THE IPR-R1 TRIGA MARK I REACTOR:
IMPROVING THE BRAZILIAN NUCLEAR TECHNOLOGY IN 45 YEARS OF OPERATION

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TRIGA MARK I IPR-R1 REACTOR

- DEDICATED IN NOVEMBER/06/1960
- ORIGINALLY 100 kW - UPGRATED 250 kW
- FUEL: ENRICHED URANIUM
- MODERATOR: ZIRCONIUM HYDRIDE
- REFLECTOR: GRAPHITE
- COOLING SYSTEM: DEMINERALIZED WATER
TRIGA MARK I IPR-R1 REACTOR USES

- Production of radioisotopes for different educational and scientific institutions uses;
- Scientific experiments;
- Training of nuclear engineers for research and power plant reactor operation;
- Experiments with materials and minerals;
- Neutron activation analysis
## Igorr - TRTR 2005

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ENERGY RELEASED (kW)</th>
<th>SAMPLES IRRADIATED AT IPR-R1</th>
<th>Neutron Activation Analysis</th>
<th>Experiments, Tests, Other Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960 - 1964</td>
<td>152,989</td>
<td></td>
<td>217</td>
<td>1,577</td>
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<tr>
<td>1965 – 1969</td>
<td>85,601</td>
<td></td>
<td>14,184</td>
<td>3,405</td>
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<td>1970 - 1974</td>
<td>247,480</td>
<td></td>
<td>50,026</td>
<td>3,562</td>
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<tr>
<td>1975 – 1979</td>
<td>505,162</td>
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<td>137,943</td>
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<td>1980 - 1984</td>
<td>384,036</td>
<td></td>
<td>167,477</td>
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<td>1985 – 1989</td>
<td>131,295</td>
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<td>36,430</td>
<td>650</td>
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<td>1990 - 1994</td>
<td>69,666</td>
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<td>10,399</td>
<td>214</td>
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<td>1995 – 1999</td>
<td>154,639</td>
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<td>13,063</td>
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<td>2000 – 2004</td>
<td>167,029</td>
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<td>17,006</td>
<td>455</td>
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<td><strong>TOTAL</strong></td>
<td><strong>1,897,897</strong></td>
<td><strong>446,745</strong></td>
<td></td>
<td><strong>13,986</strong></td>
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</table>
IMPROVEMENTS AT THE IPR-R1 REACTOR

• The Pneumatic System
• The Water-Water Cooling System
• The Reactor Aluminum Tank
• The Control Rod Drive Mechanisms Replacement
• The Neutrongraphy Facility
• The New Reactor Control Console
THE NEW IPR-R1 REACTOR CONTROL CONSOLE
THE USE OF COMPUTER SYSTEMS AT THE IMPROVEMENTS OF THE REACTOR

- Use of software to improve data acquisition and signal processing system
- Use of calculations codes to calculate the physics and engineering parameter
- Use of software as a tool to improve burnup and decay calculations
Data Acquisition and Signal Processing System

Five screens compose the program:

- Navigation Screen
- Reactor Power Level Instrumentation
- Cooling and Water Parameters System
- Radiation Level Monitoring Channels
- Extra Instrumentation Measurements Parameters
Data Acquisition Cards:

Two Cards Model PCLD-789

- Accuracy: 0.0244% of the range ± 1 LSB;
- Input: 16 differential channels;
- Over voltage protection: ± 30 V continuous;
- Input range: ± 10 V maximum, varies with gain selection;
- Gain: 1, 2, 10, 50, 100, 200, 500 and 1000;
- Cold junction compensation: +24.4 mV/°C (0.0 V at 0.0 °C);
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Reator TRIGA IPR-R1

NIVEIS DE RADIAÇÃO [ mR/h ]

AEROSOIS  |  POÇO  |  ÁREA  |  Entr PRIMÁRIO  |  RESINAS  |  S. SECUNDÁRIO

- **AEROSOIS**: 0.1 mR/h
- **POÇO**: 26.7 mR/h
- **ÁREA**: 3.8 mR/h
- **Entr PRIMÁRIO**: 0.5 mR/h
- **RESINAS**: 0.0 mR/h
- **S. SECUNDÁRIO**: 0.0 mR/h

**Limite**: 2.5 mR/h
**Limite**: 75 mR/h
**Limite**: 25 mR/h
Neutronic Calculation to the TRIGA IPR-R1 Reactor Using the WIMSD4 and CITATION Codes

- Integral curves of the control and safety rods

Burnup Calculations of Nuclear Fuel Using Monte Carlo Transport Methods
The use of the WIMSD4 and CITATION codes

• The Reactivity Excess,
• The Temperature Reactivity Coefficients
• The Control, Safety And Regulation Rods Reactivity Worth
• The Integral Curves Of The Control And Safety Rods
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Burnup Calculations of Nuclear Fuel Using Monte Carlo Transport Methods

- Monteburns
- MCNP4B
- Origen 2.1
USES OF THE COMPUTER CODES IN NEUTRON ACTIVATION ANALYSIS

- ACQUIREMENT OF GAMMA SPECTRA
  - Maestro (ORTEC)
  - Genie 2000 (CANBERRA)

- EVALUATION OF GAMMA SPECTRA
  - Hyperlab-PC (Hungary)

- ELEMENTAL CONCENTRATIONS
  - Kayzero/Solcoi (Belgium)
CONCLUSIONS

• The developed data acquisition system has been operated during normal operation and during all experiments realized with the reactor since July 2003.

• Some codes used along the years have been changed and new ones have been introduced to study the reactor parameters.

• In general, the results of the methodology using the codes WIMSD4 and CITATION to simulate the TRIGA IPR-R1 reactor are very close to the experimental values.
CONCLUSIONS

• The Monteburns system code has also been used in simulations of the IPR – R1 TRIGA Reactor at CDTN, Belo Horizonte, Brazil.

• Criticality calculations are well within the expected accuracy of the calculation methodology and MCNP model.

• The Monteburns codes system is able to supply neutronic parameters like neutron fluxes, keff, power distribution, control rods reactivity worth, core excess reactivity, fission products poisoning.
REFERENCES


THANK YOU SO MUCH
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