyze all the aspects of a conversion of the core from HEU to LEU. Because a decision should be taken in at most two or three years, about the return of the highly enriched fuel elements to the USA, in the frame of the acceptance program of fuel of United States origin.

This decision has many aspects that should be combined to obtain an optimum, for instance:

-Future uses
-Operational and regulatory aspects
-Type of fuel to be used
-Economic and financial aspects
-Safety and security aspects
-Environmental and social impact

FIRST ANALYSIS

The National Atomic Energy Commission produces various radioisotopes for medical purposes with a reactor and a cyclotron located at Centro Atómico Ezeiza.

The only reactor dedicated to radioisotopes production in Argentina is RA-3, which has been operating at 5MW, and is presently operating at 8 MW, in the frame of a change of power which should arrive to 10MW at the end of this year.

One of the options is to analyze the possibility or convenience of using RA-6 reactor as a back up facility for some radioisotope production, for small periods during the year.

This implies a power level increase.

From these point of view it is interesting to define which is the maximum achievable power taking into account the compatibility of needed changes with original specifications and reducing the changes as much as possible.

Reactor's specifications allow the increasing of the power level and several proposals were presented along the history of the reactor.

Some of the reactor characteristics, as core geometry and cooling system make it an attractive option.

From CNEA's wide experience it is possible to say that 3 MW of thermal power will provide an adequate neutron flux for the stated purpose.

Preliminary studies /3/ indicate that it is possible, from thermal-hydraulic point of view, to operate the reactor at this power level, with a primary cooling system flux of 340 m3/h, maintaining the safety condition of having a clad temperature lower than 105 °C.

The mentioned cooling levels could be reached without major changes, with the pipes presently included in the core block.

The most convenient core should be decided considering all the main future uses and the safety and regulatory issues

According to thermal-hydraulic studies, the configurations that fulfil the required safety margins may have a number of fuel elements that may vary between 16 and 30 fuel assemblies.

Taking into account the uranium origin, safeguard problems, age of the fuel assemblies, etc, if the decision to change the core is taken, the replacement of the whole core in one step is foreseen as the most convenient option. Not major problems are expected considering CNEA's long experience acquired with previous projects.

Calculations should be done in order to optimize the best uranium load per fuel element for the 3 MW power level, trying to achieve the smallest core compatible with safety and operational requirements.

FUEL ELEMENTS

Besides its traditional lines on oxide fuel, CNEA is developing new design of LEU fuel elements covering two alternatives: high density, based on silicides (U3Si2) already developed, and, of very high density containing U-7Mo, collaborating with the international qualification efforts in the frame of RERTR program.

Because of these, it is convenient foreseen the use of one of these for the new RA6 core considering its important advantages /4/ i.e. higher burn up and/or longer residence time in the core.

Must be performed the necessary calculations to optimize the best uranium charge for 3 MW power level and others parameters and perform a special design for the assemblies maintaining external geometry and dimensions.

COMPLEMENTARY FACILITIES

The main complementary facilities that will be required are:

-Hot cells for the minimum stages of target's processing that necessarily should be performed locally. Considering that the major processes will be performing, as habitual, in the CAE special installations.

-Extra spent fuel and wastes storage capacity adapted to new use and foreseen the requirements for the core change operation.

It is clear that the amount of the investments for these complementary facilities is mandatory in order to take a final decision. These could imply a big amount; then, the whole commercialization balance of the radioisotope's production project should be taken into account at the moment of analyzing the financing of the facilities.

ALTERNATIVE OPTION

Considering that it might be a strategic interest in returning the HEU fuel elements in the frame of the US acceptance program, and converting the reactor to LEU, it is important to state that present capabilities of the reactor should be maintained.

An increase of power is not mandatory for most of the uses of the reactor.

In this case only the investments for a new core are necessary in order to convert it to LEU fuel.

No technical problems are envisaged at all.

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