1. Background

The Annular Core Research Reactor (ACRR) is a pool type nuclear reactor that is capable of steady state (SS), pulse (P), and transient rod withdrawal (TRW) operations. ACRR is operated by Sandia National Laboratories (SNL) for the Department of Energy (DOE). The ACRR facility is planning to upgrade the two (2) wide range neutron monitoring drawer assemblies. These provide a variety of power indications to the operator at the reactor console and also provide bi-stable trips that are used to shutdown the reactor.

Currently the Wide Range drawers are the ThermoFisher Scientific Neutron Flux Monitor with Signal Processor (Manual 145) with a ThermoFisher Scientific High Voltage Power Supply 201401-101 powering the fission chambers.

1.1. Goals

1.1.1. Improve the reliability of the wide range system

1.1.2. Replace aging wide range drawers and high voltage power supply

2. Tasks

2.1. Task 1: Design two (2) wide range drawer assemblies

2.1.1. Completed by October 31st, 2013

2.1.2. Deliverable: WR drawer design is accepted and approved by Sandia. All relevant documentation is complete

2.2. Task 2: Build and perform factory acceptance testing for two (2) WR drawer assemblies

2.2.1. Completed by November 30th, 2013

2.2.2. Deliverable: WR drawers are ready to ship to Sandia. Documentation of the build and factory acceptance testing is complete.

2.3. Task 3: Two (2) WR drawers are shipped to Sandia and one (1) is installed in the ACRR reactor console.

2.3.1. Completed by January 15st, 2014

2.3.2. Deliverable: The two (2) drawers that passed the factory acceptance testing are received by Sandia and the proper quality assurance inspection documentation has been completed. One (1) of those drawers is installed at the ACRR reactor console.

2.4. Task 4: Acceptance testing and calibration of the installed WR drawer

2.4.1. Completed by January 31st, 2014

2.4.2. Deliverable: A Sandia approved acceptance testing plan has been successfully performed and documented for the installed WR drawer. The installed WR drawer has been successfully calibrated and is ready for use during operation.

2.5. Task 5: Train ACRR staff on the new drawers and their maintenance and calibration procedures

2.5.1. Completed by January 31st, 2014

2.5.2. Deliverable: Written and performance evaluations of ACRR staff showing successful completion of the training. All training material used will become the property of SNL.

2.6. Task 6: Provide final documentation of as installed WR drawers

2.6.1. Completed by January 31st, 2014

2.6.2. Deliverable: All required documentation is provided to Sandia.

3. Standards

The standards listed below should be integrated into the design of the new system to the extent practical. Designs should meet all other applicable standards not listed here. Design criteria for the new system shall be based primarily on the design standards listed in this section

3.1. ANSI 15.15, Criteria for Reactor Safety Systems of Research Reactors

3.2. NUREG 1537, Guide for Preparation and Review of Applications for Licensing Non Power Reactors, Chapter 7 Instrumentation and Control Systems

3.3. DOE O 5480.30 Chg 1, Nuclear Reactor Safety Design Criteria

3.4. DOE O 420.1C Chapter 5, Facility Safety

3.5. IEEE STD 1023-2004, IEEE Recommended Practice for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations and other Nuclear Facilities

4. General Project Requirements

4.1. Reliability Requirements

4.1.1. The contractor shall provide mean time between failure data for each component

4.1.2. The contractor shall provide a warranty statement for each component

4.1.3. The contractor shall provide a Failure Modes and Effects Analysis for designed system or other industry approved reliability analysis

4.1.4. The contractor shall establish key performance indicators for each safety significant component based on operability and reliability goals

4.2. Supportability Requirements

4.2.1. The contractor shall provide planned supportability lifetime for components

4.2.2. The drawers shall provide diagnostics

4.2.3. The components shall fail in a way that identifies the cause

4.3. Maintainability Requirements

4.3.1. The contractor shall specify the unit of maintenance (UOM) for the system

4.3.2. The contractor shall provide a recommended list of spares

4.3.3. The contractor shall identify critical spare parts

4.3.4. The contractor shall provide the cost for each spare component listed

4.3.5. The contractor shall provide a recommended quantity for each spare component listed

4.3.6. The contractor shall provide spare parts for critical components and should continue to support future spares which are projected to be needed over the lifetime of the drawer

4.3.7. The contractor shall provide maintenance plans for each component

4.3.7.1. If there is a high consequence due to a component failure, a preventive/predictive maintenance plan or a basis why there cannot be such a plan shall be provided

4.3.8. The contractor shall provide calibration procedures

4.3.9. The drawers shall allow replacement of single components

4.3.10. The drawers shall be able to be maintained and repaired by ACRR operators and engineers with limited support from the contractor

4.3.11. The components at the UOM level shall be accessible

4.4. Testing Requirements

4.4.1.The drawers shall provide accessible test points for each channel

4.4.1.1. Each channel shall test the signal in and signal out

4.4.2.The drawers shall provide baseline signal traces at each test point

4.4.3.The drawers shall provide on-line fault detection

4.4.4.Each channel should have built-in calibration tests

4.4.5.The drawers should provide automatic pre-use checks

4.5. Configuration Management and Quality Assurance Requirements

4.5.1.The contractor shall allow SNL to perform a formal review and acceptance of their QA program

4.5.2.The contractor shall provide basis for design decisions

4.5.3.The contractor shall provide as installed drawings

4.5.4.The contractor shall provide vendor manuals/specification sheets for all components

4.5.5.The contractor shall provide the processes used for configuring components

4.5.6.The contractor shall provide documentation of the final configuration of all components at the UOM level

4.5.7.The contractor shall provide any standards used in the design besides the ones listed in Section 2

4.5.8. The contractor shall provide a description of the system architecture, both functional and physical

4.5.9.The contractor shall provide operating procedures for the system

4.5.10. The contractor shall provide maintenance and calibration procedures for the system

4.5.11. The contractor shall provide all documentation in digital format

4.5.12. The contractor shall implement quality assurance practices throughout design, manufacturing, acceptance testing, installation, and initial calibration phases. Work will be evaluated against ANS 15.8, ANSI 15.15, and DOE O 414.1D

4.5.13. The contractor should perform NRTL inspection, or equivalent, and provide documentation of certification to SNL

4.6. Training Requirements

4.6.1.The contractor shall conduct training for approximately 15 personnel (e.g., reactor operators, engineers, and maintenance personnel) on how to operate and maintain the new system at the component level

4.6.1.1. The training shall take place at the ACRR facility after final acceptance of the system

4.6.1.2. Training shall include written and performance evaluations of the students

4.6.1.3. The training should take place at any contractor recommended intermediate phase

4.6.2. The contractor shall develop training material using a systematic approach (e.g., Analyze, Design, Develop, Implement, and Evaluate)

4.6.3. The contractor shall provide all training material in hard and electronic copy

4.7. Acceptance Testing Requirements

4.7.1. The contractor shall perform factory acceptance testing before installing components

4.7.2. The contractor shall provide results of all factory testing

4.7.3. The contractor shall perform acceptance testing after installation.

4.7.4. The contractor shall provide results of all post installation acceptance testing including documentation of all system alterations

4.8. Sandia Approval Requirements

4.8.1. Sandia shall approve all designs before manufacturing begins

4.8.2. Sandia shall perform on-site witness verification points during factory acceptance testing

4.8.3. Sandia shall approve the post-installation acceptance test plans before the plan is performed

4.9. General Design Requirements

4.9.1. The contractor shall provide an installation plan

4.9.2. The drawers shall have all components and indications labeled with media resistant to wear

4.9.3. The drawers shall have all wiring labeled with media resistant to wear

4.9.4. The drawers shall operate in nominal environmental conditions (0 to 60C and 10 to 95% relative humidity)

4.9.5. The drawers shall be installed and mounted consistent with the industrial standards identified by the Facility Design Standards Manual for Sandia, or equivalent code and standard

4.9.6. The WR drawers shall operate on an input power that is within the Reactor Console range (120 VAC 60 Hz)

4.9.7. The drawers shall meet human factors standards of IEEE STD 1023-2004

5. Wide Range Drawer Requirements

5.1. Log Power Channel

5.1.1. The log power channel shall have a range from at least 1x10^-8 to 200% log power (10^1-10^{11} nv)

5.1.2. The log power channel shall be displayed on the front panel

5.1.3. The log power channel shall output a voltage or amperage signal (currently a 0-10V signal to a FP-AI-110 module)

5.1.3.1. The output signal shall be an isolated signal

5.2. Linear Power Channel

5.2.1. The linear power channel shall have a range from at least 0.1-200% linear power (10^1-10^{11} nv)

5.2.2. The linear power channel shall be displayed on the front panel

5.2.3. The linear power channel shall outputs a voltage or amperage signal (currently a 0-10V signal to a FP-AI-110 module)

5.2.3.1. The output signal shall be an isolated signal

5.3. Startup Rate Channel

5.3.1. The startup rate channel shall have a range of -1 to 7 decades per minute

5.3.2. The startup rate channel shall have a bi-stable trip

5.3.2.1. The setpoint shall be adjustable, or should allow for an adjustable setpoint which can be actuated using a push button

5.3.3. The startup rate channel shall be displayed on the front panel

5.3.4. The startup rate channel shall output a voltage or amperage signal (currently a 0-10V signal to a FP-AI-110 module)

5.3.4.1. The output signal shall be an isolated signal

5.4. High Pulse Power (HPP) Interlock Channel

5.4.1. The HPP interlock channel shall be a bi-stable trip

5.4.1.1. The setpoint shall be adjustable, or should allow for an adjustable setpoint which can be actuated using a push button

5.4.1.2. The setpoint shall be able to be set to less than 100kW (~4% linear power)

5.4.2. The HPP interlock channel shall output a voltage signal (currently a 5V TTL signal to FP-DI-330 module)

5.4.3. The HPP should be set off log or linear power channel (currently set off the log power channel)

5.5. High Power Shutdown Signal

5.5.1. The high power shutdown signals shall be a bi-stable trip

5.5.1.1. The setpoint shall be adjustable, or should allow for an adjustable setpoint which can be actuated using a push button

5.5.1.2. The setpoint shall be able to be set between 10 to 200% power

5.5.2. The high power shutdown signal shall output a voltage signal (currently a 5 V TTL signal to a FP-DI-330 module)

5.5.3. The high power shutdown signal should be set off log or linear power channel (currently set off the log power channel)

5.6. Non Operational Signal (NOP)

5.6.1. The non-operational signal shall be a bi-stable trip signal

5.6.1.1. The bi-stable shall trip when:

5.6.1.1.1. the fission chamber detector signal is lost (power is < 1E-9 % log power)

5.6.1.1.2. the signal processor output signal decreases below the operation scale

5.6.1.1.3. there is a loss of any power supply (±15 VDC, high voltage power supply, etc.) to the WR drawer

5.6.1.1.4. the WR drawer is in test (Channel in test, CIT switch actuated)

5.6.2. The non-operational state shall be displayed on the front panel

5.6.3. The non-operational signals shall output a voltage signal (currently a 5V TTL signal to a FP-DI-330 module)

5.7. Drawer Construction

5.7.1. The drawers shall fit into the standard 19” Reactor Console instrument rack

5.7.2. The drawers shall provide the capability for racking out and in

5.7.2.1. The drawer shall protect workers from voltages greater than 50V so the drawer can be opened when energized

5.7.3. The drawers shall be made out of durable metal

5.7.4. The drawers should be physically designed to the extent practical that sharp edges, pinch points, electrical shock, and other such hazards are not present

5.8. Fission Chamber High Voltage Power Supply

5.8.1. The power supply shall provide 0-20mA of current

5.8.2. The power supply shall provide adjustable voltage between 0-1000 volts
5.8.3. The power supply shall have short circuit protection
5.8.4. The power supply should have an adjustable auto-recovery time from short circuit (100-800 milliseconds range)

5.9. Wiring runs (if needed)

5.9.1. Wiring runs shall be done using a shielded cable (or equivalent) with suitable gauge for the applications
5.9.2. Wiring runs shall be installed in accordance with the applicable requirements of SNL's Electrical Safety Manual, including the NEC

6. Technical Proposal: Evaluation Criteria

6.1. Reliability
6.2. Supportability
6.3. Maintainability
6.4. Performance
6.5. Contractor Past Performance
6.6. Total Cost and Schedule
6.7. Miscellaneous

The criteria are listed in descending order of importance. Best overall value will be determined by comparing differences based on Contractor's relative capabilities to all other offers received. Sandia may acquire contractor information regarding the above criteria from any variety of sources.

Reliability: Defined as the ability to perform as designed in operational environment over time without failure. The contractor proposal that clearly identifies the reliability of their system and their knowledge/documentation of the system's reliability and failures will be evaluated higher. The contractor shall show that the system could meet the listed standards.

Supportability: The system's design supporting detection, isolation, and timely repair/replacement of the anomalies (time and cost to support). Contractors should show their system is easy to understand and defend (transparently safe), provides robust diagnostics, is well documented, and has easy to identify failures. Contractors should also include the anticipated lifetime of vendor support for proposed components.

Maintainability: The ability of the system to be repaired/restored to service when maintenance is conducted by trained people and using established processes (time and cost to fix). Contractors will be judged on maturity of preventive and corrective maintenance procedures, modularity of the system, physical access to components, ability to test system components, availability of critical spare parts, and human factors of the system. The system will also be judged on the demonstrated ability for Sandia to perform most maintenance activities without the contractors support.

Performance: The contract should demonstrate that the proposed system will meet all of the requirements listed in this Statement of Work. The contractors should demonstrate that their system can be fully integrated with the parts of the ACRR that are not changing.

Contractors Past Performance: Contractors should describe in detail similar systems installed in the past (preferably in a nuclear reactor environment). Include how the system is different than what is being requested. Contractors should also provide up to three (3) references and include the following information:

- Description of system
- Date delivery was made
- Company name and address
- Contact phone number and email address

The references will be judged on:

- Reliability, supportability, maintainability, and performance of system(s)
- Final documentation provided to them
- Customer support and training during and after installation
- On-time delivery

Any warranty for the proposed system should also be included in the bid.

Cost and schedule: The contractor will be judged on the cost of the proposed system over its lifecycle. This includes any extra cost incurred by Sandia for working with a non-domestic company. The proposed contractor schedule will also be used in evaluating the proposals. Sandia would prefer a schedule that completes the Design and Manufacturing phases by November 2013 and the Installation and Training phases by January 15th 2014 depending on the availability of the ACRR facility.

Miscellaneous: These items will be considered as added benefits to Sandia that are not direct requirements of the project.

- Drawings can be created with Sandia provided templates with the understanding that once drawings are given to Sandia at time of completion the drawings will become Sandia property
- Documentation that can provided with all the meta data in a form that is easily imported into the Sandia configuration management system (Enterprise Bridge, eB)
- System architecture information that can be provided in a format that can easily be implemented into the eB Nuclear Equipment Database