OPERATIVE EXPERIENCE OF ATUCHA I NPP APPLIED TO ATUCHA II NPP

a) ***Restitution of the functionality and later optimization of the first reactor shutdown system with the control rod.***

b) ***The implementation of an additional safety system (Secondary Heat Sink).***

c) ***The update of the surveillance program for the reactor pressure vessel(RPV) recipient that implied the evaluation of the integrity of the RPV under the processes of postulated thermal shock.***

OPERATIVE EXPERIENCE OF ATUCHA I NPP APPLIED TO ATUCHA II NPP

- The update of the thermal-hydraulic phenomena studies with and without neutronic coupling, under different postulated scenarios.

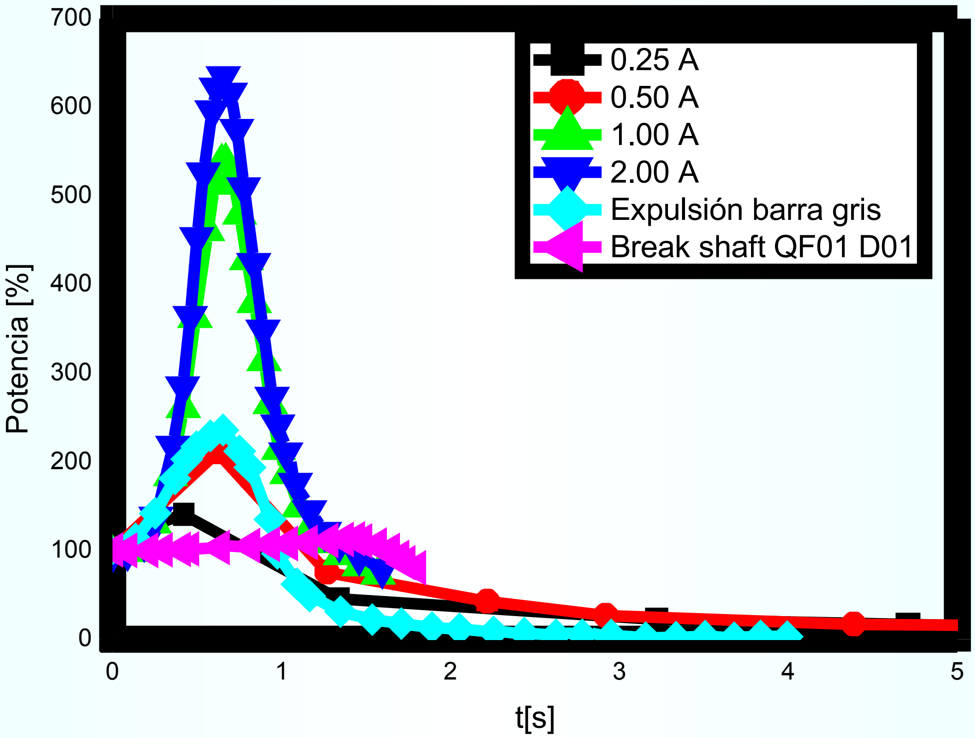
- In general terms, the plant presents a good behavior in accidental scenarios with postulated breaks located in the hot leg of the primary system (LOCA Loss Of Coolant Accident).

- When the postulated accidental scenario responds to a break in the cold leg of the primary system the behavior of the plant shows criticality reactivity excursion that drives, with a certain temporary delay between 1.1 to 1.3 seconds, to a excursion of power due the positive feedback of reactivity for void fraction in the coolant and consequently to the damage of the fuel elements.

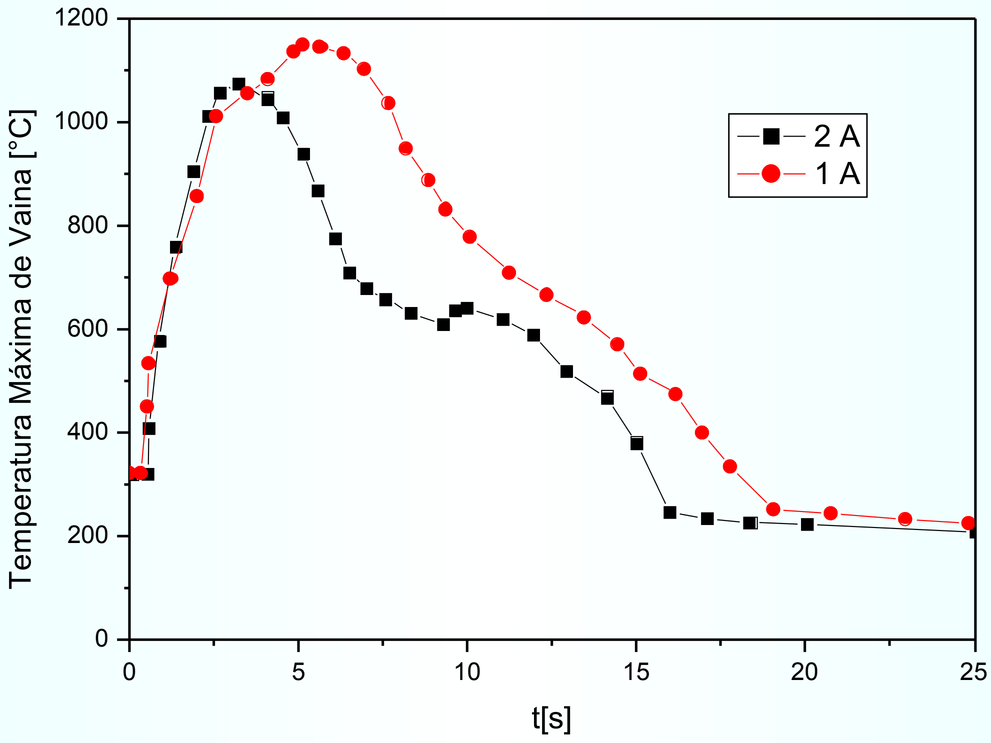
OPERATIVE EXPERIENCE OF ATUCHA I NPP APPLIED TO ATUCHA II NPP

- In the frame of the evaluation about the number of the required shutdown bar for the extinction of the reactor and in order to assure an appropriate sub criticality of ATUCHA I under different accidental scenarios postulate for reactivity transitive it has also been found that due to the positive coefficients of reactivity for the feedback of the coolant, the power of the reactor increases until causing the shutdown signal of the reactor (RESA) for higher power than 108%.

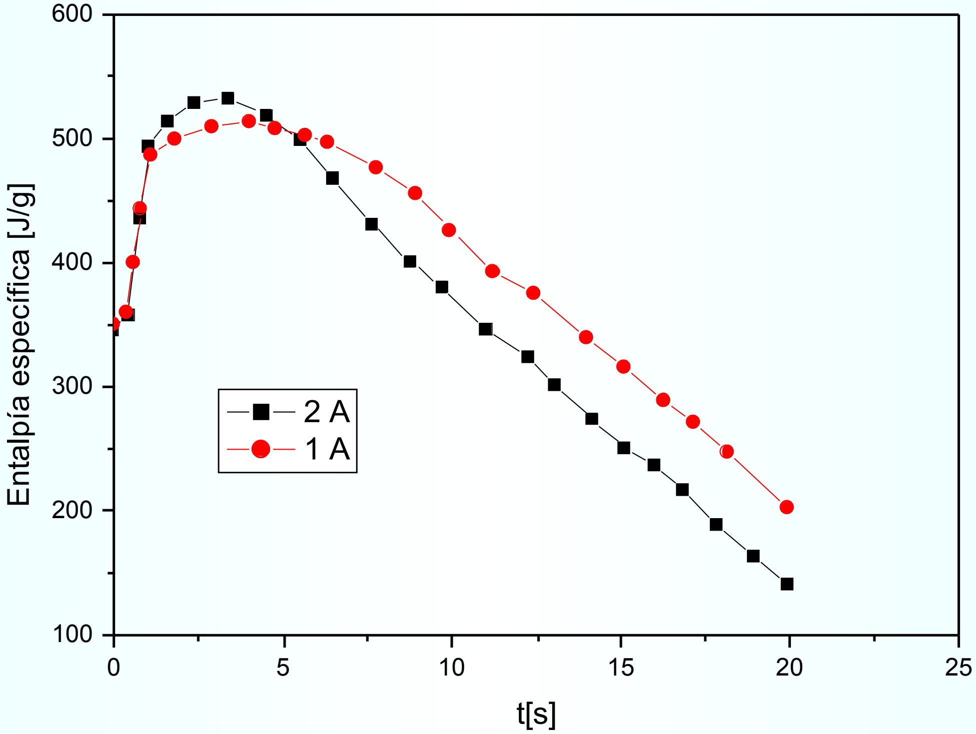
OPERATIVE EXPERIENCE OF ATUCHA I NPP APPLIED TO ATUCHA II NPP



OPERATIVE EXPERIENCE OF ATUCHA I NPP APPLIED TO ATUCHA II NPP



OPERATIVE EXPERIENCE OF ATUCHA I NPP APPLIED TO ATUCHA II NPP



OPERATIVE EXPERIENCE OF ATUCHA I NPP APPLIED TO ATUCHA II NPP

- As a results of the up to dated studies different modifications, improvements and optimizations were introduced in the following systems of Atucha I NPP:

1. the reactor protection system.

2. fast boric acid injection system.

3. the emergency cooling system.

ATUCHA II NPP
Feature of Core Reactor Design

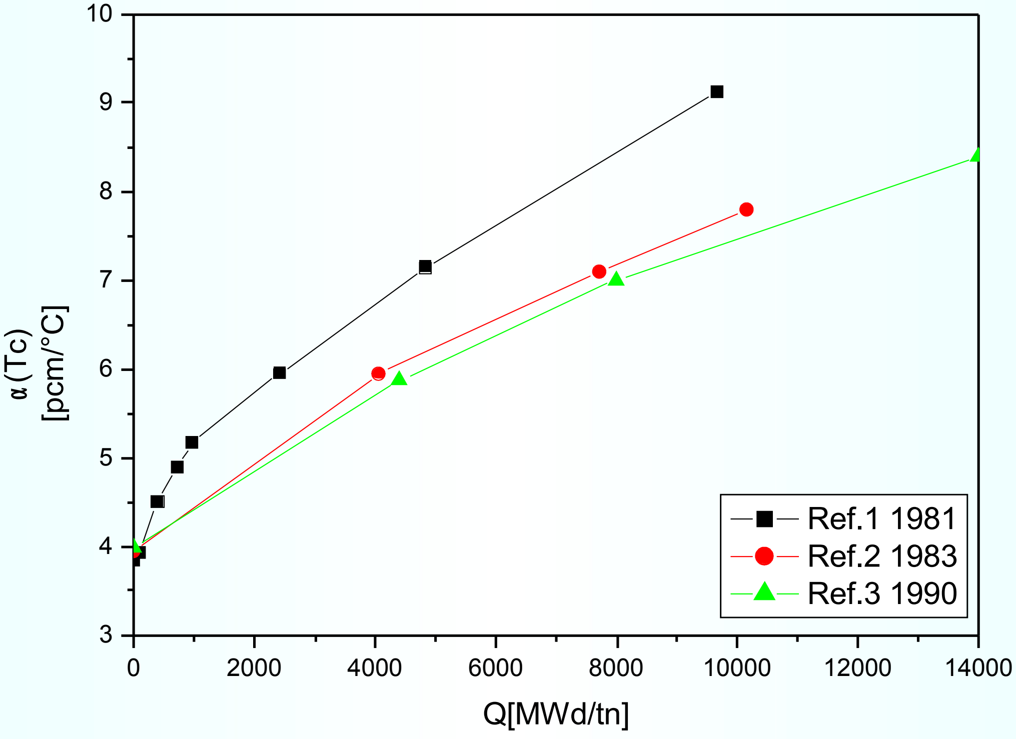
a) ***Positive coefficient of reactivity feedback for void fraction in the coolant.***

b) ***Positive coefficient of power feedback.***

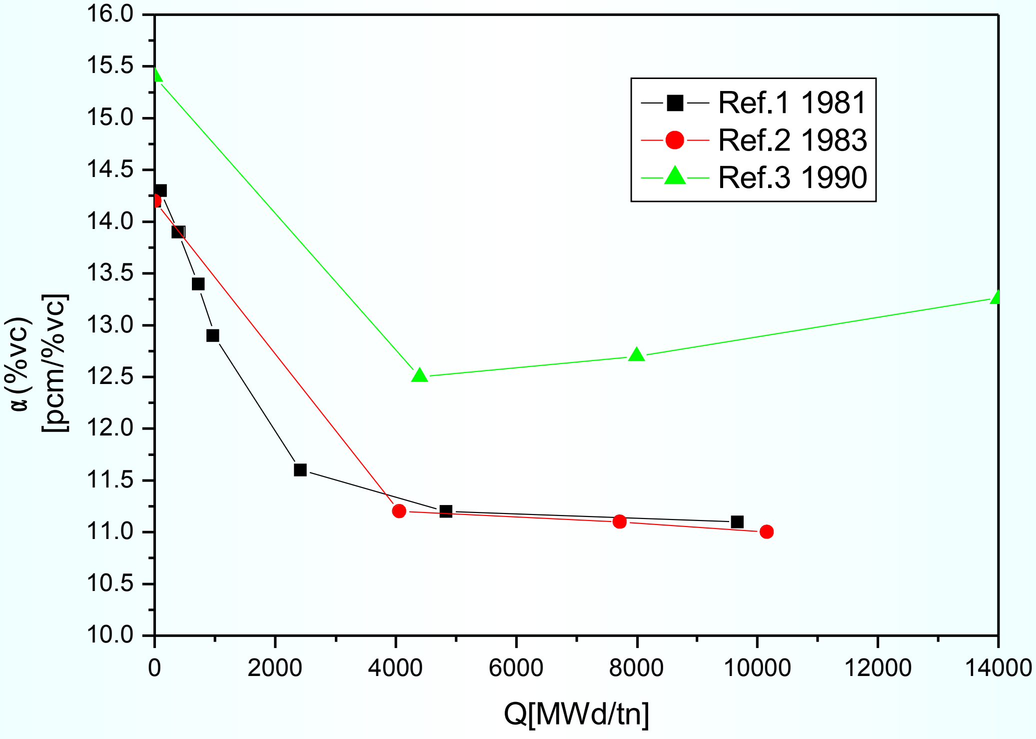
d) ***Break concept postulated for the design of the safety systems. Emergency systems efficiency to mitigate criticality excursions in scenarios for LOCA.***

c) ***Keeping the reactor core for a long term under sub criticality***.

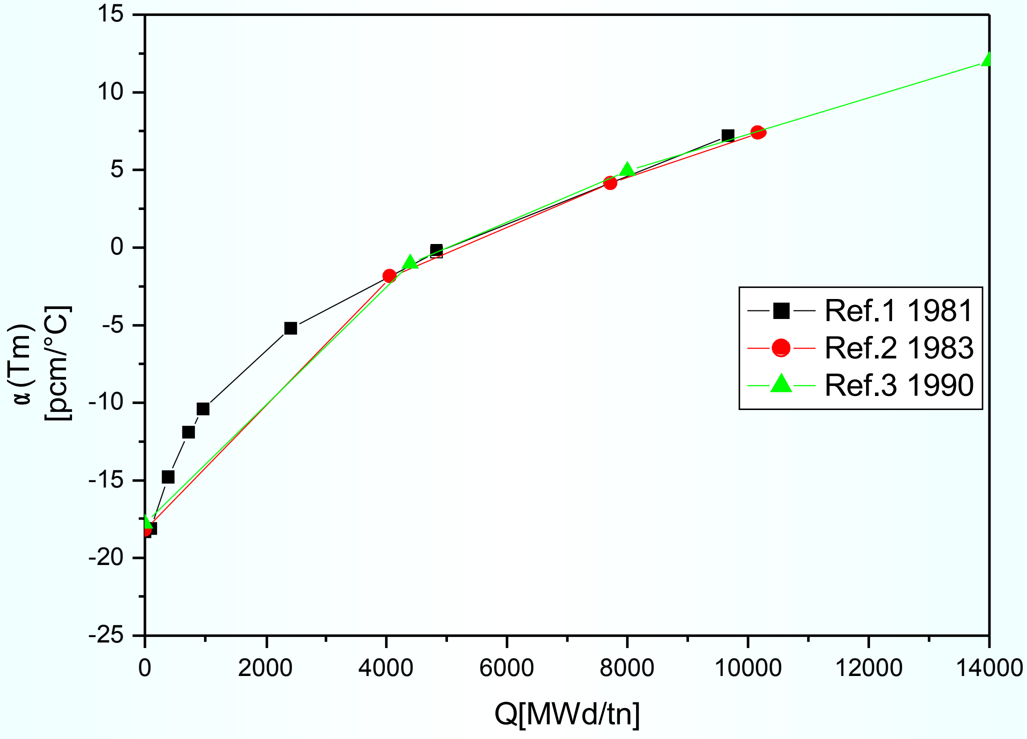
ATUCHA II NPP
Coolant temperature coefficient of reactivity



ATUCHA II NPP
Coolant void coefficient of reactivity



ATUCHA II NPP
Moderator temperature coefficient of reactivity



ATUCHA II NPP
Coefficients of reactivity for BOL and BEQ cores

	1992		Ref.3(CIRTE)		PSAR	
	BOL	BEQ	BOL	BEQ	BOL	BEQ
Fuel temperature (10^{-5}/°C).	-1.15	-0.50	-1.10	-0.44	-1.00	-0.30
Coolant temperature (10^{-5}/°C).	4.40	6.20	4.00	5.90	3.20	7.40
Coolant void fraction (10^{-5}/%).	**17.10**	**14.20**	**15.40**	**12.50**	**14.00**	**11.00**
Moderator temperature (10^{-5}/°C).	-18.90	-3.60	-17.80	-1.00	-18.00	-5.00
Reactor power (10^{-5}/%).	**-4.25**	**-1.00**			**-4.40**	**0.30**
Xennon concentration (10^{-16}/at/cm^3).	-2.72	-2.30				

ATUCHA II NPP
Positive coefficient of power feedback

- Several studies and analyses of the behavior of the reactor of the CNA II under the conditions imposed by different power cycles took place in order to determine:

a) ***If the reactor can maintain the level of partial load for indeterminate time.***

b) ***In which moment and at what speed is possible to return to total load.***

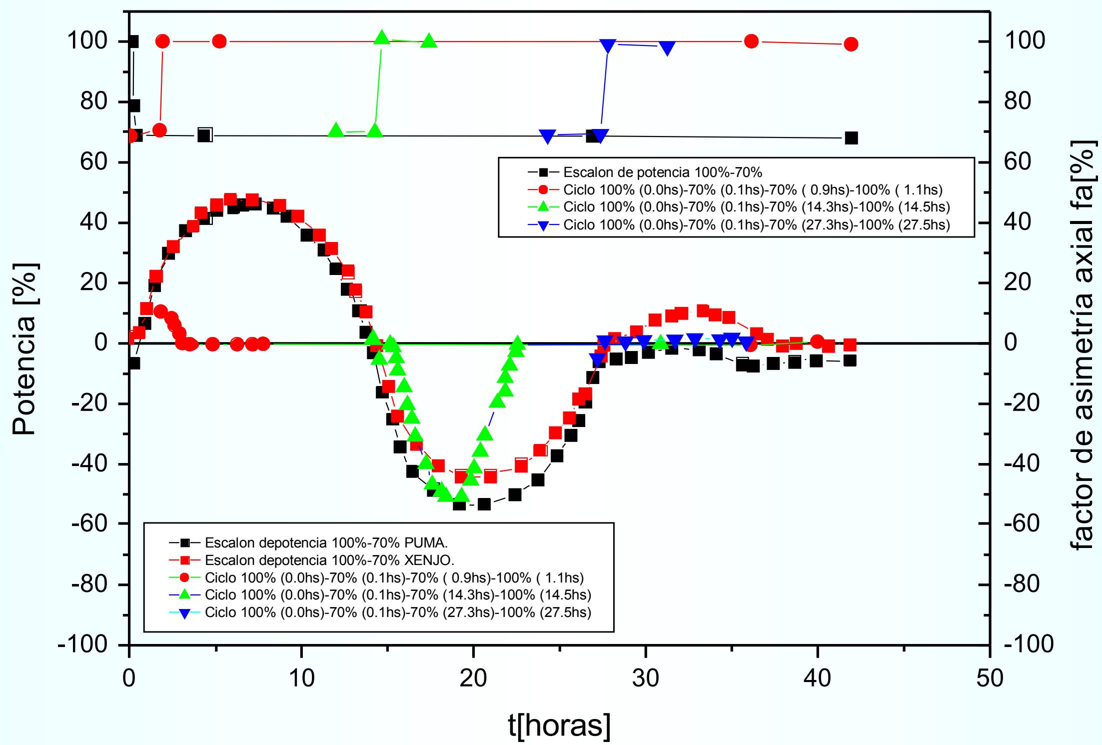
ATUCHA II NPP
Positive coefficient of power feedback

- The possibility of carrying out cycles of power is limited by two factors:

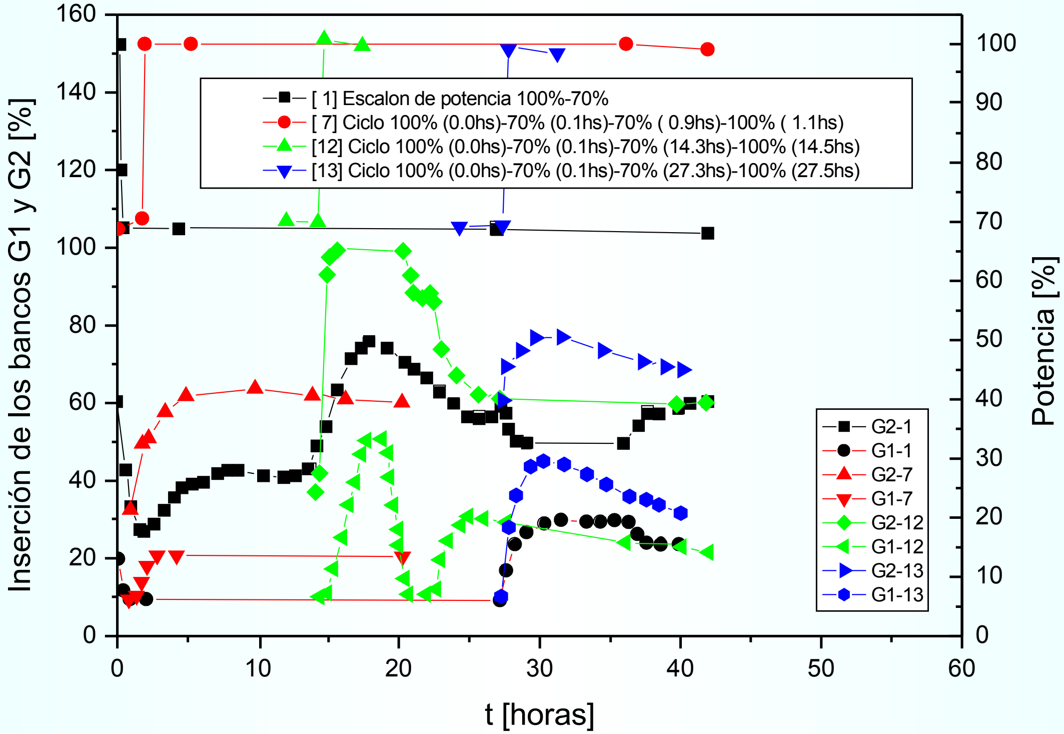
a) The negative reactivity introduced by the increase of the Xenon concentration 135 after a diminution of power, which must be compensated by the reactivity of reserve provided by the control rods.

b) The oscillations of power induced by the movement of the control rods can lead to in some point of the reactor, reach the established limits of operation.

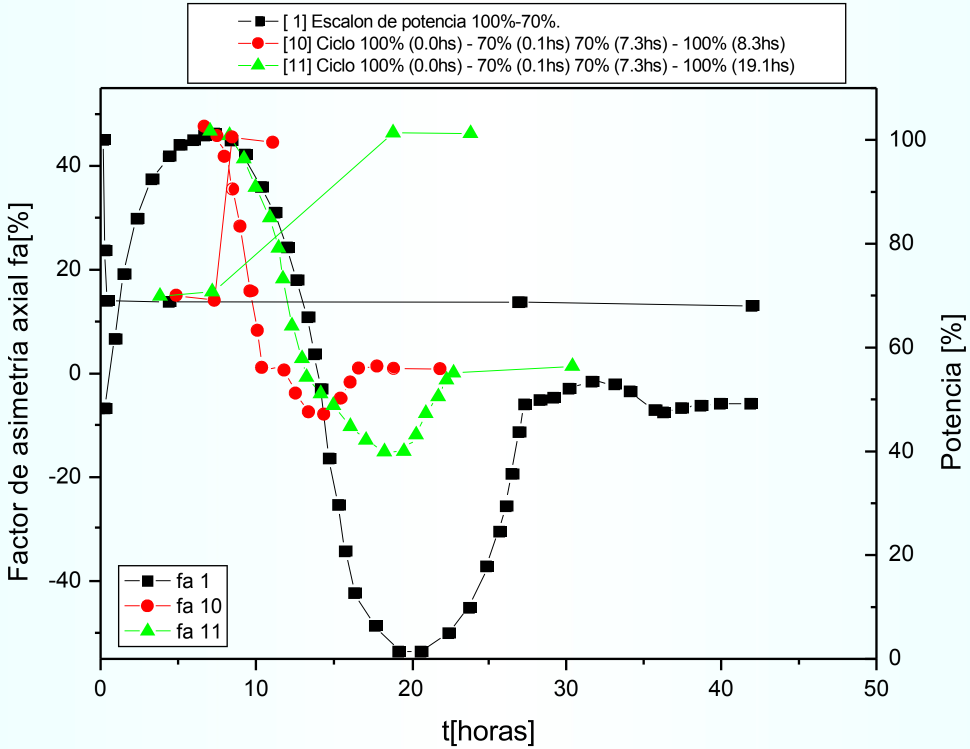
ATUCHA II NPP
Positive coefficient of power feedback



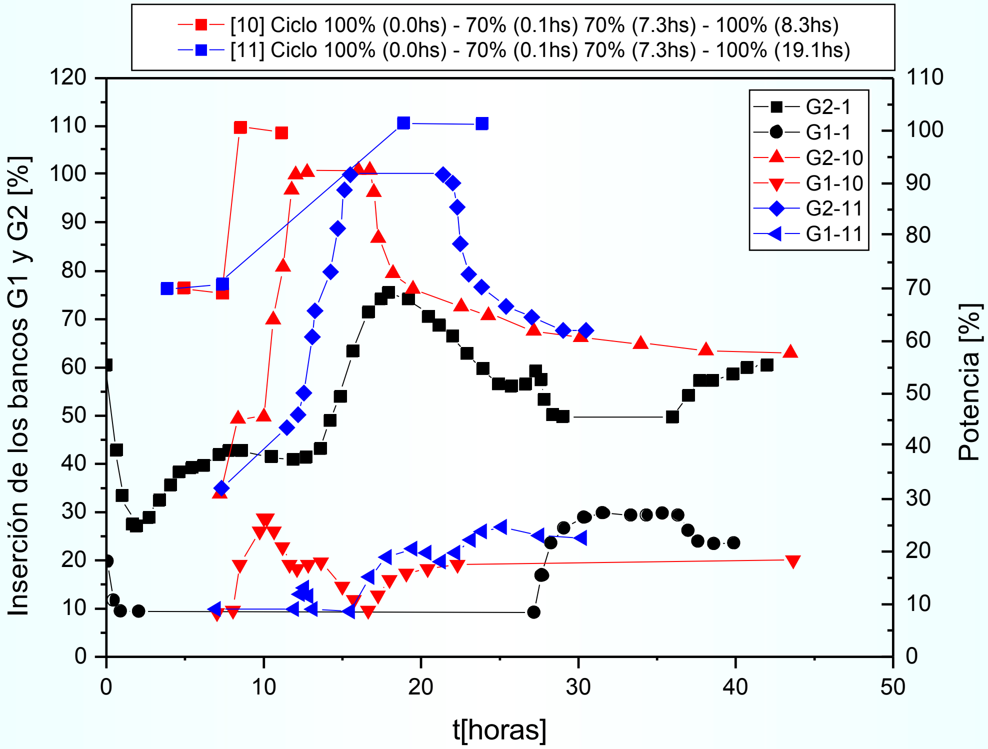
ATUCHA II NPP
Positive coefficient of power feedback



ATUCHA II NPP
Positive coefficient of power feedback



ATUCHA II NPP
Positive coefficient of power feedback



ATUCHA II NP
Licensing Project

- The licensing project of the CNA II points to:

  1. A safe design from the point of view of the plant nuclear safety.
  2. An absolute reliability in the performance of the safety systems in front of the postulated operational scenarios.
  3. An efficient operation of the plant.

- The licensing process will be performed based on the identification of the physical phenomena that take place in the reactor core under the conditions imposed by normal operation, abnormal predicted operation, abnormal not predicted operation, and accidental scenarios.

ATUCHA II NPP
Licensing Project

- Within this process, commonly denominated PIRTs (phenomena identification and table ranking), we have identified the following physical processes:
  1. Design of the reactor based on a primary system of separated refrigeration and a separated moderator system (partial or total).
  2. Break Concept. Break Preclusion. Leak before break.
  3. Neutronic-thermal hydraulic coupled phenomena.
  4. Hydrodynamic instabilities between fuel channels.
  5. Uncertainties in the propagation of density waves.
  6. Nonhomogeneous flow distribution in the lower plenum.
  7. Uncertainties in flow distribution between fuel channels and upper plenum.

ATUCHA II NP
Licensing Project

8. Uncertainties on the flow behavior through the hole connection between upper plenum and moderator tank.
9. Stability and homogeneous distribution of the boric acid injection in the tank of the moderator.
10. Speed of injection of boric acid versus the speed of propagation of depressurization waves.
11. Effectiveness of the emergency systems.
12. Confiability of the system of power control .
13. Reactor System Protection.
14. Control System of emergency systems.
15. Software confiability of I&C systems.
16. Sub criticality maintenance in the long term.

ATUCHA II NPP
Safety improvements

- Consequently and according to the characteristics that the design of the CNA II presents, it was established the necessity of a review in the first instance of the:

  ***a) Neutronic core design*.**

  b) Thermal Hydraulic core design.

  c) Break concept.

  d) Fast boric acid injection system desing.

  e) Emergency core cooling system (ECCS) design.

Conclusions and y recommendations

- *1. To carry out a study on the neutronic-thermal hydraulic coupled phenomena under normal and accidental scenarios, through a code adapted to the characteristics of the CNA II heterogeneous core, in order to allow the anticipation of the necessity or not of a redesign of the fuel element, and therefore of the neutronic design core as well, in order to mitigate the adverse effects of the positive coefficient of reactivity by void fraction in the coolant.*

Conclusions and y recommendations

- 2. *To verify the feasibility of mitigating the effects of the positive coefficient of power, during the operations of power cycle with a code adapted to the characteristics of the CNAII heterogeneous core, which allows to anticipating the necessity or not to establish the implementation of engineering solutions that assure the confiability and effectiveness of power control system.*

Conclusions and y recommendations

- *3. To carry out a study that allows knowing the speed diffusion of injected boric acid in the tank of the moderator system under normal and accidental scenarios that lead to critical reactivity excursions in order to analyze the measures necessary for mitigation under such circumstances. The study must consider the neutronic-thermal hydraulic coupled phenomena in the core of the reactor, through a calculation code that allows the three dimensional analysis of the corresponding phenomena.*