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Progress on the University of Florida Training Reactor

(2013 Edition)

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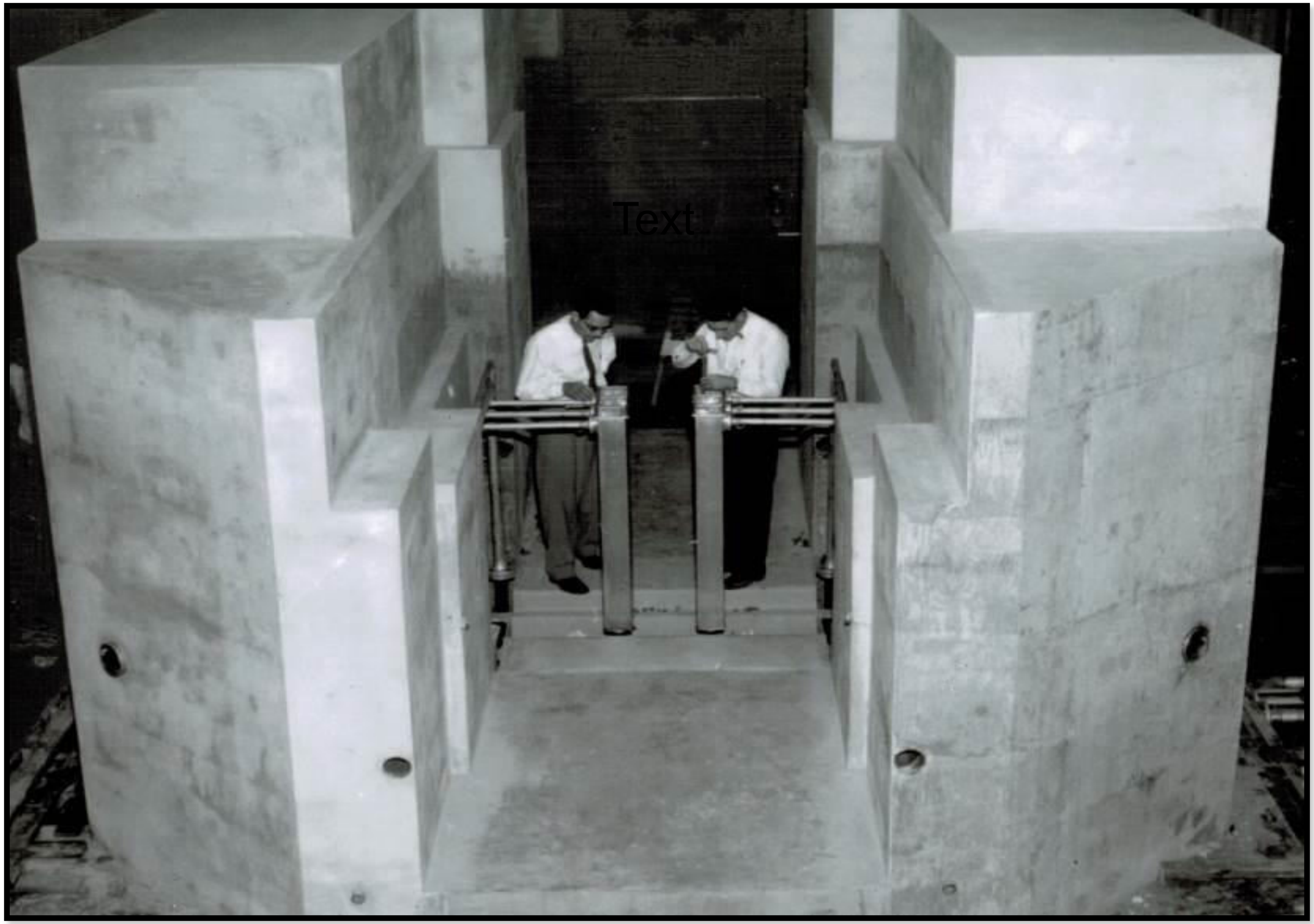
Introduction

University of Florida Training Reactor (UFTR) operating license came up for 20 yr renewal in 2001



Licensing Basis (Prehistory)

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1959	Originally licensed at 10kW
1964	Power uprate to 100kW
1982	Relicensed → current license
2002	Updated FSAR submitted for relicensing
2006	HEU-LEU Conversion SAR approved, appended to 1982 FSAR
2007	Consideration of a digital controls system
2011	Current leadership team emplaced
2013	New safety analysis report and tech specs submitted to NRC. Functional requirements specs complete for digital controls system

Goal

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- To prove that the UFTR represents a negligible risk to the health and safety of the public

- New licensing approach allows for a reduction in the number of safety systems that are classified as safety related

- Ease the licensing path for the digital controls upgrade

UFTR Model

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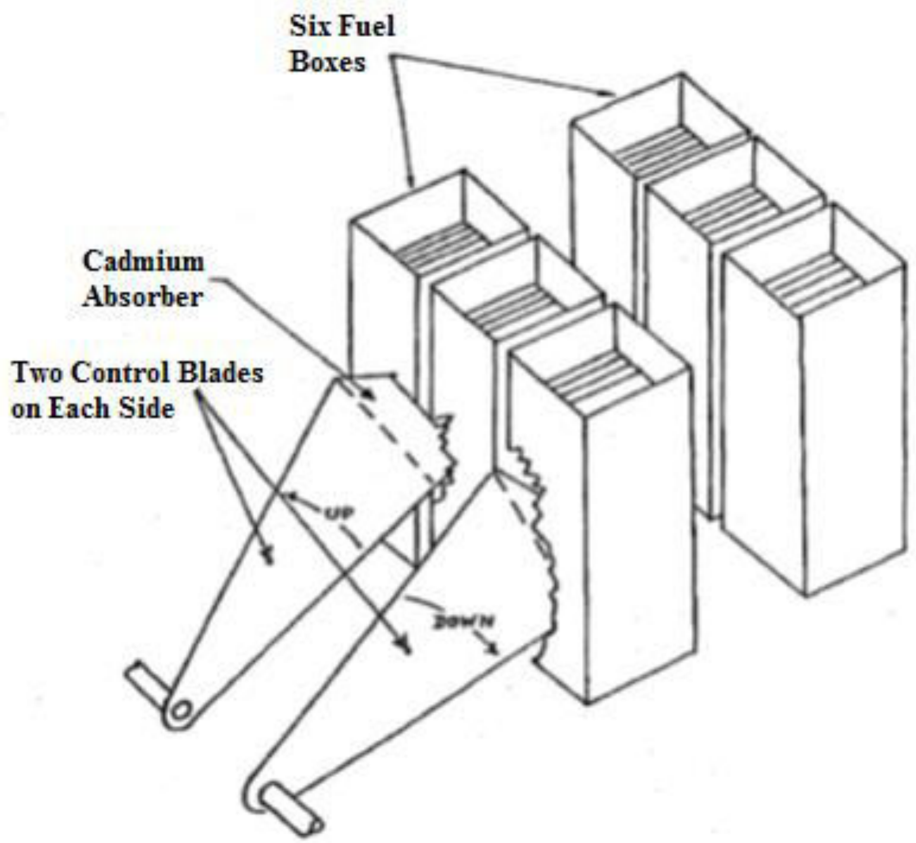
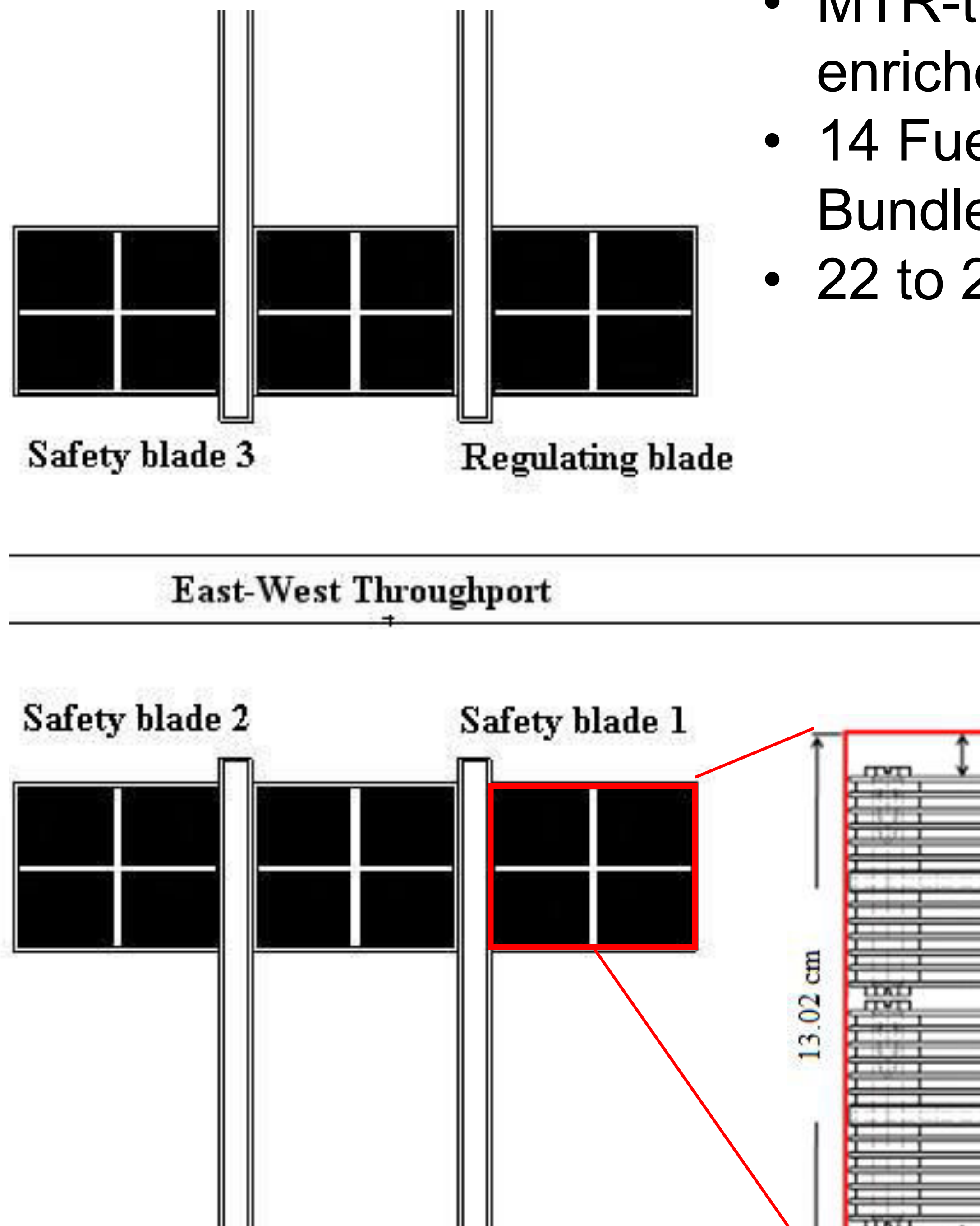
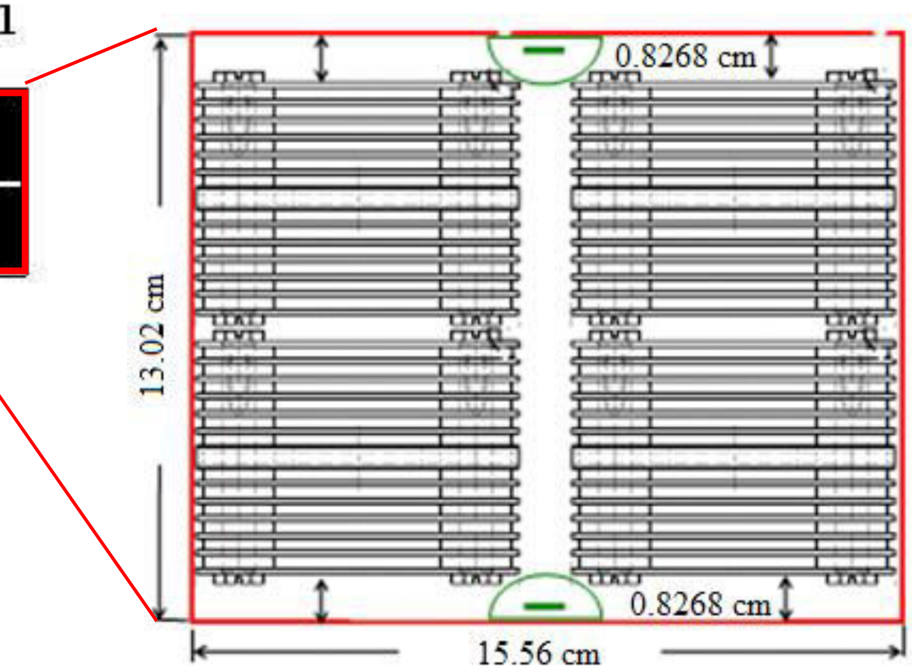


- Four control blades: three safety, one regulating
- Cadmium poison on blades





- MTR-type 19.75% enriched U_3Si_2-Al alloy fuel
- 14 Fuel Plates in each Bundle
- 22 to 24 Fuel Bundles

Inherent Design Safety

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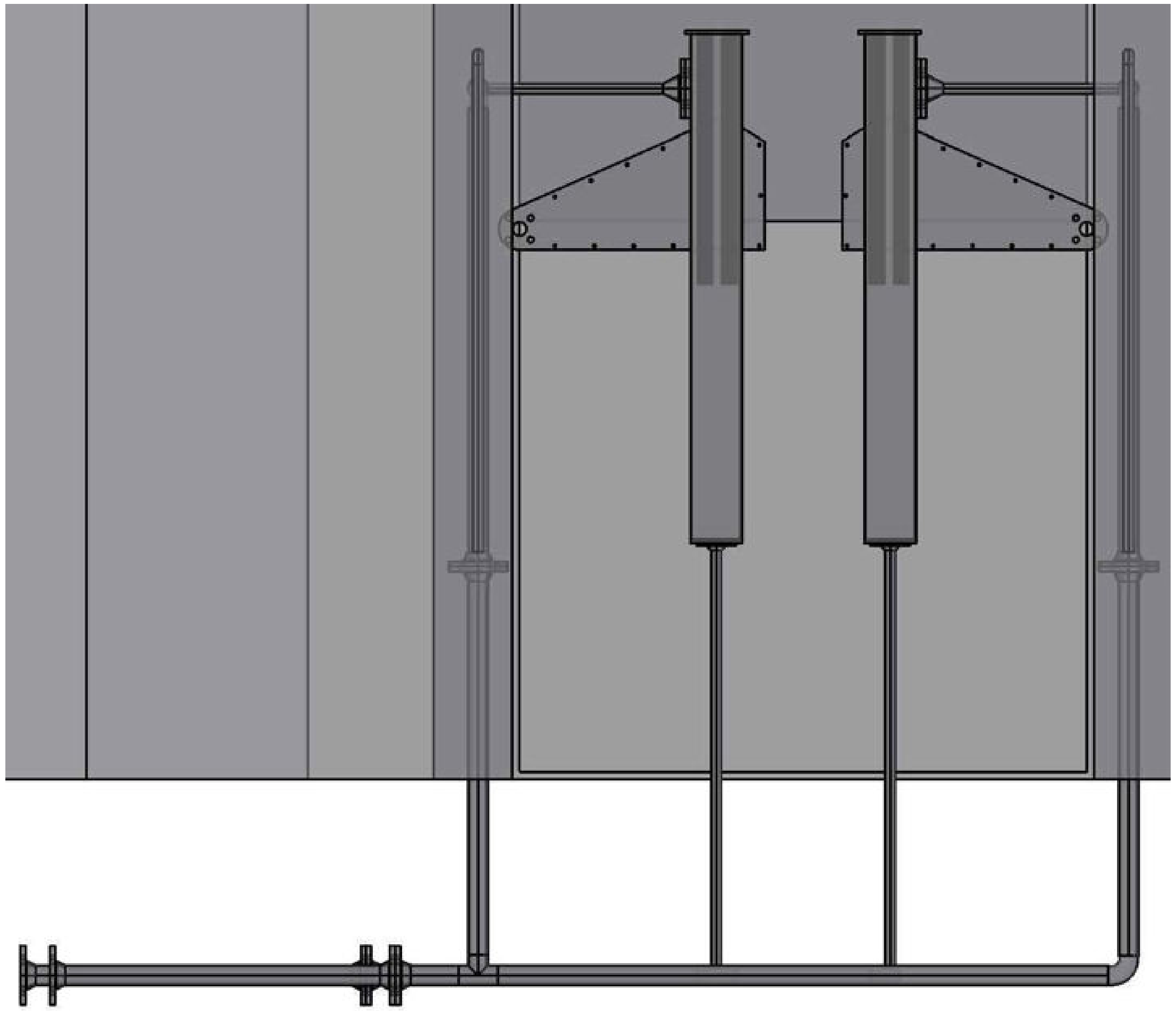
Four inherent design features that maximize safety:

1) Negative temperature and void coefficients
2) Limited amount of excess reactivity (1.4%Δk/k max)
3) Small amount of contained excess fission products
4) Low probability of escape of fission products



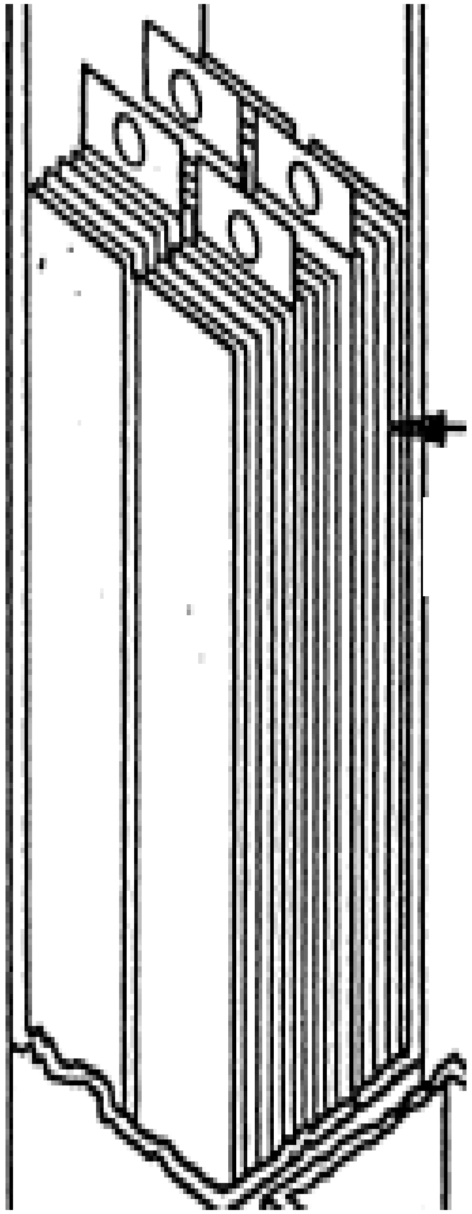
Pressure discs in piping

Maximum Hypothetical Accident

- The MHA is a 4500 lb. concrete shield block is dropped on the fuel
- Demonstrating that this accident poses no threat to the safety of the public or reactor personnel will **help** to satisfy the regulatory requirements of the NRC

MCNPX and SCALE6.1

- The bundle with highest power (calculated with MCNPX burn card) is selected for evaluation
- SCALE calculates radionuclide inventory
- Doses calculated for the most exposed member of the public and for facility staff



Radiation Exposure

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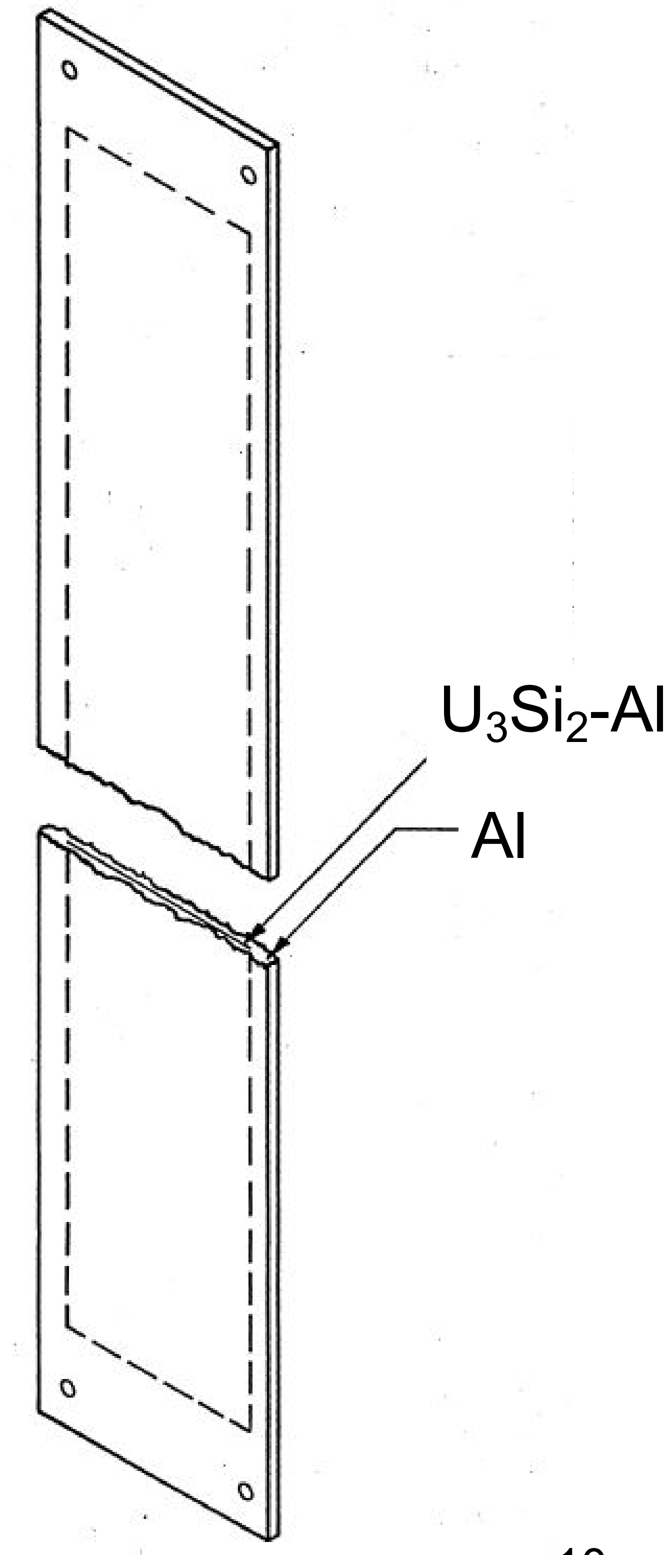
Occupational Exposure Inside Reactor Cell (rem)	TEDE Dose		Thyroid Dose	
	5 min Exposure	Limit	5 min Exposure	Limit
	0.136	5	4.197	50

Public Exposure 10m from Reactor Stack (rem/year)	TEDE (rem/year)	Limit (rem/year)	Exposure
	0.0065	0.1	6.5%

MHA: All doses within health limits

Rapid Insertion of Reactivity

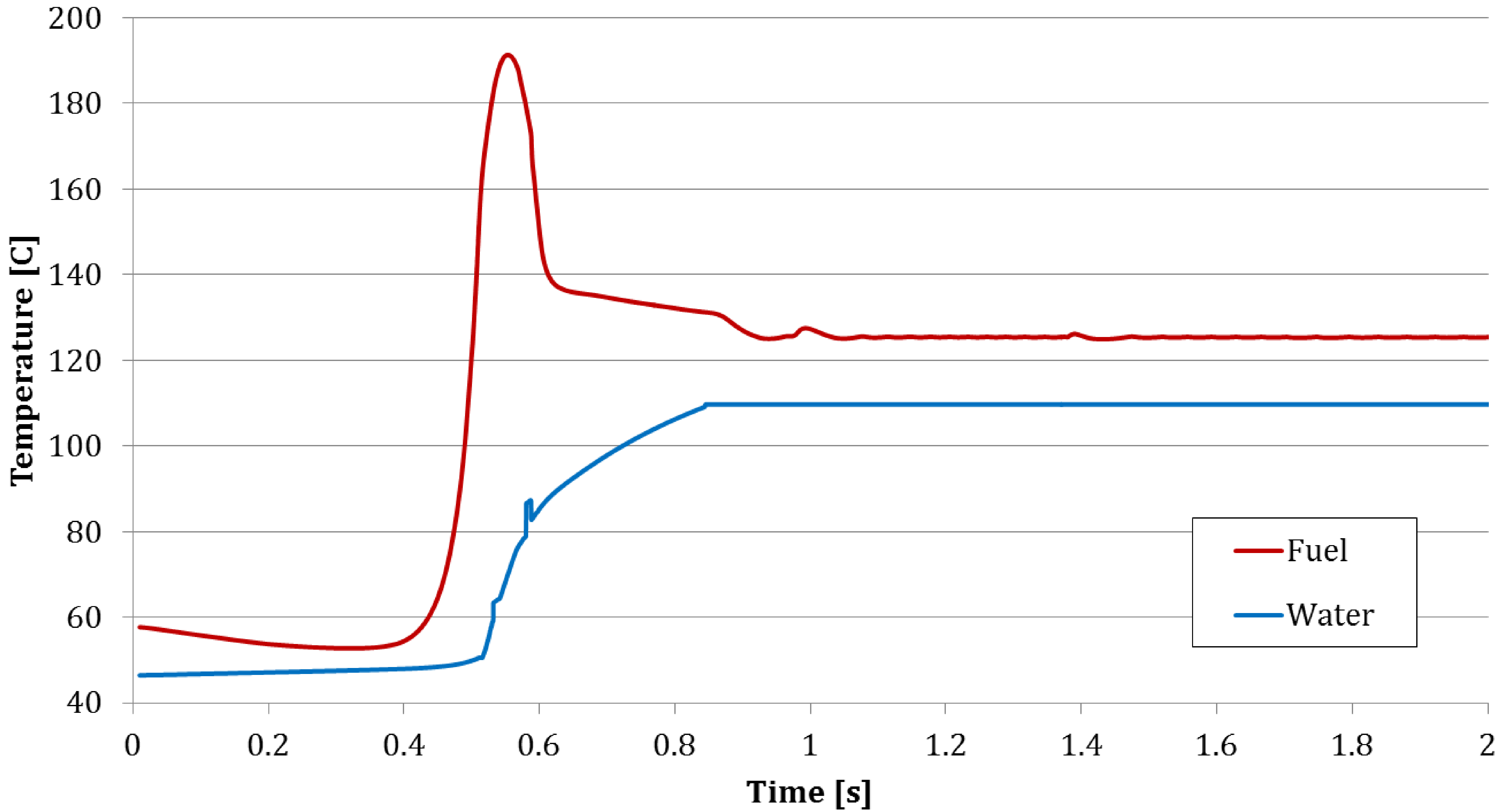
- The fuel must remain below the Fuel Temperature Safety Limit of 530˚C
- Used PARET-ANL, a coupled reactor kinetics-hydraulics code developed by Argonne National Labs
- PARET calculated the temperature of the hottest fuel plate



PARET Results

- The code completed the analysis of transients as large as $2.00 (1480 pcm) inserted in 0.5 seconds
- The insertion caused a peak power of 116 MW; the pulse lasted 0.2 seconds
- The insertion cause the fuel temperature to rise to a maximum of 191˚C

Fuel Temperature



Maximum Bundle Loading

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- The maximum temperature of 191˚C is well below the Safety Limit of 530˚C
  - A change to the Technical Specifications of the UFTR is called for that would limit the maximum loading to 22 bundles so that there is an excess reactivity of no greater than 1480 pcm

- Future analysis would involve Relap5-3D to investigate larger insertions of reactivity, therefore increasing the number of loadable bundles

Conclusion

- The worst possible public exposure scenario is shown to be ~ 6.5% of the allowed annual dose
- The maximum fuel temperature is 191˚C, and there is no credible scenario that will cause the UFTR to approach its Safety Limit of 530˚C

The inherent safety features of the design and operational loading limits ensure that there is no threat to the health and safety to the general public under any circumstances

DCPS Upgrade Project
Proposed UFTR DCPS Architecture

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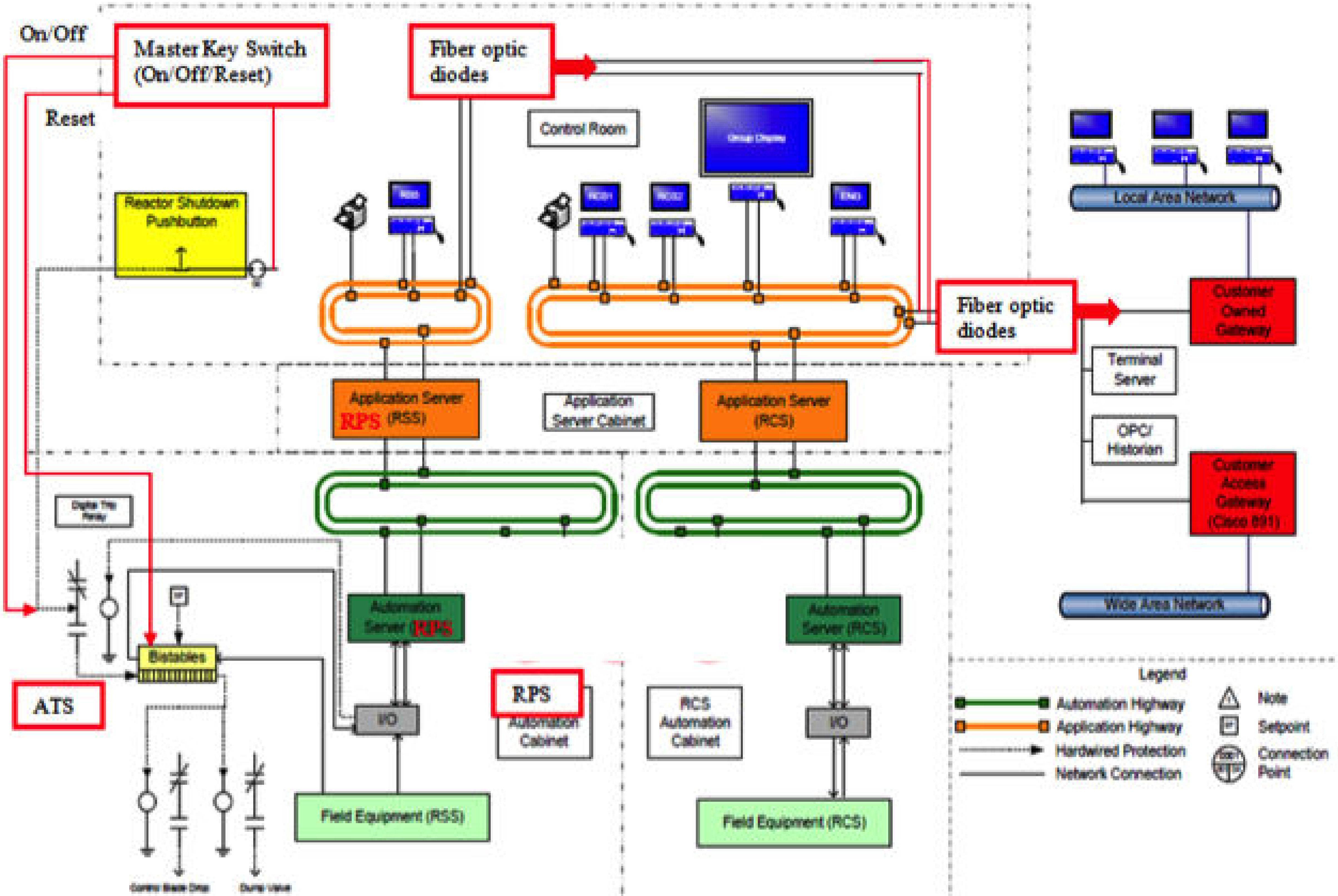

Digital Controls Upgrade Project Overview

Install new digital Reactor Control and Protection Systems

2 Siemens T-3000 systems (1 each for RPS and RCS)

RCS monitors and controls everything

Install a new independent Analog Trip System for redundancy in safety system

UF responsible for design of new bistable relays in separate cabinet

Will use binary trip signals (where possible) from new field equipment

Install brand new master key switch and additional SCRAM button

Use digital and binary signals (where possible) from field equipment

New Mirion Technologies DWK250 and DGK250 Nuclear Instrumentation

New Siemens HVAC system for reactor cell

New High Plume Exhaust System to increase altitude of controlled effluents

Phases for Licensing and Implementation

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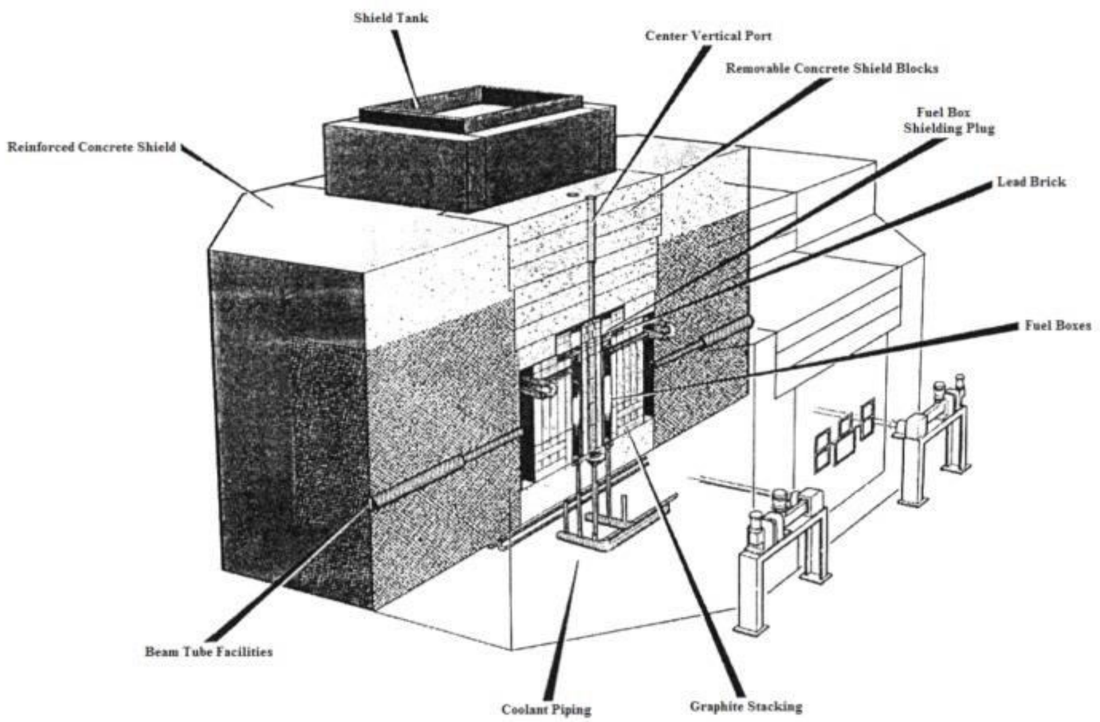
University of Florida	Vendor Partner
Phase 0. Pre Application	1. Project Startup/Conceptual Engineering
Phase 1. Initial Application	2. Basic Hardware/Software Design 3. Detailed Hardware/Software Design
Phase 2. Continued Review and Audit	4. Manufacturing 5. Testing
Phase 3. Implementation and Inspection	6. Installation & Commissioning 7.Final Documentation

Additional Facility Upgrades

- Licensing basis reconstitution
- Brand new HVAC system
- Major security upgrades
- New Nuclear Instrumentation (NIs)
- Ar-41 monitoring and release mitigation



FRS and Sensor I/O Lists will be released to Siemens soon

Safety and security are the top priorities

Digital RPS and redundant analog ATS for all safety trips of the reactor

Master key and RCS authorized RO password both required for operation of the reactor

Master key provides a layer of physical security beyond just digital security

Future work

Siemens hardware and software design of the 2 T-3000 systems

UF completion of ATS hardware design and subsequent manufacturing

System integration of all 3 systems (RPS, RCS, and ATS) – likely in 2014

System testing, especially software testing – likely in 2014-2015

Questions?