



# 2004 Status of the CNEA Qualification Programs for the Fabrication of High Density Fuels for Research Reactors

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## 2004 Status of the CNEA Qualification Programs

### SCOPE

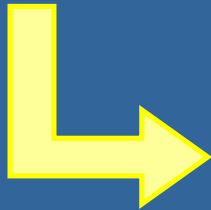
- Description of CNEA qualification programs for high density MTR fuel
- Status and achievements during 2003
- Future activities



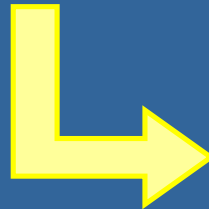


# 2004 Status of the CNEA Qualification Programs

CNEA qualification  
programs for  
high density MTR fuel



- FABRICATION
- TESTING
- IRRADIATION



- Silicide fuel
- U-Mo fuel





## 2004 Status of the CNEA Qualification Programs

# CNEA BACKGROUND



- Domestic supply
- Supply to Foreign Research Reactors  
since 1985  
> 12000 Fuel Plates
- Participation in international Programs to Qualify Fuel Materials





## Silicide Fuel

- Miniplates
- Two  $U_3Si_2$  fuel elements  
4.8 gU/cm<sup>3</sup>  
P-06 and P-07  
were fabricated and  
irradiated in the RA-3 (Argentina)





# 2004 Status of the CNEA Qualification Programs



## **P-06**

**Started: September 2000**

**Ended: May 2003**

**Dwelling time: 456 efpd**

**Final Burnup: 55 %**



## **P-07**

**Started: November 2001**

**Ended: November 2003**

**Dwelling time: 382 efpd**

**First stage final Burnup: 55 %**

## **RA-3**





# 2004 Status of the CNEA Qualification Programs

## SILICIDE FUEL

### Status and Achievements

Fuel Element	End of Irradiation (55 % Burnup)	EOL In-Pool Visual Inspection	Hot-cell Examination
P-06	Completed (May 2003)	Completed (June 2003)	Completed (November 2003)
P-07	Completed (November 2003)	Completed (December 2003)	... 2005





## 2004 Status of the CNEA Qualification Programs

# P-06 and P-07 FINAL VISUAL INSPECTION

## Fuel Plates

- No swelling or unexpected dimensional changes were observed
- No blisters or rough zones were detected
- The outer plates showed uniform oxide layers

## Fuel Elements

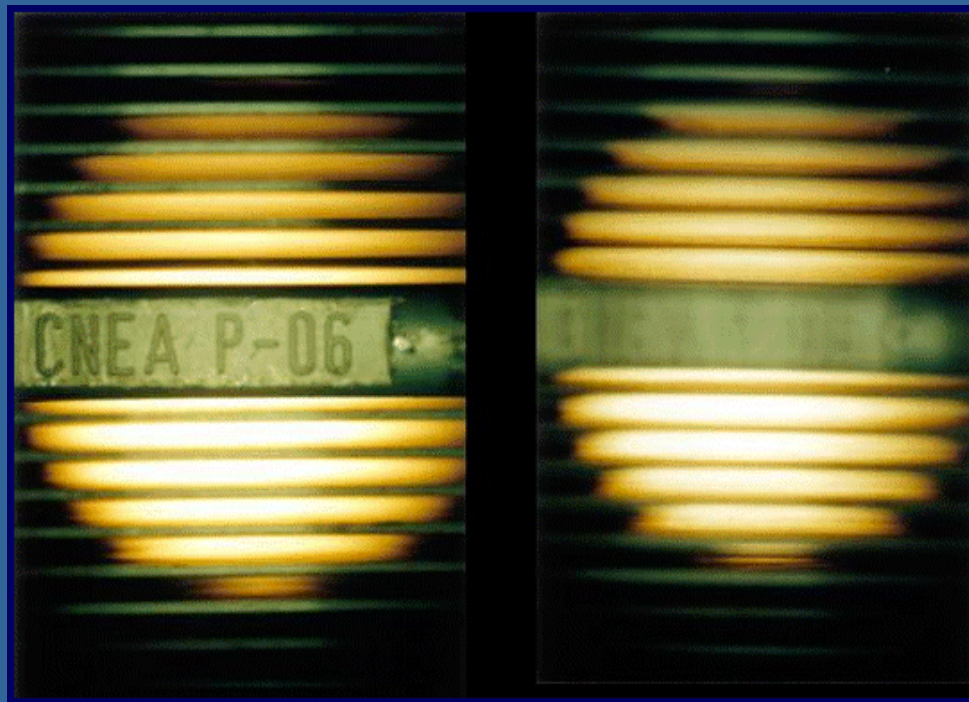
- Both FE kept their structural integrity and no anomalies were observed
- Inspection with back lighting showed that the fuel plates remained perfectly flat without any bowing or distortion
- Gap between fuel plates is uniform all along the coolant channel





# 2004 Status of the CNEA Qualification Programs

## P-06 FINAL VISUAL INSPECTION





# 2004 Status of the CNEA Qualification Programs

## P-07 FINAL VISUAL INSPECTION

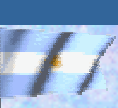




## 2004 Status of the CNEA Qualification Programs

### P-06 PIE

- Removal of one external Fuel Plate
- Transportation to the Hot Cells
- Non-destructive and destructive examinations
  - Visual Inspection
  - Plate thickness measurement
  - Oxide thickness measurement (metallographic samples)
  - Microstructure
  - Absolute burnup determination (Depletion of U235)

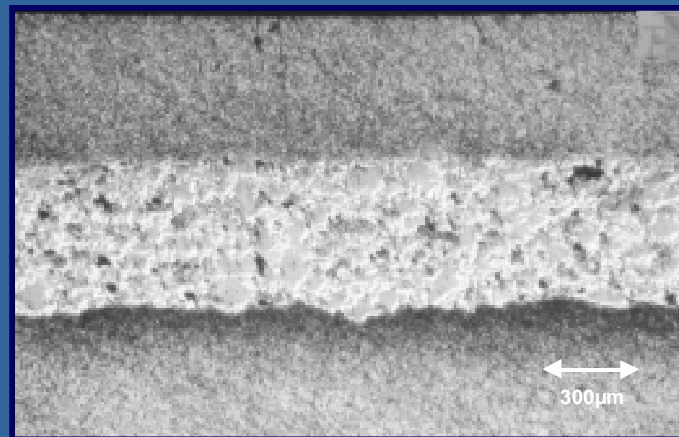




# 2004 Status of the CNEA Qualification Programs

## P-06 Hot Cell PIE Results

Position	Oxide layer thickness ( $\mu\text{m}$ )	
	Metallographic	Eddy Current
Top	9	9.2
Center	11	10.8
Bottom	10	10.3





## 2004 Status of the CNEA Qualification Programs

# UMo Fuel

## CNEA Initial Program

- Development of basic knowledge on UMo-AI
- Fabrication of UMo powder using alternative routes
- Set up of the technology to fabricate sound plates using different UMo powders
- Irradiation of leading elements in HFR and RA-3





# UMo Fuel Activities

## Status 2003

- Initially focused on:  
Development of the technology to fabricate sound plates using different UMo powders
- Now:  
Development of basic knowledge on UMo-AI interaction





## 2004 Status of the CNEA Qualification Programs

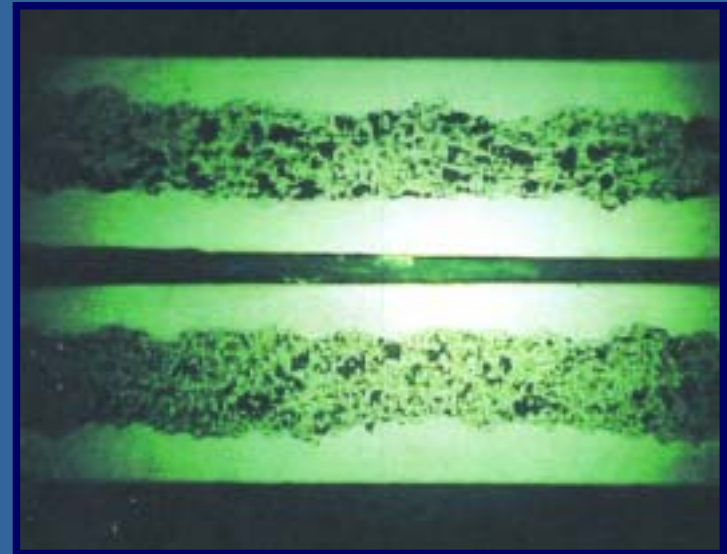
### Results of fuel plate fabrication setup

Some plates showed  
unexpected large  
interaction UMo-Al

- UMo powder with high specific area
- High rolling temperature



- Reduction of available Al
- Large porosity in the interaction zone



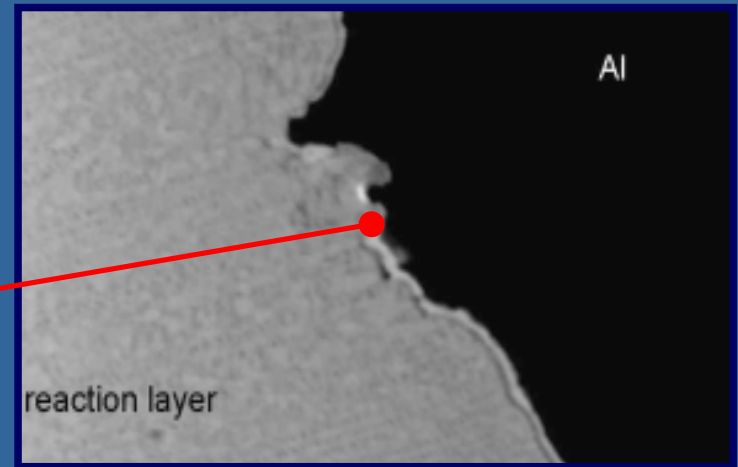


# 2004 Status of the CNEA Qualification Programs

## Fuel interaction studies

New results were presented in  
RERTR 2003

- U-7wt%Mo/Al Diffusion couples at 580C
- Narrow 3<sup>rd</sup> zone with high Al content (~85% - EDAX)
- Decomposition of  $\gamma$ (U-Mo) affects width of the interaction zone



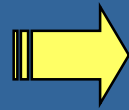


# 2004 Status of the CNEA Qualification Programs

## Future activities

- Fuel fabrication for the irradiation programs is temporally postponed
- Activities will be concentrated in:
  - Study of Fuel-AI reaction and products characterization
  - Analysis of solutions to reduce the interaction
    - Less active powders
    - Use of other materials for the matrix
    - Modifications of the fabrication parameters
- Irradiation of miniplates to test the solutions





# Final Remarks

- The main part of the CNEA Qualification Program on silicide fuel was completed during 2003
- Results are as expected for this fuel material and in accordance with NUREG-1313
- The main objective of the UMo Program remains the same
- The activities in the near future were modified
  - Fabrication activities were postponed
  - Focus on fuel interaction studies and remedies

