

# UT TRIGA Control System Upgrade

## Phase 0 Meeting

# Overview

- Motivation
- Plans and Strategy
- Status

# Motivation: NETL History

- TRIGA Mark II reactor construction at NETL 1989-1992
- Initial criticality 1992
- Control system, digital I&C integrated with analog safety system
- Digital with 2 compiled software sets, 2 operating systems
  - Operator interface, General Atomics software, windows platform
  - Hardware interface, QNX
- Current system is the original system with few peripheral upgrades
  - Tektronix recorder display, replaced with a PC based emulator
  - RMS II & area monitors replaced with Ludlum, display networked monitors
  - GA effluent monitor replaced with Canberra, display networked monitor

# Motivation: Limiting Characteristics

- The compiled drivers cannot be modified
  - Drivers support original equipment and cannot be updated
  - Additional computers & displays required to support peripherals
- Virtually all equipment is obsolete
  - Cannot be replaced
  - Cannot be updated
  - Repair parts via cannibalization
- Multiple annual requests for DOE NEUP support unsuccessful

# Contingency Planning

- Continue requests for DOE NEUP support
- Search for Tech Support to rewrite software to allow changing drivers
  - QNX not interested
  - Austin is a Tech-Hub with many system integrators
  - Local software companies declined request for proposal
- Strategy developed for alternate funding profile

# Strategy for Alternate Funding Profile

- Identify potential sources
- Phased Upgrade for incremental implementation
- Use the GA system for development and customization of controls
- Replace obsolete equipment with current COTS equipment
- Address currently identified need for improvements

*NOTE: The initial phase-in for the solution was in-progress, supported by other funds, at notification of 2022-2023 NEUP award*

# Phased upgrade

- Essentially updated version of the 1992 system
- Discrete stages for implementation as funds available
- Simple and transparent changes
- Configurable software to support indefinite life extension
- Some optimization based on operating experience
- Request for proposal submitted to Plantation Productions, Inc.

# Equipment Replacement (1/3)

- Current generation computers replace 286 PCs
- Ethernet based data acquisition hardware replaces Digital and Analog I/O running on IA/IBM-PC AT bus
- New NETL LINUX & General Atomics software
  - Replacing Windows 3.0 and QNX 4.25
  - Currently at USGS, INL, AFFRI and BAEC (Bangladesh)
  - DOW installation pending
- Power level channels
  - Current NM-1000, replaced by NLW-1000 and NMP-1000
  - Addition of a Compensated Ion Chamber
  - Obsolete NP-1000 & NPP-1000 replaced by current generation



# Equipment Replacement (2/3)

- COTS signal processing modules for Action Paks:
  - Fuel temperature modules with current generation standalone instruments
  - Water temperature modules with Ethernet based RTD module
  - 'Magnet power ground' module
- Isolation/converter modules for analog bar graph display
- Ethernet single-board computer rod control managing:
  - Electromagnets
  - Limit switches
  - Rod position indication
  - Performance of rod drop timing calculations

*Replaces functionality of the Labmaster board*

# Equipment Replacement (3/3)

- NPP-1000 for Labmaster board pulse monitoring function
- HD displays for Tektronics graphic and text display emulator

# Design Optimization (1/3)

- Improve control - GA & QNX collects data at 0.1 second intervals
  - Reactor power can change significantly in less than 0.1 second
    - NM data at 0.2 sec., QNX scan 0.1 sec. creates significant delay in display and control
    - Time dependent power level changes are used to calibrate control rods
    - Discontinuous jumps in power indication required lowering operating power
  - Options under consideration:
    - Adjust controller time constants in new system, or
    - Develop single board computer using rod drop timer with 0.025 second samples, or
    - Develop an embedded system using analog signals
- Isolated analog power level signals, display and/or processing
  - If power level display fluctuates, analog display may provide better information
  - Option for off-line data processing supporting control rod calibration

## Design Optimization (2/3)

- Increase sample rate for playback (min. QNX/GA 1 sec., LINUX 0.1)
- Selectable startup channel (AFFRI)
  - Configurable for NLW or NMP
  - Channel sensitivity may require Technical Specification change
  - Prevents single failure for startup channel
- SCRAM logic
  - SCRAM Initiation with two channel trip signals (INL/NRAD)
  - This will require a Technical Specification change
  - Up to four channels will have SCRAM capability
  - Permits online calibration, testing and maintenance
  - Prevents spurious SCRAMs

# Design Optimization (2/3)

- Miscellaneous process instruments upgrade
  - Pool level, adding measurement to the float switches for hi/lo and scram
  - Conductivity, adding continuous monitoring capability
  - Fuel temperature
    - adding monitors for all available sensors
    - Remove from Technical Specifications

# Phase 1: Overall System Requirements/Design

- System Requirements modeled on IEEE 830-1998 software requirements
- Software Requirements for GA software on CCS/UIT units
- Block diagrams
- External components list (to be supplied by UT)
- Preliminary list of hardware components
- Validation by UT NETL staff

## Phase 2 : Design Test Platform

- Custom TINA (Testing, Instruction, No Atomics module)
- Simulation platform for software testing
- Playback system for operating system

## Phase 3: Digital Data Acquisition Design/ Construction

- Fabricate 2 UIT computer systems (one for TINA, one for console)
- Fabricate 2 CCS systems
- Build TINA system
- Integrate (watchdog and networking)
- Design DAC backplane & build DAC
- Fabricate single board computers



# Phase 4: Software Porting

- Customize GA digital console software system for NETL

*Software is an upgrade of the existing system*

# Phase 5: Installation

- Assemble hardware for parallel operation
- Assemble auxiliary rack
- Connect/Disconnect cables for:
  - Rod drive controllers
  - Analog circuits
  - Digital circuits
- Perform wiring
- Integrate and test
- Acceptance testing
  - Part I: Reactor secured, simulating signals
  - Part II: Reactor operating

# Status

- GA Software license acquired
- Site Survey complete
- Notice of NEUP Award for control system upgrade
- Purchase pending, next (Texas) fiscal year (Sep 1)
  - General Atomics equipment
  - Plantation Productions, Inc