

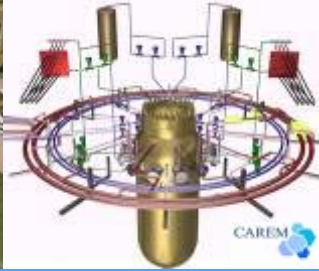
# Plant Life Management Activities for Long Term Operation of the Argentinean Water Cooled Reactors

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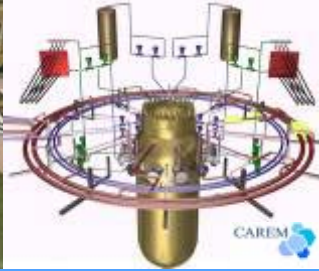


*COMISION NACIONAL  
DE ENERGÍA ATÓMICA*

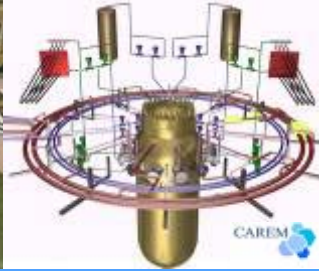


## Outline

- Brief description of Argentinean nuclear situation
- Plant Life Management (PLIM):
- Development of methodology for an integrated and common PLIM approach
- R&D ageing related activities
- Technical assistance to NPP activities.
- Future Challenges



# Brief Description of Argentinean Nuclear Situation



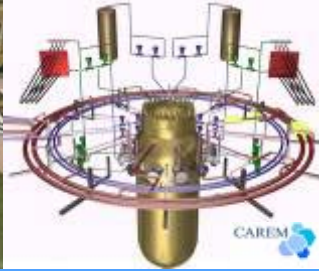
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## Argentinean Nuclear situation

Argentinean  
NPPs

- Two operating NPPs (Atucha I, Embalse)
- One NPP under construction (Atucha II)
- One prototype NPP in design stage (CAREM)

“Different reactors within the country and within the region”  
However, we still want to have an integrated view of PLIM for LTO



## Argentinean Nuclear situation

### Atucha I

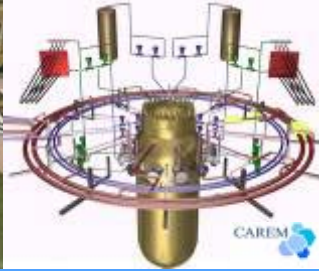


Pressure Vessel – PHWR Unique! (except for Atucha II)

252 vertical fuel channels

In service refuelling

357 Mwe Gross Power



## Argentinean Nuclear situation



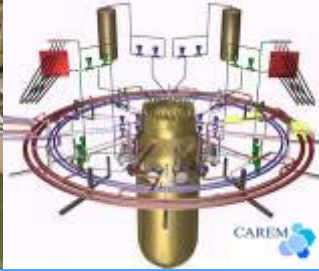
### Embalse

PHWR CANDU - 6

380 horizontal Pressure Tubes

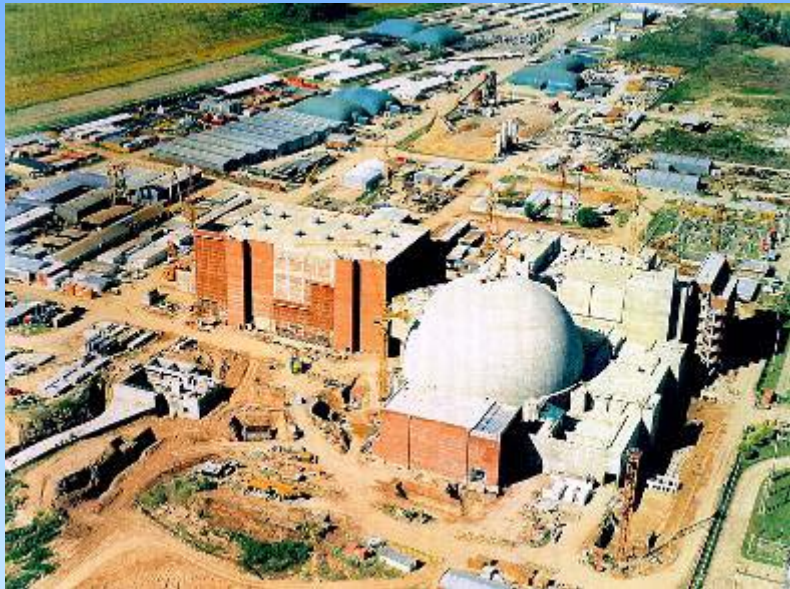
On line refuelling

648 Mwe Gross Power



## Argentinean Nuclear situation

### Atucha II

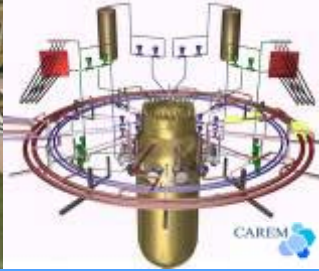


Pressure Vessel - PHWR

451 fuel channels – On line refuelling

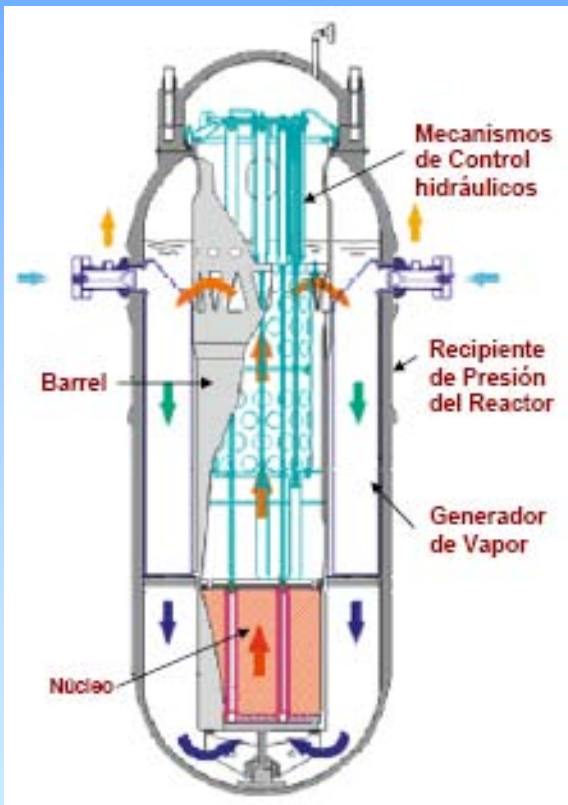
740 Mwe Gross Power

Delayed Construction – Commissioning  
expected for 2011



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## Argentinean Nuclear situation



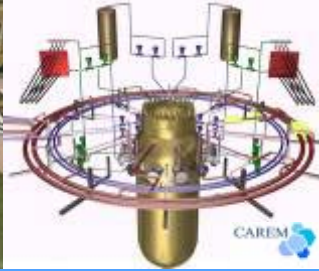
### CAREM

Innovative Prototype Reactor - Natural Convection

Integrated Design with In-vessel Steam Generators

25 Mwe Nominal Power - Scalable





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## Argentinean Nuclear situation

### Key Players



State Owned Utility

Responsible for the O&M of NPPs



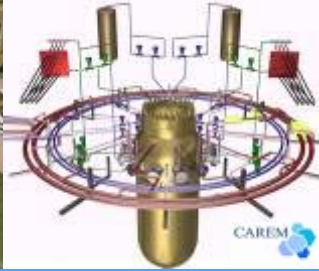
State Owned R&D Institution

Provides technological support to Na-Sa in many aspects

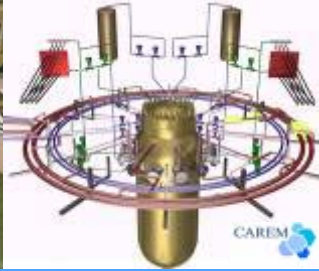


Regulatory Body

National authority for all nuclear facilities in the country



# PLIM activities in the last four years (2005 – 2009)



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## PLIM Activities (2005 – 2009)

PLIM for LTO activities

Embalse Life Extension Project

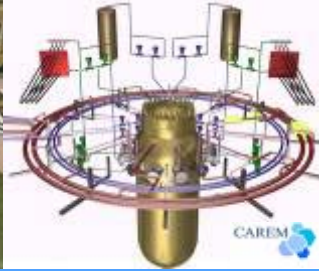
Along with the Operator (Na-Sa) and the designer (AECL)

Links between NPPs and CNEA labs: R&D and technical assistance

Failure root cause and materials analysis.  
Cable and polymers degradation studies.  
Suppliers qualification.  
Irradiation and thermal ageing studies on different materials and supplies.

Development of an integrated approach for Long Term Operation

Started for CAREM reactor. To be developed for Atucha II with the worthy collaboration of IAEA



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## Development of methodology.

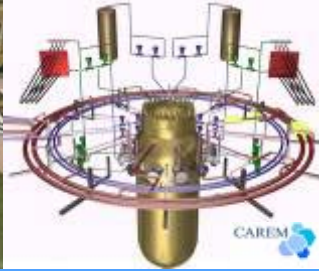
Development of an integrated approach for Long Term Operation

Already started for CAREM reactor and conversations are being held with Atucha I, who is enfacing the build-up of their own PLIM department

To be completed for Atucha II with IAEA collaboration through Technical Cooperation Program ARG/4/093

A single approach will be very beneficial, but should take into account the stage in which the plant is; among other plant-specific needs

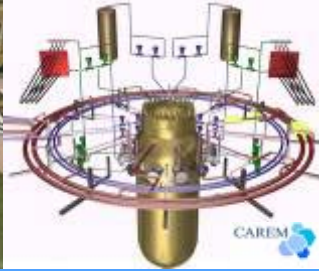
**Objective:** To have in place a program that allows us to operate our plants for the longest possible time in a safe and reliable way



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## Development of methodology: Stages and procedures under development

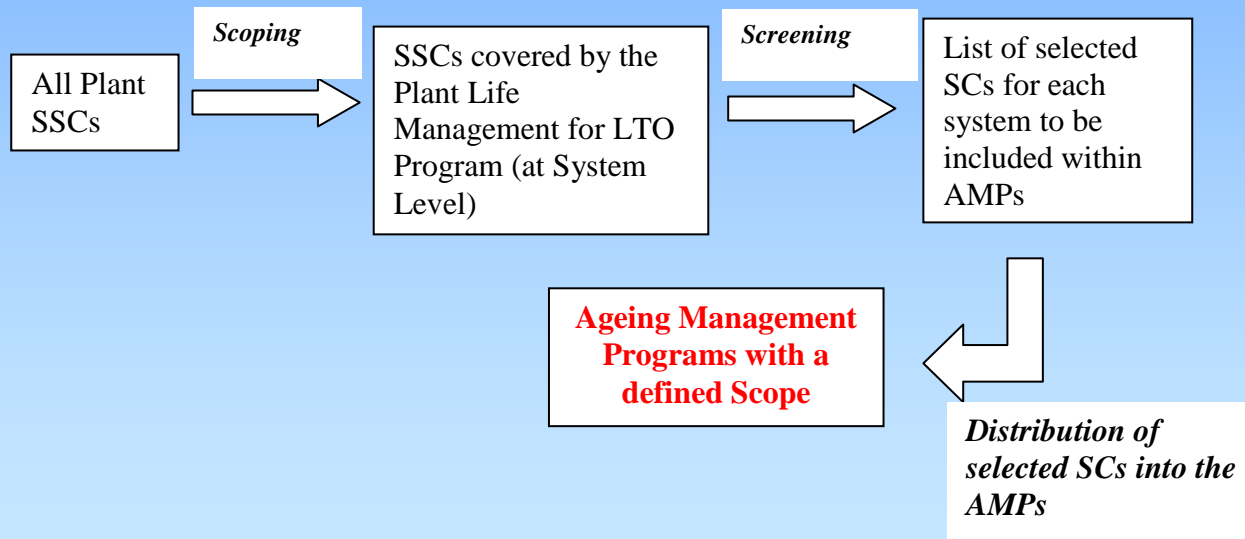
- Stage I → { Design Review and Screening of major System, Structures and Components (SCCs)
- Stage II → { Development of a Generic Ageing Database
- Stage III → { Analysis and /or design of specific AMPs
- Stage IV → { Determination of measurable Program Performance Indicators
- Stage V → { AMP evaluation and feedback



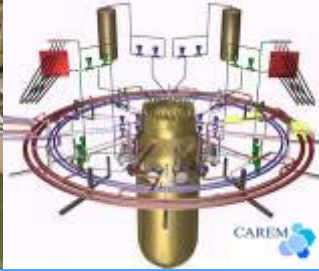
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## Development of methodology: Documents to be issued (under development)

1. General procedure for PLIM program design
2. Screening and scoping procedure

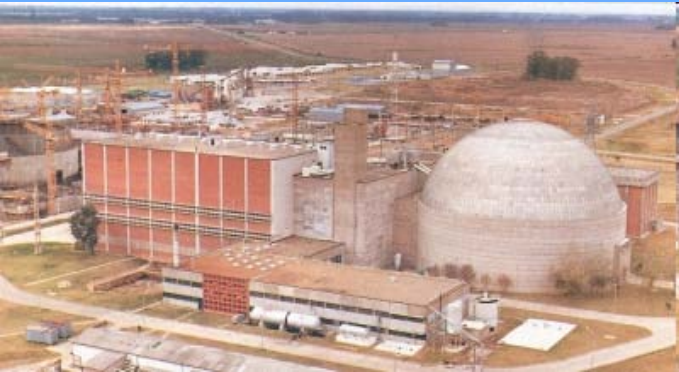


3. Ageing Management Program design guidelines
4. Degradation guidelines customized to materials and components of Argentinean NPP



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## Specific AMP design: Cables Ageing Management Program



### Current situation of Atucha I NPP

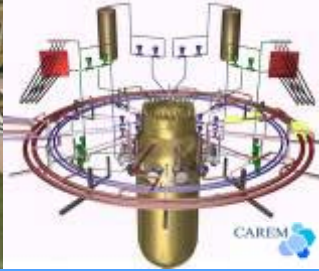
Currently this NPP has neither EQ program nor cable condition monitoring Program. Maintenance activities are performed on a corrective basis

Most of the cables insulation material are PVC and SiR



### Current situation of Atucha II NPP

- The storing condition and component preservation was good.
- Non-EQ cables are similar to those used in Atucha I
- EQ cables are being purchased with up to date requirements and specifications
- Early discussions about EQ and Cable Aging Management Program are being carried out.

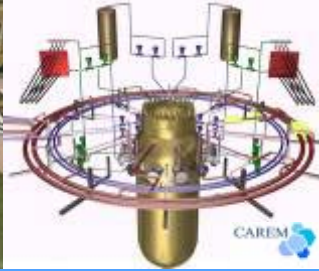


## Specific AMP design: Cables Ageing Management Program

### Stages:

1. Screening of cables involved in systems and components relevant for the Long Term Operation. This task is being carried on together with plant personnel.
2. Stored cable condition assessment based on original standards qualification for cables (DIN-VDE).
3. Determination of Aging related mechanism effect.
4. Data collection of the initial condition for the baseline of aging management program
5. Condition monitoring and in service inspection procedures elaboration and implementation.
6. EQ maintenance and surveillance program (under development)





## R&D related activities: Cable Ageing Studies

Material characterization of stored and in-service cables

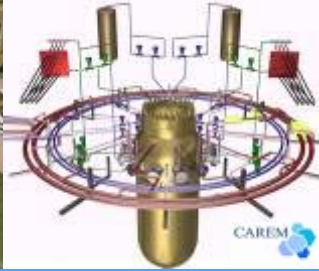
Thermal endurance properties of stored cables

- *Activation energy*
- Plastizer lost
- Elongation at break
- Development of master curves of elongation at break at different temperature and correlation of elongation at break with non destructive essay properties (indenter test, under development)

Radiation damage studies for re-fuelling machine cables

*Development of LOCA Test (in progress)*

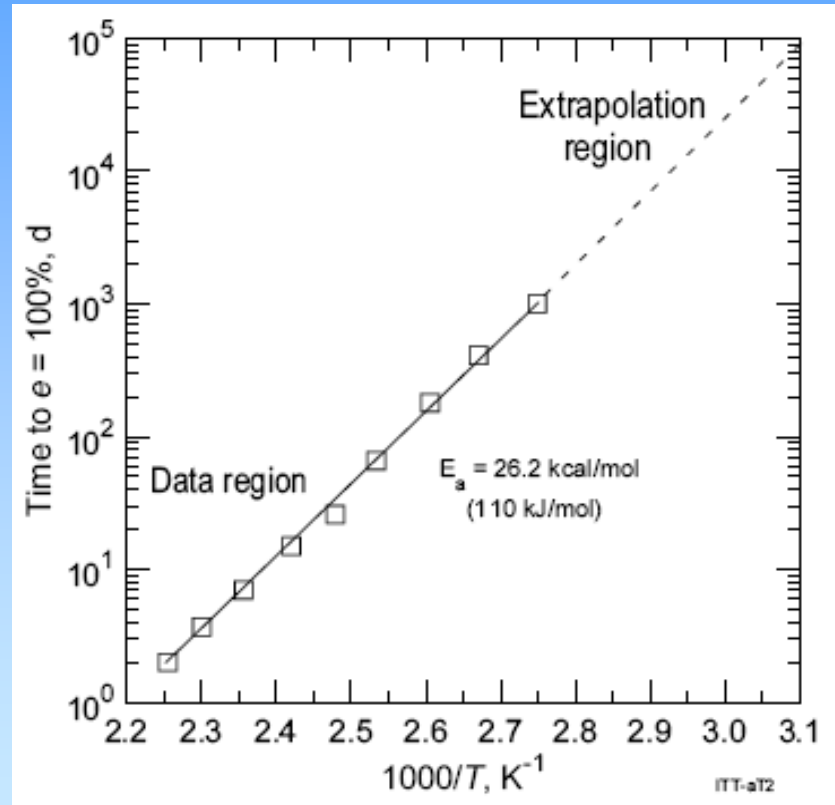
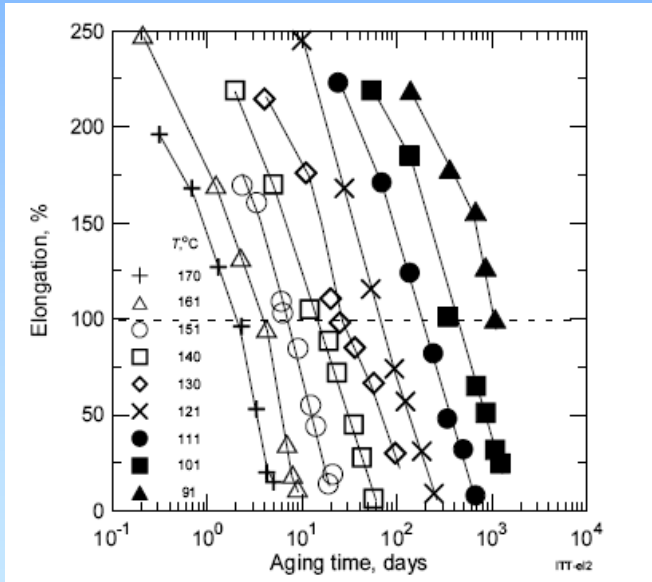
Participation on SCAP Project as full members



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# R&D related activities: Cable Ageing Studies

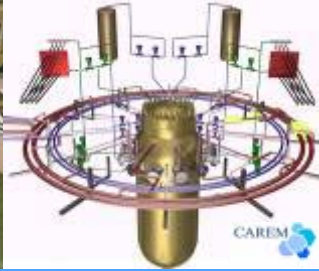
## Activation energy



**IEC 60216** Guide for the determination of Thermal Endurance Properties of Electrical Insulating Materials.

**IEEE 98** IEEE Standar for the Preparation of Test Procedures for the Thermal Evaluation of Solid Electrical Insulating Materials

**XLPO** SAND2005-7331 Nuclear Energy Plant Optimization (NEPO) Final Report on Aging and Condition Monitoring of Low Voltage Cable Materials

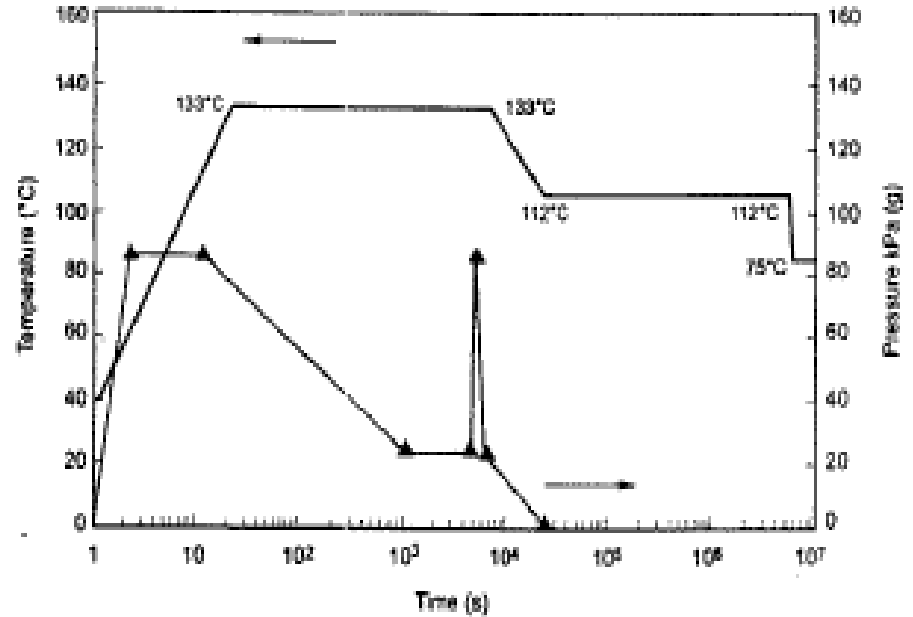
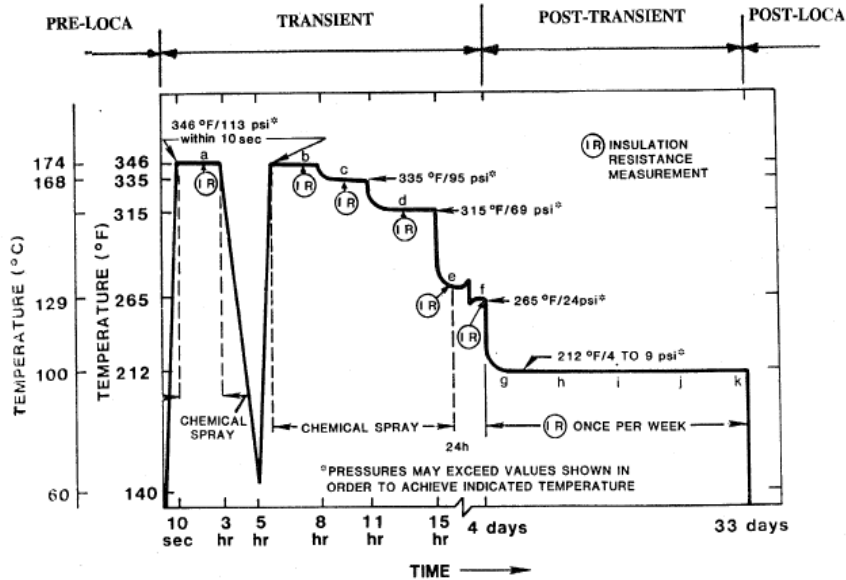


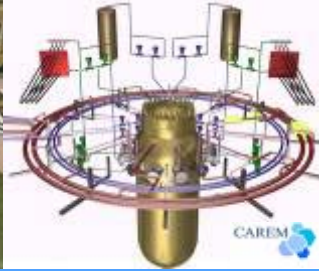
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# R&D related activities: Cable ageing studies

## Development of LOCA tests

Measurement of relevant properties under LOCA conditions and after LOCA cycle (i.e. Insulation resistance)

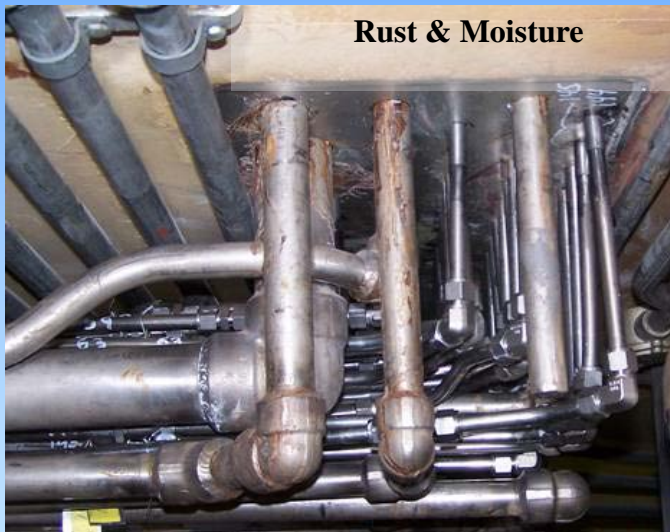




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## Technical assistance: Failure analysis

### Case 1: Non containment penetration

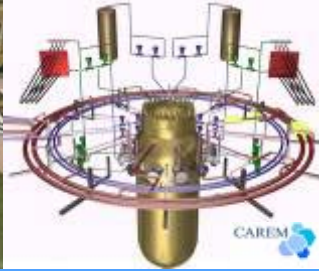


Outer surface: Pits



Inner surface: No damage

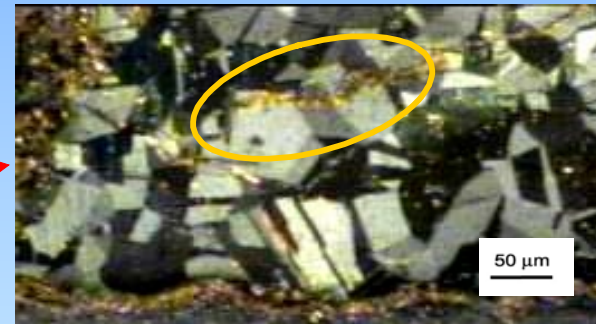
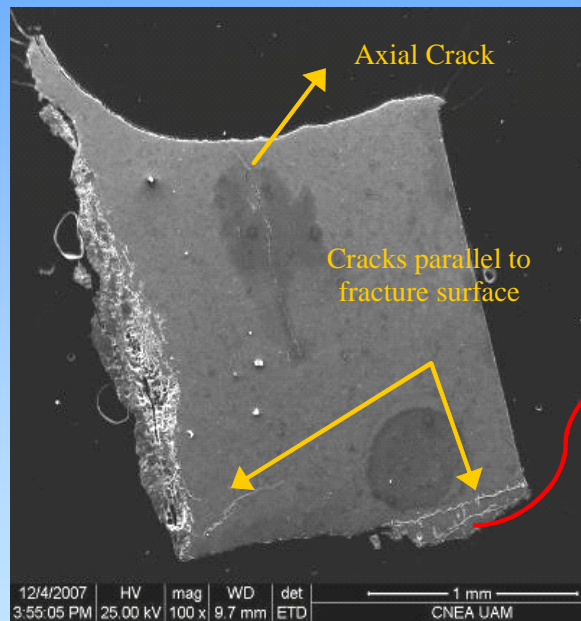
The failure has been found on a non-containment mechanical penetration, the leaking pipe was an AISI-304 pipe. The penetration is formed by two carbon steel plates. The pipes are welded to the upper plate and ilmenite sand is used as filler and as a shielding element. The samples shown signs of pitting in outer surface.



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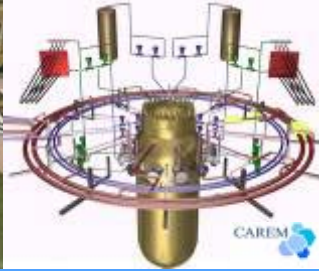
## Technical assistance: Failure analysis

### Case 1: Non containment penetration



Transgranular Crack

The metallographic analysis has shown typical transgranular and branched cracks. As a conclusion, the failure of the pipe was due to Stress Corrosion Cracking (SCC) produced by the anions ( $\text{Cl}^-$ ) found as contamination in the ilmenite sand.



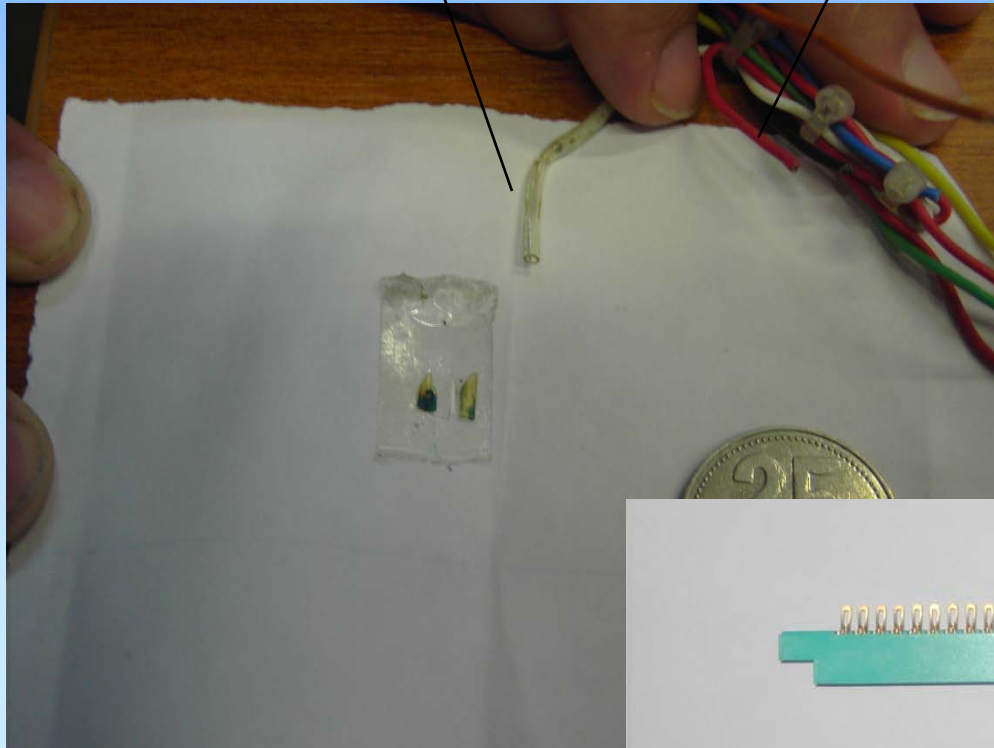
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## Technical assistance: Failure analysis

### Case 2: Corrosion in electronic devices

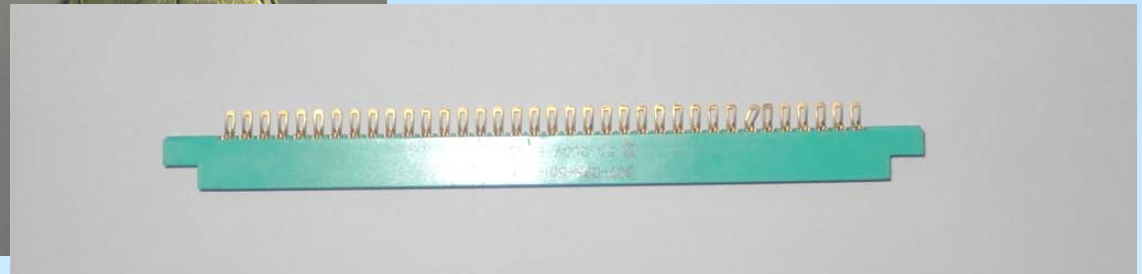
PVC

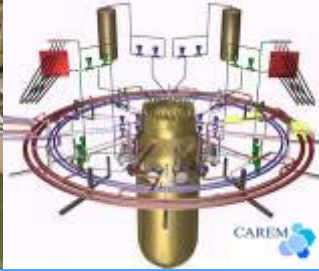
XPLE



In a normal inspection of electronic equipment, several failures in welded connections were detected.

The failure analysis consisted in a characterization of failed connector and corrosion products.

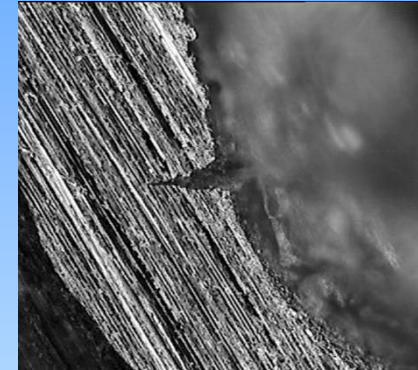
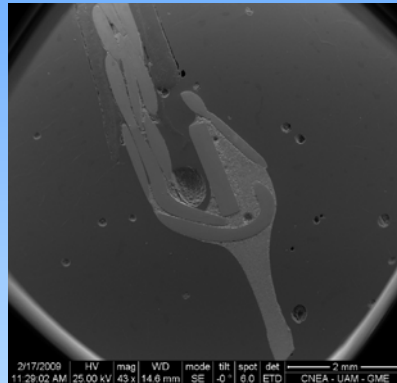
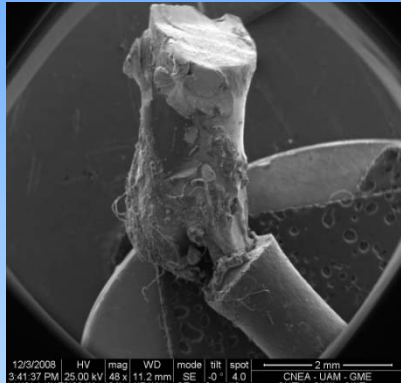




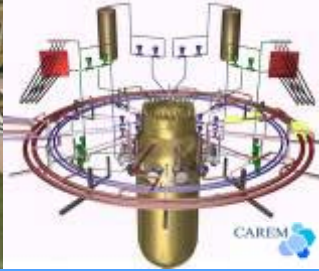
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## Technical assistance: Failure analysis

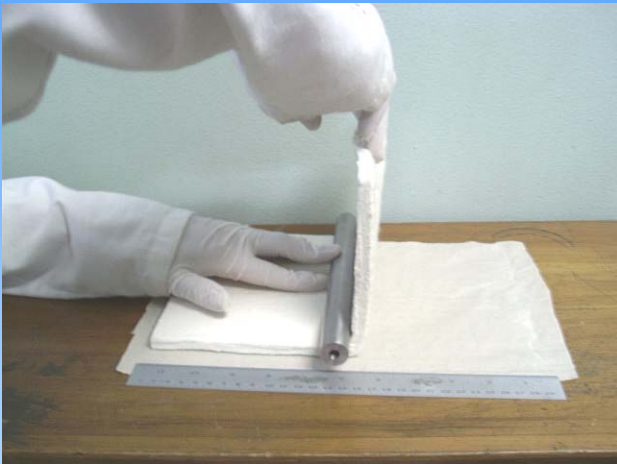
### Case 2: Corrosion in electronic devices



- The welded connection was grinded at different depths in order to evaluate de crack size and morphology. Materials and corrosion product were characterized by FTIR, XRD, SEM and EDS
- Corrosion product found: Manly copper carbonate, and chlorine containing products.
- The failure could be related to chlorine evolution coming from the PVC splice-cover, and due to some transients in temperature and moisture.



## Technical assistance: Suppliers qualification (ageing studies)

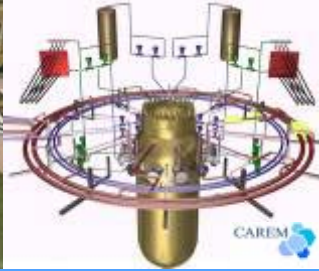


The PLIM division has made several tests to qualified materials and supplies for Argentinean NPPs, like electronic components, thermal insulation, etc

A new material based on a silica aerogel reinforced with a non-woven glass-fiber batting, was proposed to replace the conventional stone wool blanket. The PLIM department has studied the radiation damage and the possible changes in radiological activity after the exposure of both materials to neutrons.







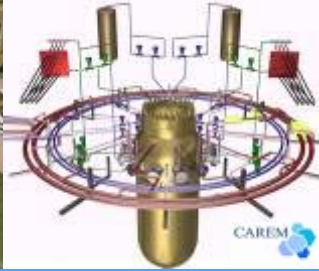
## Conclusions

As a result of the efforts made by CNEA, a solid working group has been developed to cope with the different topics on PLIM for LTO.

This group is developing several activities of R&D related with Ageing Degradation Mechanisms and Ageing Effects, integrating the experience and capabilities of different laboratories and providing technical assistance to Argentinean NPPs.

## Future Challenges

Future work will be focused on the development of EQ test and on the application of recently developed procedures to design and implement specific ageing management programs for the different SSCs of Argentinean NPPs. For this task it is essential to continue enhancing the synergic cooperation between the NPP personnel and R&D institutions.



**Many Thanks for your  
Attention!!**