December 29, 2008

MEMORANDUM TO: Kathryn Brock, Chief
Research and Test Reactors Branch A
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

FROM: Duane A Hardesty, Project Manager **/KBrock for/**
Research and Test Reactors Branch A
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF NOVEMBER 18, 2008 PUBLIC MEETING BETWEEN THE UNIVERSITY OF FLORIDA TRAINING REACTOR (UFTR) AND NRC STAFF (TAC NO. M79588)

On November 18, 2008, the Nuclear Regulatory Commission (NRC) staff met with staff from UFTR and Areva at NRC headquarters.

A public meeting notice was issued on November 7, 2008, and posted on the Nuclear Regulatory Commission (NRC)'s external (public) web page (ADAMS Accession No. ML083020097). The meeting summary, attendance list, and UFTR presentation are attached.

ENCLOSURES:
1. UFTR Category 1 Meeting Summary
2. UFTR Meeting Attendee list
3. UFTR Presentation

Docket No. 50-083
cc: See next page

CONTACT: Duane Hardesty, NRR/DRP/PRTA
301-415-3724
E-mail: duane.hardesty@nrc.gov

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DATE	12/11/08	12/11/2008	12/29/2008

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cc:

Administrator
Department of Environmental Regulation
Power Plant Siting Section
State of Florida
2600 Blair Stone Road
Tallahassee, FL 32301

State Planning and Development Clearinghouse
Office of Planning and Budgeting
Executive Office of the Governor
The Capitol Building
Tallahassee, FL 32301

William Passetti, Chief
Bureau of Radiation Control
Department of Health
4052 Bald Cypress Way
Tallahassee, FL 32399-1741

Test, Research and Training Reactor Newsletter
Director of Nuclear Facilities
University of Florida
202 Nuclear Science Building
Gainesville, FL 32611-8300

LICENSEE: University of Florida

FACILITY: University of Florida Training Reactor (UFTR)

SUBJECT: SUMMARY OF MEETING BETWEEN UFTR AND NRC STAFF

On November 18, 2008, the Nuclear Regulatory Commission (NRC) staff met with staff from UFTR and Areva at NRC headquarters, Two White Flint North, 11545 Rockville Pike, Rockville, Maryland. Enclosure 2 is a list of meeting attendees.

The purpose of the meeting was to discuss a potential future license amendment request for upgrading the control and instrumentation systems for the UFTR to an Areva digital Instrumentation and Control (I&C) system. This meeting was follow-on to a previous meeting that took place on November 13, 2007 (ML0873610274).

The presentation prepared by UFTR (Enclosure 3), was intended to provide an overview of UFTR reactor and safety features of the reactor including introduction to the UFTR existing analog system, proposed design and features for the digital safety system, and discussion of regulatory specifics concerning the proposed amendment, including Diversity and Defense in-Depth (D3), quality, and reliability for the proposed digital I&C system. However, due to time constraints and familiarity of the attendees with the existing design, the presentation started on slide 26 and focused on the proposed digital I&C system.

Dr. Haghighat, UFTR Interim Director, discussed the recent changes to the UFTR organization personnel structure, and the list of documents the new staff reviewed in anticipation of submitting a license amendment for an upgraded Digital I&C system. The list of documents was a subset of the guidance documents the NRC cited in the 2007 meeting (Accession No. ML073610274). Dr. Haghighat presented the proposed digital control system design and safety channel configuration, and discussed how the UFTR's staff interpreted the NRC guidance. The remainder of the discussion included a series of questions directed to the NRC staff regarding understanding the NRC guidance documents. This included inter-process communication, risk assessment, reliability, and cyber security. The meeting concluded with a discussion of the schedule for docketing the documents needed for performing the acceptance review.

The licensee stated that they will use the process applicable to power reactor digital I&C in their application. NRC staff pointed out that much of the effort being undertaken by UFTR for this amendment was most likely not applicable to a research reactor. The licensee further stated that they want to follow the power reactor process because they want to have a system in place similar to what they believe will be in industry in the future. In addition this system and the application process will be used as a teaching tool for students. The university will be using undergraduate and graduate students to conduct much of the work, including software development.

The licensee also presented a proposed timeline for safety system design, manufacturing, installation, and testing for the new I&C system. NRC staff cautioned that the presented schedule was very aggressive and that NRC review would most likely take considerable more time than UFTR was estimating. The NRC staff stressed the importance of close communication between the NRC and licensee during development of the licensee's application. The licensee stated they will keep the NRC staff aware of developments.

Docket No. 50-83
Enclosures: As stated
Contact: Duane Hardesty, NRR/DPR 301-415-3724

Information Exchange for Future UFTR Digital I&C Licensing Amendment

Date: 11/18/2008 **Time: 1:00 PM – 3:00PM** **Location: T-9F5**

NRC Facilitator: Duane Hardesty **Type of meeting:** Category 1 – Public Meeting

----- Agenda Topics -----

1. Introduction to the University of Florida Training Reactor – exiting analog control system
2. Proposed design and features for the safety system and unique safety features
3. Discussion of Diversity and Defense In-depth (D3), Safety, and Reliability Analyses for the digital system
4. Discussion of issues concerning license application for Digital Control Systems

Attendees:

Name	Email	Phone	Organization
Alexander Adams	alexander.adams@nrc.gov	(301) 415-1127	NRR/DPR/PRTA
Steven Arndt	steven.arndt@nrc.gov	(301) 415-6502	NRR/ADES/DE
Lionel Bates	Lionel.bates@areva.com	(770) 225-9645	Areva NP, Inc.
Kathryn Brock	kathryn.brock@nrc.gov	(301) 415-2015	NRR/DPR/PRTA
Gordon Clefton	gac@nei.org	(202) 739-8086	Nuclear Energy Institute
Paul Loeser	paul.loeser@nrc.gov	(301) 415-2825	NRR/ADES/DE/EICB
Dr. Ali Haghighat	haghighat@ufl.edu	(352) 392-1401 x-306	UFTR
Duane Hardesty	duane.hardesty@nrc.gov	(301) 415-3724	NRR/DPR/PRTA
William Kemper	William.kemper@nrc.gov	(301) 415-7585	NRR/ADES/DE/EICB
Brian Shea	bshea@ufl.edu	(352) 392-1429 x-319	UFTR
Eric Wallace	Eric.wallace@areva.com	(770) 225-9596	Areva NP, Inc.
Steve Wyman	Stephen.wyman@nrc.gov	(301) 415-3041	NRR/ADES/DE/EICB

UFTR Digital Control System Upgrade

Alireza Haghighat
Professor and Chair
UFTR Interim Director

Nuclear & Radiological Engineering Department
University of Florida
Gainesville, Florida

For presentation to the NRC, Washington DC, Nov. 18, 2008

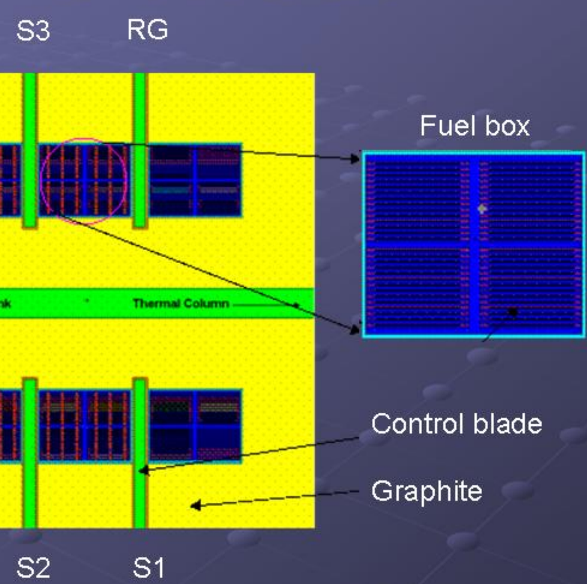
Contents

- Introduction to the UFTR
  - History & Design
- Safety system
- Current UFTR Analog Control system Diagrams
- Unique Safety features
- Review of licensing documents
- Questions related to licensing documents

UFTR timelines

- Established in 1959 with a power of 10 kW
- In 1963, its power was increased to 100 kW
- In 1970, its fuel was changed from LEU to HEU
- In Sept. 2006, its fuel was changed from HEU to LEU

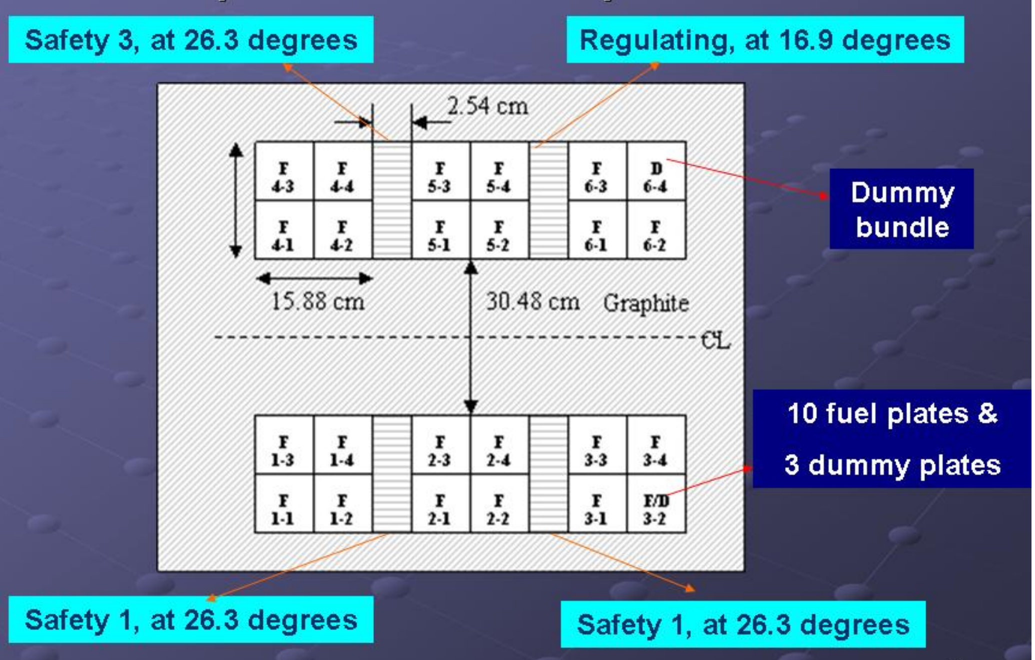
UFTR Core



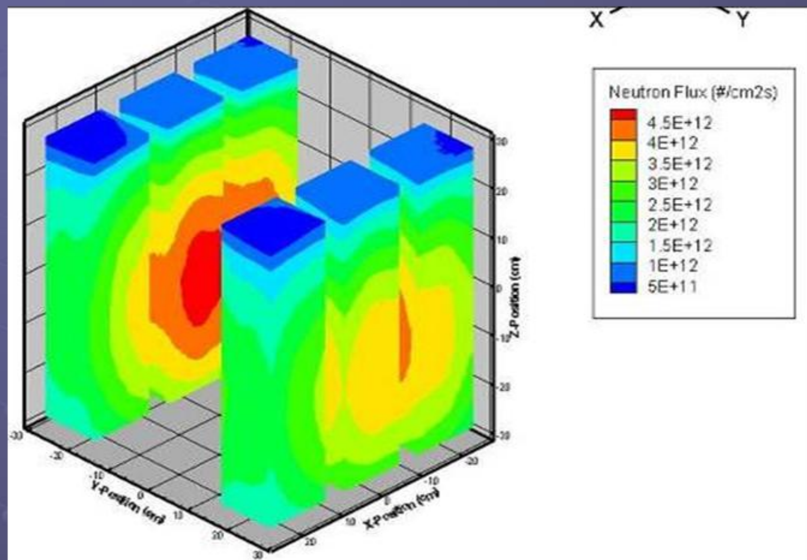
Fuel Plate Characteristics

	LEU
Fuel Type	U_3Si_2-Al
Fuel Meat Size Width (cm) Thickness (cm) Height (cm)	 5.96 0.051 60.0
Fuel Plate Size Width (cm) Thickness (cm) Height (cm)	 7.23 0.127 65.1
Cladding material	6061 Al
Cladding Thickness (cm)	0.038
Fuel Enrichment (nominal)	19.75%
"Meat" Composition (wt% U)	62.98
Mass of ^{235}U per Plate (nominal)	12.5 g
Number of Plates per Fuel Bundle	14

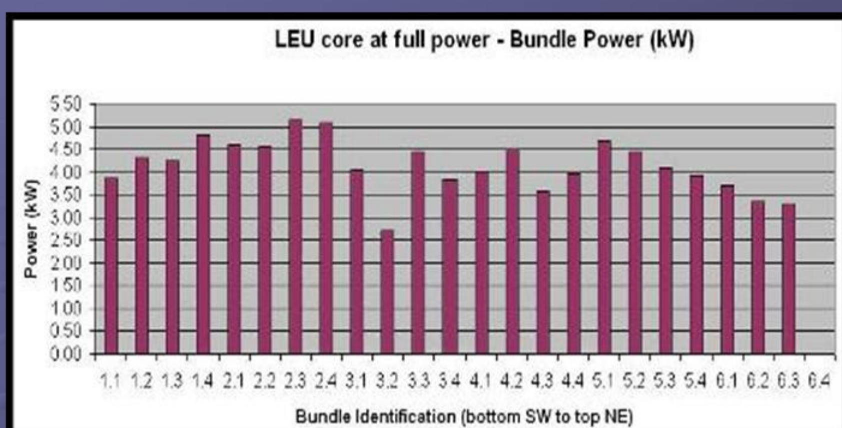
LEU Core at critical condition – Fuel pattern and blade positions



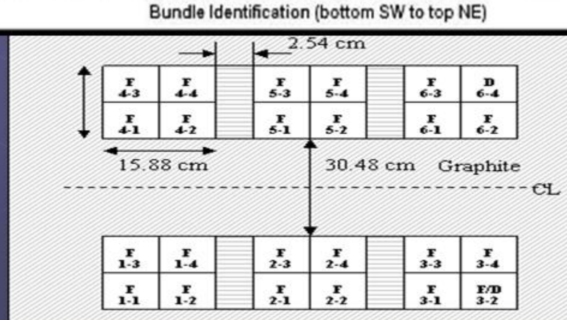
LEU Core - Total neutron flux distribution



Bundle-wise power distribution (kW)



Schematic of the core



Core Lifetime

Expected end-of-life LEU core with fuel burnup of ~86.67 MWD;

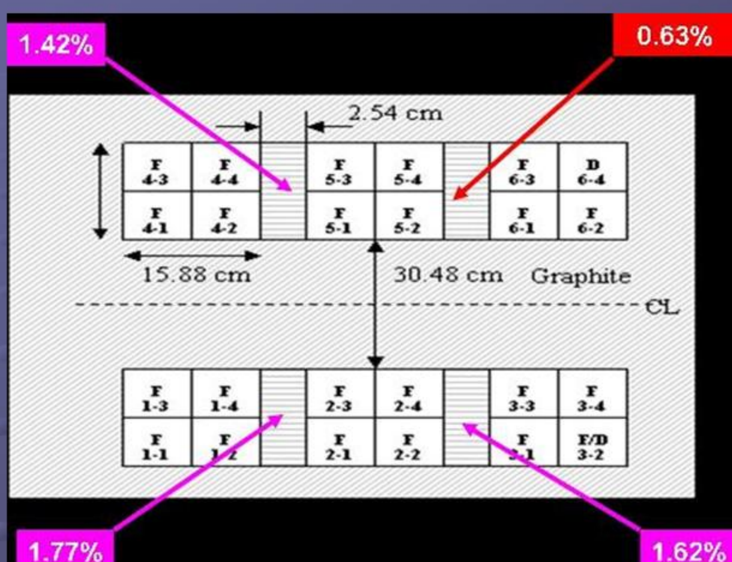
This is based on full-power operation time of

4 hr/day,

5 day/week,

20 years

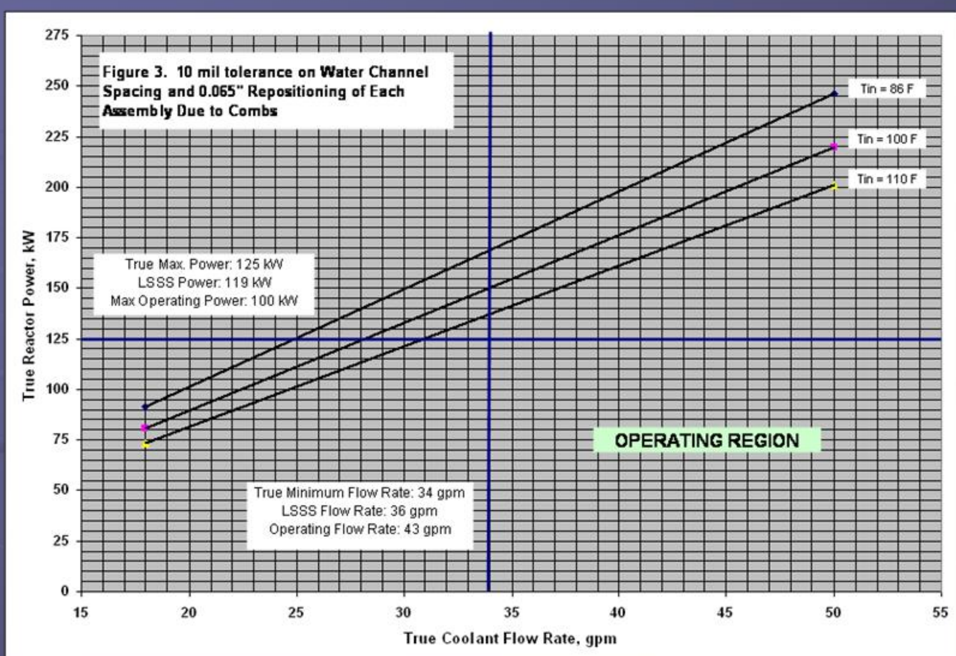
Control Blade Worth



UFTR Control Parameters and Settings

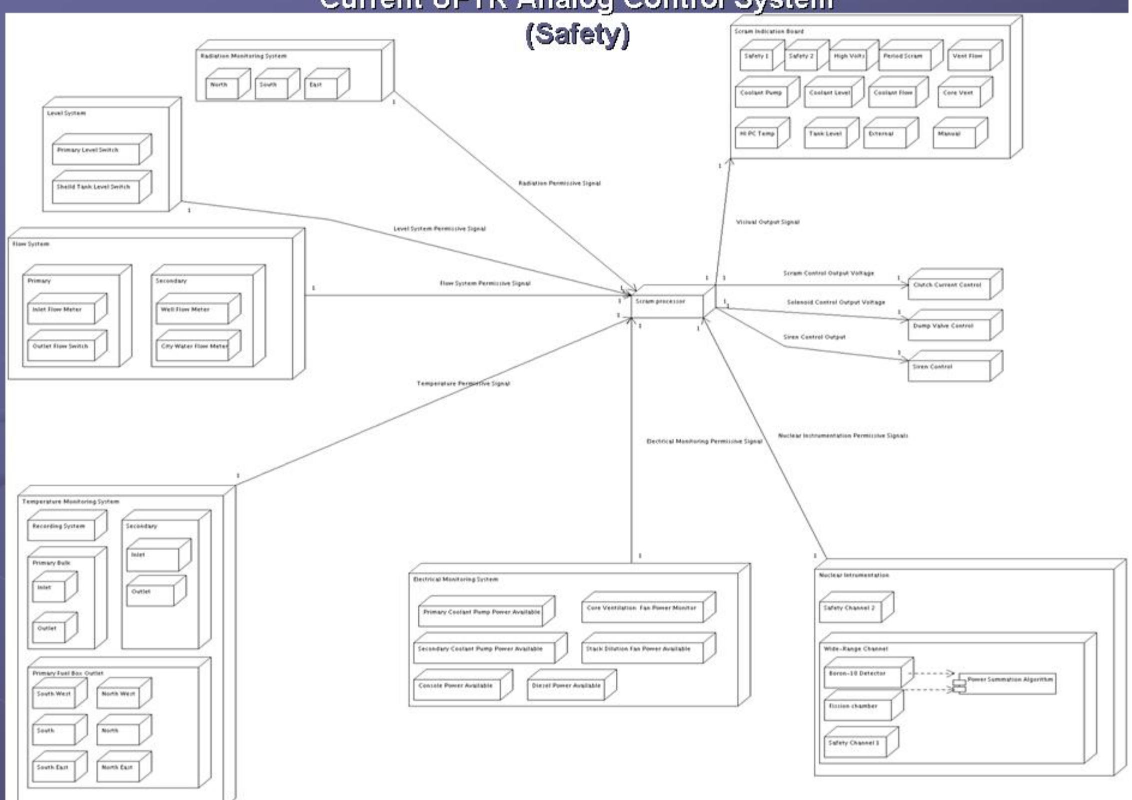
Parameter	True Limit	LSSS	Operating Values
Power (kW)	125	119	100
Flow Rate (gpm)	34	36	43
Inlet Temperature (F)	100	99	80
Outlet Temperature (F)	165	155	95

Operating Region

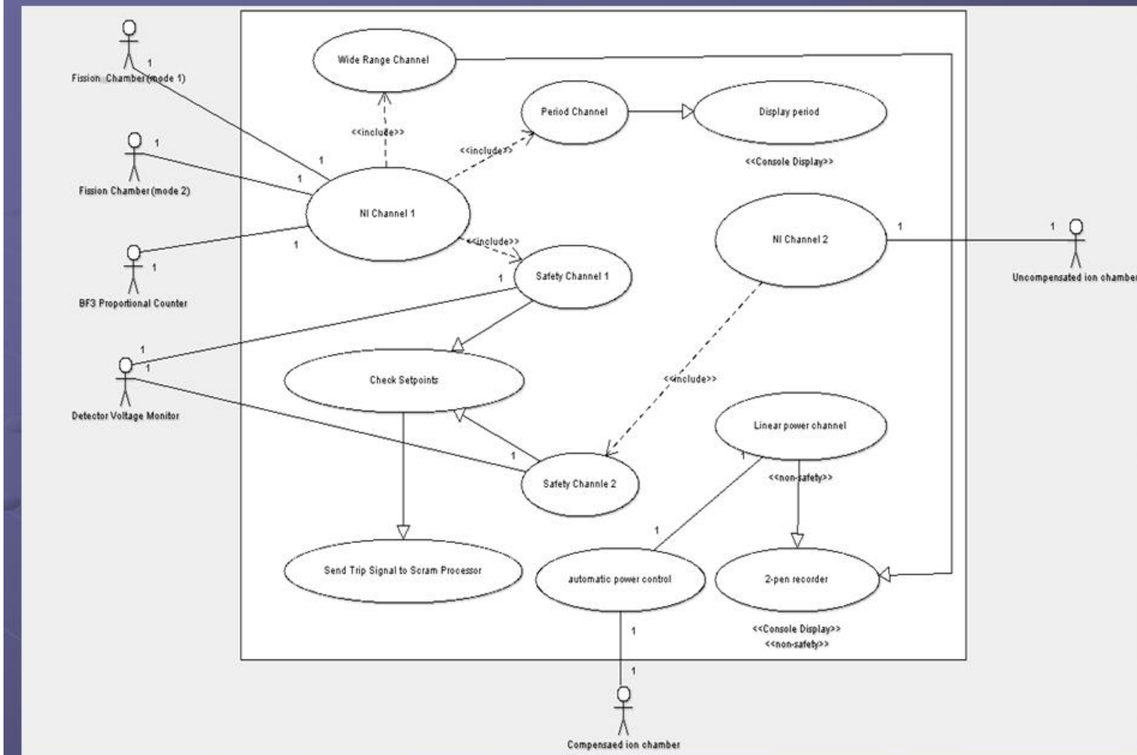


Current
UFTR Analog Control System
Diagrams

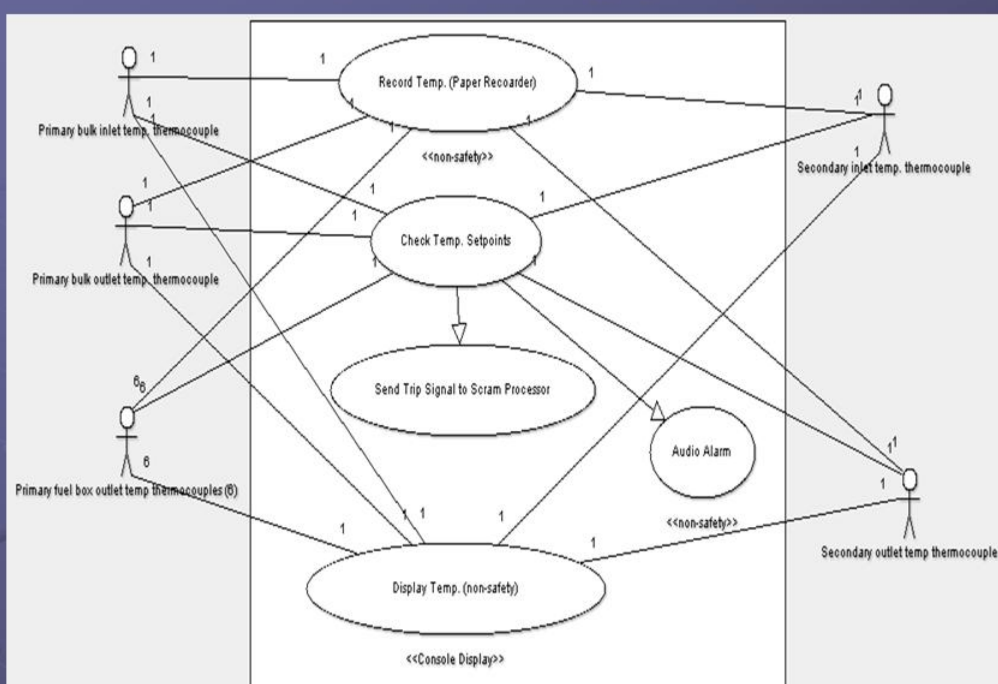
Current UFTR Analog Control System
(Safety)



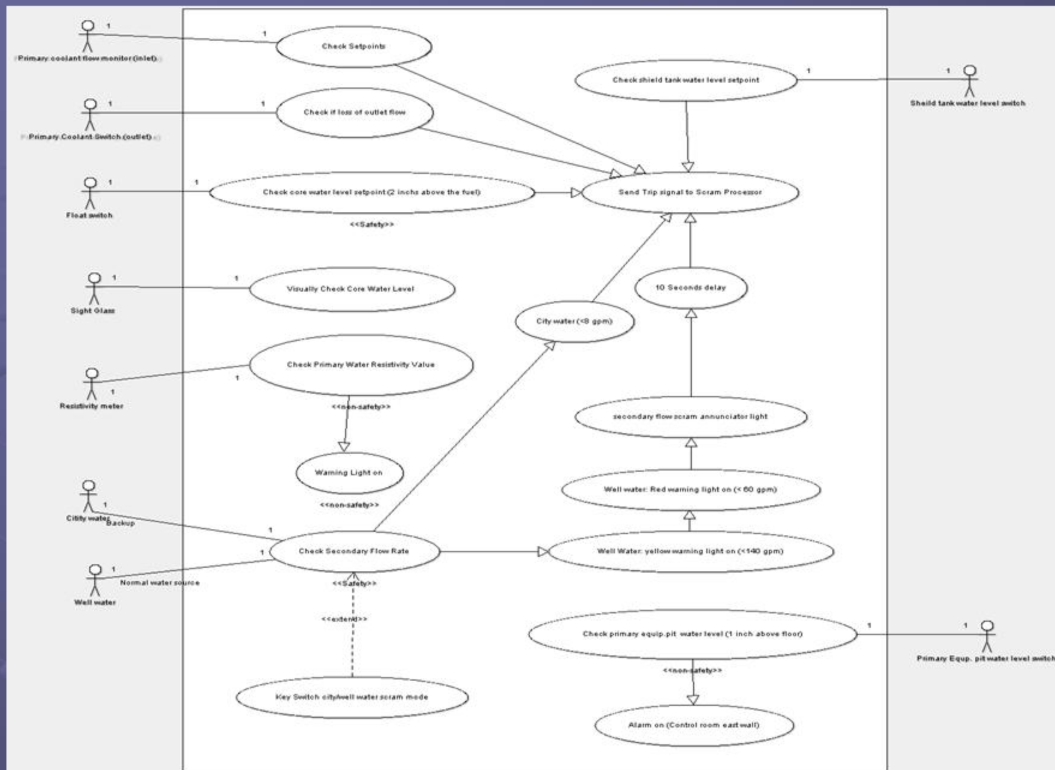
Nuclear Instrumentation



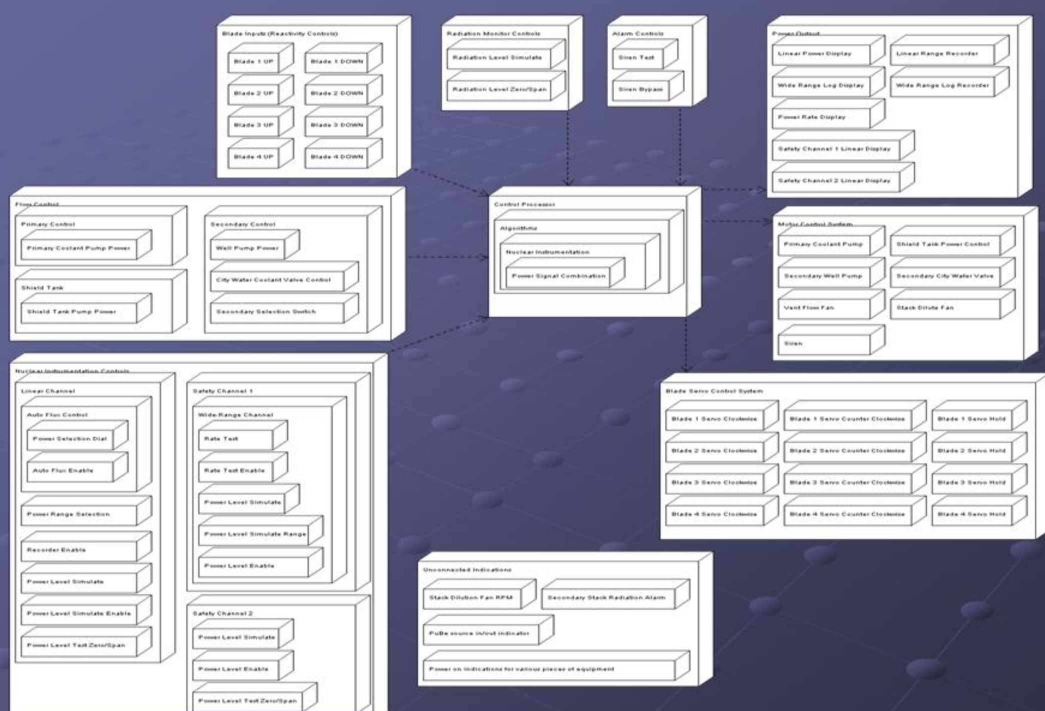
Temperature Monitoring Systems



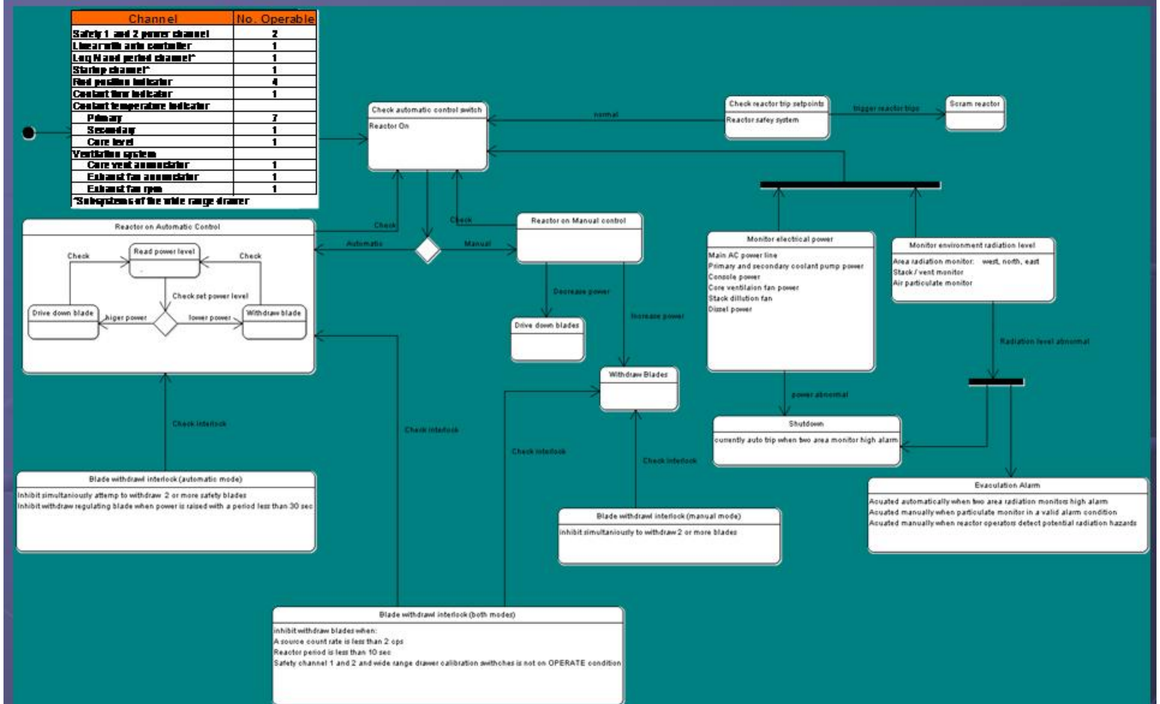
Flow and Level Monitoring System



Current UFTR Analog Control System (non-safety)



UFTR Reactor Control



Reactivity Limitations

Shutdown Margin: The minimum shutdown margin, with the most reactive control blade fully withdrawn, shall not be less than 2% Δk/k.

Excess Reactivity: The core excess reactivity at cold critical, without xenon poisoning, shall not exceed 1.4% Δk/k.

Coefficients of Reactivity: The primary coolant void and temperature coefficients of reactivity shall be negative.

Maximum Single Blade Reactivity Insertion Rate: The reactivity insertion rate for a single control blade shall not exceed 0.06% *Δk/k* sec, when determined as an average over any 10 sec blade travel time from the characteristic experimental integral blade reactivity worth curve.

Experimental Limitations: The reactivity limitation associated with experiments is specified to 0.6% ***Δk/k***.

Control System

Four cadmium-tipped control blades, which are protected by shrouds to ensure freedom of motion.

Only one control blade can be raised by the manual reactor controls at any one time. The safety blades shall not be used to raise reactor power simultaneously with the regulating blade when the reactor control system is in the automatic mode of operation.

The reactor shall not be started unless the reactor control system is operable.

The control-blade-drop time shall not exceed 1.5 sec from initiation of blade drop to full insertion (rod-drop time), as determined according to surveillance requirements.

Control System (cont.)

- The following control blade withdrawal inhibit interlocks shall be operable for reactor operation for the following conditions:
  - a source (startup) count rate of less than 2 cps (as measured by the wide range drawer operating on extended range)
  - a reactor period less than 10 sec
  - safety channels 1 and 2 and wide range drawer calibration switches not in OPERATE condition
  - attempt to raise any two or more blades simultaneously when the reactor is in manual mode, <u>or</u> two or more safety blades simultaneously when the reactor is in automatic mode
  - power is raised in the automatic mode at a period faster than 30 sec

    (The automatic controller action is to inhibit further regulating blade withdrawal or drive the regulating blade down until the period is ≥ 30 sec.)

Specifications for Reactor Safety System Trips

Specification	Type of Safety Trip
Automatic Trips	
Period less than 3 sec	Full
Power at 119% of full power	Full
Loss of chamber high voltage (≥10%)	Full
Loss of electrical power to control console	Full
Primary cooling system	Rod-drop
Loss of pump power	
Low-water level in core (< 42.5")	
No outlet flow	
Low inlet water flow (< 36 gpm)	
Secondary cooling system (at power levels above 1 kW)	Rod-drop
Loss of flow (well water < 60 gpm, city water < 8 gpm)	
Loss of pump power	
High primary coolant average inlet temperature (≥109° F)	Rod-drop
High primary coolant average outlet temperature (≥155° F)	Rod-drop
Shield tank	Rod-drop
Low water level (6" below established normal level)	
Ventilation system	Rod-drop
Loss of power to dilution fan	
Loss of power to core vent system	
Manual Trips	
Manual scram bar	Rod-drop
Console key-switch OFF (two blades off bottom)	Full

Unique Features
Reactivity Insertion Accidents

- Step insertion of 0.60 **%Δk/k**
  - LEU power increases to 1.25 MW
  - After a short time power decreases to an equilibrium power of 600 kW, and the peek temperature for fuel is 108 C that is

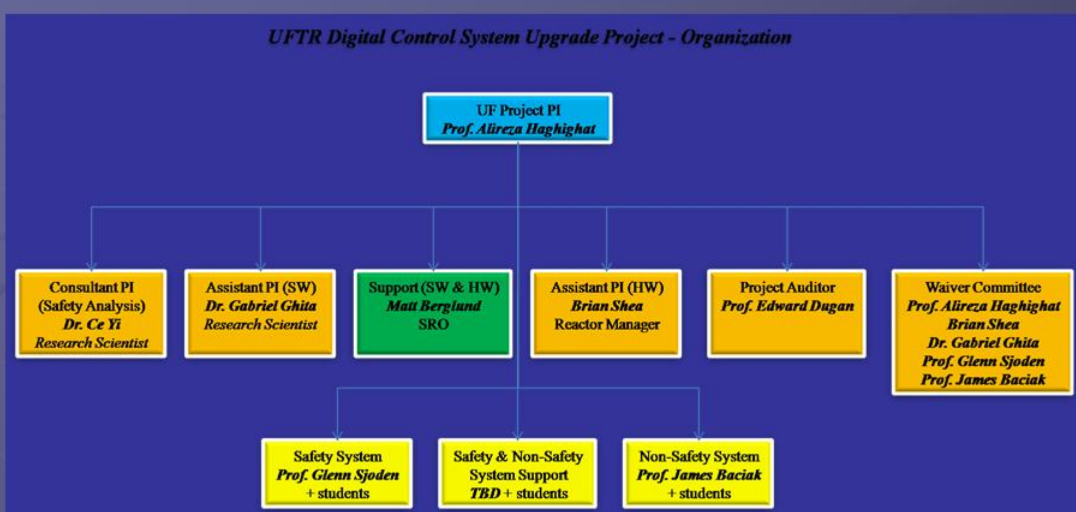
    < 582 C, melting temperature of 6061 Al (LEU)

- Reactivity ramp insertion of 0.06 **%Δk/k/s**
  - Power increases to 125 kW, total reactivity of 0.126 %, fuel temperature increase by 1 C (51 C – 52 C).

Unique Feature

- Low power (the peak power per bundle = 5 kW)
- Low fuel temperature (~50 C);
- The unprotected insertion of 0.6%, 300 seconds, core reaches an equilibrium power level of about 600 kW. The peak temperature of fue is about 108C (fuel melting point is 582 C)
- Under regular conditions, reactor can be shutdown if one dumps the cooling water

Personnel & Tasks



Reviewed Documents

- Diversity & Defense in Depth (D3)
- Cyber Security
- Highly-Integrated Control Rooms – Communication issues
- Highly-Integrated Control Rooms – Human Factors Issues
- Licensing Process
- Probability Risk Assessment & Reliability

New UFTR Digital Control System

Selected platform

- On Sept. 5, 2008 signed an agreement with AREVA NP Inc. and Siemens Co. to receive
  - A Teleperm XS (TXS) safety system
  - A T-3000 non-safety system

To address the D3

- Redundancy
  - Double flow-rate meters (primary (inlet & outlet) & secondary (well & city water))
  - 2 RTDS for each thermo-couple (primary (inlet & outlet), secondary (inlet & outlet), fuel box (6))
  - Add one more radiation monitor (west side)
  - Double water level meters (fuel box, shield tank)
  - On-line monitoring of the primary coolant storage tank
  - Add one more RPM sensor for the stack dilution fan
  - Nuclear Instrumentation
    - Double BF3
    - Double Fission Chamber
    - Double Ion Chamber

To address the D3 (cont.)

- Diversity
  - Consider two (2) diverse safety channels

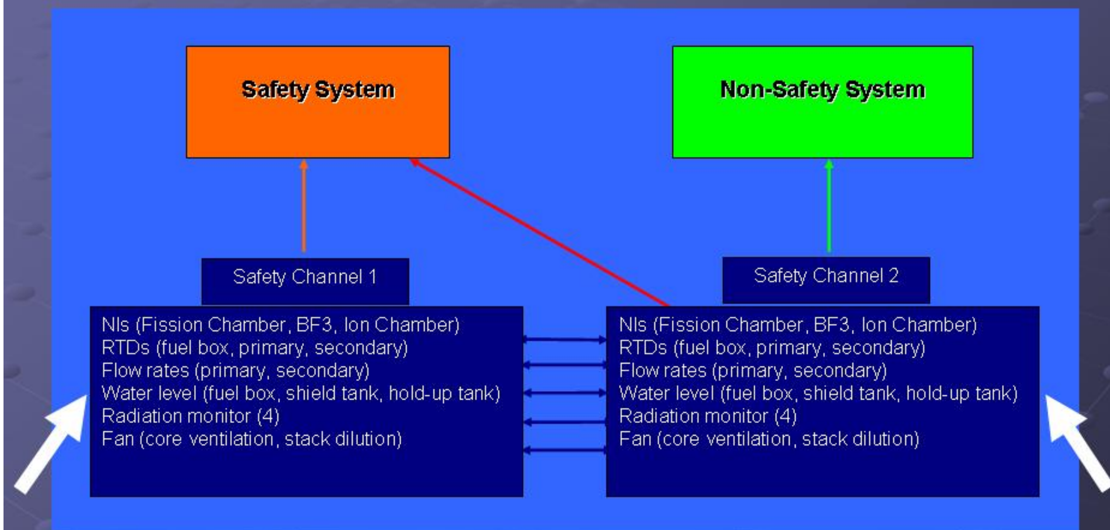
Input to each Safety Channel					
Sensor/monitor	Core	Primary	Secondary	Reactor cell	Confinement
Nucl. Inst. (NI)	X				
Temp (RTD)	X	X	X		
Flow-rate	X	X	X		
Water level	X	X		X	
Radiation monitor				X	
Fan				X	X

To address the D3 (cont.)

- Minimum information on display:

Item	Location - How
Reactivity control	Core - NI's, blade position
Reactor coolant integrity	Primary - Flow rate, Temperature, pump power
Reactor coolant integrity	Secondary - Flow rate, Temperature, pump power
Radioactivity control	Radiation monitors, core ventilation fan
Containment conditions (isolation & integrity)	Stack dilution fan

New UFTR Digital Control System - Safety Channel Configuration



Notes: Proposed Digital Control System (safety)

- One (1) out of two (2) signals of the same type is necessary for operation
- A subset of signals is adequate, e.g., 2 out 3 NIs,
- If anyone of the LSSS is violated, the trip system is actuated (Control Blades are dropped, and in specific situations Dump Valve is also disengaged)
- In case of loss of electricity, there is a mechanism that disengages the clutch current control and dump valve control
- We do not need an Engineered Safety Features Actuation System (ESFAS), because no cooling is necessary for decay heat of fuel
- For training purposes, we intend to utilize the non-safety system as a back-up.

Questions

Communication/interconnection & HICM

- Intends to use the T-3000 as a backup?
  - Can the NRC provide a better definition for "sufficient quality" ?

- Can a software driven process be used for Online Testing or Diagnostic (OTD) of hardware? E.g., can the T-3000 be used for this purpose?

- Is there a standard method of network evaluation to assure separation?

- Is there any recommended platform for the Computer-based Procedural Systems (CBPS)?

Questions

Risk Assessment & Reliability

- Is the RG 1.200 adequate for the purpose of DI&C risk assessments?
  - E.g., for the Level 1 PRA – Address the following: Initiating Event Analysis, Success Criteria Analysis, Accident Sequence Development Analysis, Systems Analysis, Parameter Estimation Analysis, Human Reliability Analysis, and Quantification

- Use the Ohio State's methodology: Use DFM (Dynamic flowgraph Methodology) in the deductive mode to identify event sequences/initiating events that lead to Top Events, Use Markov/CCMT in the inductive mode to verify completeness and quantification of the event sequences identified by DFM, and integrate the dynamic methodology results into the overall PRA

Questions

Cyber Security

- Isolation of safety system network and computer system; is it necessary to use the PNNL intrusion system for evaluation of the safety network and system evaluation? How do we get access to this system?

- Create plans to prevent corruption of software during its life:
  - Developing Software Life-Cycle Documentations as suggested in the relevant ISGs

NRC phasing

Phase I. Documents Needed to Be Docketed Prior to Acceptance for Review

Phase II. Documents Needed to Be Docketed Within Six Months after Acceptance

Phase III. Documents Available for Audit – non docketed

Phase IV. Documents available for audit prior to operation

Phase I - Questions

Task	Comments/Questions
1. Commercial Grade Dedication Plans	N/A
2. D3 Analysis	Should this analysis be finalized?
3. Description of system in sufficient detail to determine compliance with the ISG on	AREVA position paper
Communications	
4. Design Analysis Report	What kind of analysis is needed here?
5. Design Report on computer integrity, test and calibration; and Fault detection and	Is this IEEE 603 compliant? (how, design not complete!)
self-diagnostics	
6. Detailed theory of operation description.	
7	Missing!
8. EMI, Temperature, Humidity, and Seismic testing plans	Our current license does not require this plan
9. Software QA Plan / Procedures	Addressed later
10. System description to block diagram level	
11. Hardware & Software Architecture Descriptions	
12. Preliminary FMEA (non-docketed)	
13. Quality Assurance Plan for digital hardware and software	
14. Reliability Analysis	How? design is not complete!
15. Safety Analysis	How? design is not complete!
16. System Requirements Specification	
17. System Test Plan	

Phase 1 – Questions (cont.)

Task	Comments/Questions
18. Software Life Cycle Documentation	
a. Software CM Plan	
b. Software Design Specification	
c. Software Development Plan;	
d. Software Installation Plan	Covered in SCMP
e. Software Integration Plan	Covered by TXS SER and FAT
f. Software Maintenance Plan	
g. Software Management Plan	Covered by AREVA OI-1456 TXS Project Phase
h. Software Operations Plan	
I. Software Project Risk Management Program	SQAP & QAPP
j. Software Requirements Specification	
k. Software Safety Plan	Multiple documents covered in AREVA OI-1587 SSP
l. Software Test Plan	
m. Software Tool Verification Program	What is needed here?
n. Software Training Plan	Include in QAPP or overall QA Program
o. Software V&V Plan and procedures	
19. Requirements Traceability Matrix (updated as needed)	

Phase 1 – Status

- QA Plan
  - Current UFTR license does not require compliance to the 10CFR50 App. B as supplemented by ANSI/ASME NQA-1 1986 edition
  - We intend to follow, for the most part, the requirements of 10CFR50 App. B
  - We have prepared a QA Plan (QAP), working on a QA Project Plan (QAPP)
- Software V&V Plan
  - Has developed a first draft
- Software Configuration Management Plan (SCMP)
  - Has developed a first draft
- FRS (Functional Requirements Specification) or System Requirements Specification (SRS)
  - Is developing a document
- Developing documentation on FMEA/D3 Concepts
  - Is developing a document

Timeline

- Signed an agreement with a 7-phase plan on Sept. 2008, with the expected completion of May 2010
- Has already developed a preliminary design for the safety system
- Finalize the safety system design by March 2009
- Manufacturing will be conducted between March and July 2009
- Submit the necessary documentations for the 1st phase by July 2009
- Submit the 2nd phase documentations within the following 2 months
- Testing (FAT/integration) will be performed during Between August and November 2009
- Depending on the licensing review, building renovation will begin in October 2009 or later, should be completed within two months
- Depending on the licensing review, begin installation in January 2010, should be completed within 6 weeks
- Depending on the licensing review, begin the necessary post-installation testing for the following 2-3 months