PURDUE
UNIVERSITY

SCHOOL OF NUCLEAR ENGINEERING

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December 18, 2017

SUBJECT: Purdue University – Request For Additional Information Response For Digital Control and Instrumentation Upgrade License Amendment Request

Dear Mrs. Montgomery,

The Purdue University Reactor staff has received your request for additional information with respect to the Purdue University license amendment request dated February 27 and 28, and June 21, 2017 (Agencywide Documents Access and Management System Accession Package Nos. ML17061A257 and ML17220A077), which requests an upgrade of the Instrumentation and Controls.

Responses to RAIs #22 and #23 will be supplemented at a later date. The wiring diagram for the SCRAM system is submitted in a separate letter.

I hereby certify under penalty of perjury with my signature below that the information contained in this submission is true and correct to the best of my knowledge.

Sincerely,

Clive Townsend
PUR-1, Reactor Supervisor
School of Nuclear Engineering
Docket No. 50-182
License No. R-87

Enclosure: RAI License Response
Technical Specifications – No. 14
PUR1-SRS-SDD-002 – HMI Functions Software
PUR1-HDD-001 – Hardware Design Document

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Request for Additional Information (by Topic)

For the RAIs, provide the information requested or explain why additional information is not needed.

1.0 **Reactor Room Heating, Ventilation, Air Conditioning**

In Section 3.1.1 of the PUR-1 Reactor Protection and Control System (RPCS) functional requirements specification (FRS) (ADAMS Accession No. ML17172A638) for Environmental Qualification, the equipment design specification is stated to be:

- **Temperature 5 degrees Celsius (°C) to 35°C (41 degrees Fahrenheit (°F) - 95°F)**
- **Humidity 20% to 80% (non-condensing)**

There are no known (documented) accident conditions that would cause temperature or humidity to go outside of these ranges. However, the potential exists for normal changes in the seasons to affect temperature (i.e., no Heating, Ventilation, Air Conditioning (HVAC) in extreme summer or winter climate). There is no direct readout for reactor room environmental conditions.

Provide the following information:

RAI #1: Describe how Purdue determined the operating temperature and humidity range listed in the RPCS functional requirements specification.

During the design phase of the new PUR-1 instrumentation and controls, historical information was gathered regarding historic bounding conditions experienced in the reactor room. These conditions were then listed in the RPCS functional requirement specification Section 3.1.1. The lower temperature limit of $41°F$ and upper limit of $95°F$ represent the bounding conditions. These conditions are more restrictive than the ratings of the installed equipment. For example, the neutron flux monitoring system is rated for operation between $32°F$ and $185°F$ with a humidity range of $\leq 95\%$ (per Standard Data TK 250 25438 D09E Edition 5). Additionally, the humidity limits are estimated from historical operating knowledge. A newly installed HVAC unit will maintain the conditions specified as discussed in RAI #2 below. Expected operating conditions are $70°F$ and humidity levels less than $80\ \%$.

RAI #2: Describe how the HVAC unit will maintain the environmental conditions identified.

The HVAC unit installed in the reactor room is dedicated solely to the management of environmental conditions within the room. Temperature and humidity sensors mounted on the unit automatically activate operation. Air to the unit is supplied from both exterior air (filtered through a HEPA filter as required by TS 3.4.b) and from the reactor room. The mixture of this air is automatically controlled through actuation of internal dampers. Air conditioned for temperature and humidity is then expelled directly into the reactor room as well as a connected storage room. Negative air pressure (as required by TS 3.4.a.1) is affirmed by operation of the rooftop fan as discussed in the Safety Analysis Report.

RAI #3: Describe the means to measure temperature within the cabinets.

The main unit susceptible to temperature changes is the PLC. Each component of the PLC is rated from $-4°F$ to $140°F$ and can be stored well beyond that range (Test Specification IEC 60068-2-30). These cards have a temperature sensor which is monitored internally. Operators will be notified of anomalous conditions during operations (i.e. high temperature) through multiple indications on the control screen. The main indication is an "RCS DAS Trouble" alarm on the annunciator panel. The racks which will hold the final equipment have venting slots both at the bottom of the unit and the top allowing for airflow through the unit. While this air flow will not be needed to cool the equipment, it provides further assurance that the units will not overheat. Additionally, following final installation and prior to first startup, the temperature will be monitored by hand within the units to verify no anomalous conditions exist.

2.0 Electromagnetic Interference/Radio Frequency Interference

The electrical requirements (FRS 3.1.1) state that there are no equipment Electromagnetic Interference/Radio Frequency Interference requirements except verifying operability (however, no such test has been documented or performed). During the regulatory audit, the NRC staff observed that much of the cabinet wiring is single strand copper or Cat-5 twisted pairs. At the same time, there are major alternating current sources (240 Volts Alternating Current (VAC) for UPSs and 120 VAC from UPSs to other loads), as well as convenience outlets at top of the cabinet.

RAI #4: Explain how electromagnetic compatibility is assured and verified.

Electromagnetic compatibility is assured and verified by performing integral testing following final installation. Preliminary versions of these tests have been performed during Site Acceptance Testing (SAT) and Factory Acceptance Testing (FAT) where all cables and routes were installed as they will be in the final system installation. All functionality of the system was tested and performed as outlined in the FAT and SAT documents. These tests include a piecewise verification of every expected system

functionality. In addition to these integral tests, each unit has some electromagnetic interference resistance. For example, the PLC is rated to perform nominally in a pulsed magnetic field of $300\,A/m$ (per IEC 61000-4-9) and the neutron flux monitoring channels are rated according to relative European Standards. Therefore, while there is some nominal resistance to EMF interference, integral testing provides assurance of proper operation.

3.0 **Uninterruptible Power Supplies**

The new RPCS uses two rack-mounted SmartPro® 3000CRXML Uninterruptible Power Supplies (UPSs) to provide power to the system. One UPS provides power to the magnetic current supplies. Section 13.1.7 of the SAR "Loss of Normal Electric Power," states loss of normal electric power at PUR-1 will shut down the reactor. With the addition of the UPS, this is no longer the case because the UPS will continue to provide magnet power.

RAI #5: Update the SAR to describe the role of the UPS during a loss of normal electric power.

Some confusion appears to have arisen from multiple possibilities of loss of normal electric power. With the newly installed digital I&C, power can be lost to the system by a failure of the UPS units or by a loss of power to the UPS units themselves. These will be discussed separately.

During a loss of power to the UPS units (analogous to a loss of offsite power), the UPS units provide means for the operating staff to perform a **controlled** shutdown. Facility procedures dictate that following a loss of power supply to the UPS units, operators begin to shutdown the reactor either by a "gang lower" (insertion of all rods through activation of rod drive motors) or by manual scram (depressing the Scram Button, thereby cutting magnet power and causing rods to fall into the core under the force of gravity). This allows normal facility procedures to be followed for shutdown as the 30 minute power supply by the UPS units is more than sufficient to perform a normal shutdown which typically lasts approximately 15 minutes. (SAR 13.2.h)

During a loss of power supplied from the UPS units to the system, the magnet power supply will lose its ability to maintain an electrical current. This loss of current causes the magnets to fail and the rods to fall into the core under the force of gravity. Prior to the installation of the new Instrumentation and Controls, this was the only result following a loss of power supply. Section 13.2.g of the SAR which discusses "a loss of power to the electromagnets that hoist the shim rods" specifically addresses this second scenario.

Section 13.2.g of the SAR has been renamed "Failure of UPS Unit Power Supply" and reads:

> The loss of normal electric power supplied by the UPS units at PUR-1 will shut down the reactor by creating a scram with a loss of power to the electromagnets that hoist the shim-safety rods. This action will shut down the reactor from any conceivable operating condition. Since the reactor is cooled by natural convection, there are no shutdown and decay heat issues. There is adequate heat capacity in the reactor pool to address shutdown and decay heat loads. Therefore, this accident scenario is not addressed.

Section 13.2.h – Loss of Normal Electrical Power has been added and reads:

> During a loss of power to the UPS units (analogous to a loss of offsite power), the UPS units provide means for the operating staff to perform a **controlled** shutdown. Facility procedures dictate that following a loss of power supply to the UPS units, operators immediately begin to shutdown the reactor either by a "gang lower" (insertion of all rods through activation of rod drive motors) or by manual scram (depressing the Scram Button, thereby cutting magnet power and causing rods to fall into the core under the force of gravity). This allows normal facility procedures to be followed for shutdown as the 30 minute power supply by the UPS units is more than sufficient to perform a normal shutdown which typically lasts approximately 15 minutes. If the UPS units fail during this timeframe, the incident is the same as discussed in Section 13.2.g.

which is the text of the paragraph above.

Purdue personnel stated, during the site audit, that the UPS can provide ride-through for loss of facility power. The UPSs are specified and sized to provide up to 30 minutes of backup power to the RPCS. Further, Purdue staff identified that a casualty procedure would be established for controlled shutdown following the loss of building power.

RAI #6a: Explain how the operator would know if the building alternating current (AC) power is lost and describe the operator actions, associated procedures (including method of controlled shut down (e.g., ganged drive-in or scram)) and the approach the operator would use to ensure safe shutdown.

The answer to RAI #6a has been partially discussed in RAI #5 above. With respect to notification to the operator, the reactor room lights are powered by building alternating current. In the event of loss of building power, the lights in the room will go out. Operators have backup lighting from flashlights kept at the operator console as well as the light from operator console display screens. Additionally, loss of input power to the UPS units is monitored by the RCS and will cause an alert on the display screen.

RAI #6b: Propose a TS that states that normal operations of the reactor shall not be allowed on emergency power or state why this is not needed.

Technical Specification 3.2.e has been added to the proposed TSs (as attached) and reads:

> Building alternating current power must be supplied to the reactor Instrumentation and Control during normal operation. Loss of power shall require immediate shutdown by the operator to be completed within an interval of 30 minutes.

The basis for the TS is:

> The Instrumentation and Control system is designed to be capable of performing a normal shutdown in the event of a loss of off-site power. The time period to complete this shutdown is up to 30 minutes as that is the rating of the UPS units with a maximum power loading. Loss of off-site power starts the power draw from the UPS units which therefore starts the 30 minute timeframe.

The Instrumentation and Control system is designed to be capable of performing a normal shutdown in the event of a loss of off-site power. The time period to complete this shutdown is up to 30 minutes as that is the rating of the UPS units with a maximum power loading. Loss of off-site power starts the power draw from the UPS units which therefore starts the 30 minute timeframe. Additionally, surveillance TS 4.2.f has been added to read:

> A simulated loss of off-site power shall be performed annually with no interval to exceed 15 months to verify the UPS units are capable of providing Instrumentation and Control power for at least 30 minutes.

The basis for the SR is:

> Annual checks of the UPS unit functionality will verify the UPS units are capable of providing power for at least 30 minutes. Changes in battery functionality are expected to be nominal over a period of several years. Therefore the frequency of an annual check is sufficient to verify operability of the controlled shutdown condition during loss of off-site power.

Section 7.3.f.i.(b) of the SAR states that each UPS "unit supports loading up to 3600 watts when hard wired." During the Purdue site audit, the NRC staff noted that the test bed (as shown in PUR-1 SAR, Figure 7-4) for the RPCS had removable power connectors for the supplied power to the UPS.

RAI #7: If the final install will also have removable power connectors for the UPS power inputs, describe the loading supported by each UPS and explain if the load rating is sufficient for the intended loads, including any anticipated use of the cabinet mounted Tripp Lite, 120 VAC, and convenience outlets.

Estimated power draw for each of the components powered by the UPS units was performed to approximate total loading on each unit. The capacity is roughly double the current power needs. The convenience outlets on the front of the unit are intended for maintenance and calibration use only. Because the units have a significant excess in power supply, no technical specification is needed. Use of the convenience outlets will be administratively limited to reactor operators only. Additionally, UPS performance is monitored by the PLC and anomalous conditions reported to the operator.

4.0 User Access

Section 7.9.a.iv of the SAR states that the RPCS operator workstation has multiple login groups for both user authentication and for establishing access control and privileges. In addition, the RPCS operator workstation has a "super-user" login with full privileges to control or modify any aspect of operation, maintenance, and program administration and configuration management. During the audit, NRC staff reviewed the "System Generation," factory acceptance test (FAT) in which the level of privilege was stated, in Table 8-1, as level 5, 10, 15, 20, and 31; however, no description is provided to differentiate the permission associated with these levels.

RAI #8: Provide a detailed description of the permission levels associated with each of the group levels, the criteria for assignment of individuals to the various levels, and how the permission levels (i.e., group assignments) will be administratively assigned and controlled.

Multiple levels of access and user rights profiles are established for the following classes of users: viewer, maintenance, operator, engineer, and administrator. Each of these have growing access to different functions within the system. The names of these levels are used as a reference and the intended actions of the operator or staff member should not be inferred from the name. That is, if one is logged in as 'engineer' it should not be assumed that individual is 'engineering' part of the system. Simply, the Level 20 login is used to perform actions beyond that which an operator can do but below that which an administrator can. In practice, additional user profiles are added with unique logins and passwords which are then assigned a permissions status. For example, newly licensed

operator Joe Smith may be given the user login 'jsmith', associated password, and permissions level 15. This will allow him to operate the reactor but not add other users.

With respect to each of the user function levels, much of the functionality is flexible. The following discussion gives permission levels as the system is currently designed at the time of this writing. Changes in the permissions to a user level constitutes a system change and must be approved by the Committee on Reactor Operations, just as any other system change must be.

In the viewer setting, this is the most limiting functionality where the user can navigate to all non-administrative screens to view historic data. The viewer may not select a rod for movement or access data archive settings. The viewer setting is listed as Level 5. The second level is maintenance and is denoted by number 10. In this setting, various screens may be viewed beyond those which are accessible by the "view" setting. Additionally, magnet power can be activated. The third level is Level 15 and refers to the Operator. The Operator Security Level is required to manipulate control rods and use the automatic startup. The fourth level is for Engineers and is Level 20. This user status allows for use of the servo control functionality. Finally, Level 31 is the highest level of access available and is used for manipulation of the archiving of data points as well as changing user profile permission levels. The administrator may also restrict access to certain data points to lower users. As an example, the administrator may not want the Level 5 user to be able to see power indications from Channel 4. On the 'Analog Point Details' screen, the permissions level for this data point can be restricted to only those levels greater than Level 5. This example would constitute a system change as discussed in the second paragraph of this RAI response.

Proposed TS definition 1.32, "Reactor Secured," contains a new condition for the PUR-1 reactor to be secured that states "the control console is placed in a permissions status where the controls are not operable." During the regulatory audit, the NRC staff observed that this added condition is related to the password control for the RPCS operator workstation.

RAI #9: Describe in detail how the permission status is used to render the controls inoperable and explain the basis for adding this new reactor secured condition.

Regarding the basis for adding this new reactor secured condition, with the new digital instrumentation and control, the reactor secured is not simply regarding the ability of the system to raise or lower the control rods. It is additionally a status of the security surrounding the system and its archived data. The addition of the reactor secured requirement for the controls to be inoperable also ensures the control algorithm and archived data is unavailable for modification. Similar to the control of the console key, reactor room key, and security alarm system codes, differing levels of passwords will allow a user to view the control console (a tour guide for example), another user to manipulate

rods but not change data archiving (Level 15 and above), and a facility staff member to change the frequency of data collection (Level 31). Each of these has different implications to the facility.

The "controls inoperable status" disables the magnet current from being engaged as well as disabling the selection of a control rod drive for activation.

5.0 Operator Training

Purdue currently does not have any documentation identifying how operator training is being revised to reflect the changes in the system. Scientech provided a revised Operator Manual for the new digital I&C systems but there is no information that indicates that it will be used to train operators.

RAI #10: Provide a description of the operator training applicable for the proposed I&C upgrade implemented with this LAR that will be used to qualify the operators on the new console and equipment before the system is approved for use.

Operator training at the PUR-1 consists of reactor physics fundamentals, regulatory review, facility introduction, reactor design, and operations. There is no change in the physics of reactor operation, regulations, or the bulk facility. With respect to the reactor design (including instrumentation and controls), operators are introduced to the various subsystems and their relation to safety. The method for which these are introduced and their relation to the Safety Limit is unchanged. The material is altered somewhat to reflect the new components but the new digital I&C was designed at a system level to very closely reflect the current I&C. Reactor Operators are introduced to operations through supervised time on the console. This training consists of basic rod manipulations, indication monitoring, shutdown procedures, and emergency preparedness. While the mechanics behind parameter indication and rod movement has changed drastically, the fundamental concepts remain and little change is required to the operator training.

With respect to the requalification plan, this document is fairly generic and its implementation reflects the mission of the PUR-1. There are no changes required to the requalification plan.

6.0 Technical Specifications

Purdue TS 3.2 is used to specify the lowest acceptable level of performance or the minimum number of acceptable components for the reactor safety system. Proposed TS 3.2a requires that the safety-related instrumentation shall be operable in accordance with Table I, "Safety Channels Required for Operation," and Table II, "Safety-Related

Channels (Area Radiation Monitors)." The SRs under TS 4.2a require a channel calibration through an annual electronic calibration and an annual power calibration. However, nothing is proposed for daily/pre-start checks to "...assure that the reactor safety system is operable as required by Specification 3.2."

RAI #11: Provide a proposed SR that will establish the operability of the safety channels required for operation and explain how the SR will be performed.

Technical Specification 4.2.d requires a channel check of each of the Scram capabilities specified in Table I performed prior to each day's startup. This surveillance requirement will be performed by qualitatively verifying channel behavior and inducing a scram condition. The prestart checklist calls for rods to be elevated up to 6 cm, a scram induced, and visual verification the rods have dropped as expected. To test each of the scram capabilities of individual channels, simulated signals can be introduced on the face of the neutron flux monitoring channels. These signals then propagate down the signal stream to induce a scram. Various binary contact operations (LED indication) can be seen both on the operator screen and the face of the neutron flux monitoring channels to verify standard performance. Finally, the scram cause is verified by the annunciator panel (left of the display screens) and auxiliary panel (located on the right operator screen).

Again, the means by which the signal is evaluated has changed significantly in the new system but the operator mechanics have not. A simulated signal is introduced into the system which causes a scram as indicated on the operator control console. Verification that the appropriate indication is given provides assurance of nominal performance.

RAI #12: Provide additional description or justification to assess the acceptability of the proposed TS 3.2, editorial changes to Table I for "Channel," "Setpoint," and "Function."

Editorial changes made to Table I in the technical specifications were done to create continuity of language across the system documentation, indications, Technical Specifications, and operational language used in supporting documents. With respect to the Channel discussion, the word "period" has been replaced by "Change Rate" as the neutron flux monitoring channels output readings for change rate and not period. Each parameter is analogous, just expressed with a different numeric base. Because the change rate is indicated, it is clear the setpoint should be dictated in the same units rather than forcing the operator to continually calculate one from the other. Finally, more descriptive wording was used in the Table I Functions column to indicate the interlocks were "withdrawal inhibits" as insertion of rods is always allowed at the PUR-1. Prior language could have been misunderstood to mean "no rod movement" which is untrue.

PUR-1 SAR, Section 7.6.i, "Configuration Management," states, in part, that "as part of the prestart checklist, operators will verify the software version listed at the top of the displays on the console match the current release as listed in the Reactor Characteristics

and Operations Manual." During the regulatory audit, the NRC staff observed that the Purdue standard operating procedures (SOPs) have not been updated to reflect this yet.

RAI #13: Describe the update to Prestart checklist (SOP-1) that will be proposed to incorporate this pre-start check for configuration management.

Several changes need to be made to the Prestart Checklist (SOP-1) with regards to the new instrumentation and control. The former prestart checklist requires checks for functionality that no longer exists in the system (such as Fast Scram checks). This prestart checklist is one of the means by which facility staff verify compliance with the TSs prior to each days start-up and is approved for use by the Committee On Reactor Operations (CORO). Prior to full implementation of the amended facility license, a new Prestart Checklist will be approved by the CORO. This is not a regulatory document and therefore is not provided in this submission.

With respect to the Prestart Checklist and the configuration management, operators will verify the software version listed on top of the Rod Position Indication (RPI) screen matches the current version.

As discussed during the site audit, the current Prestart checklist (Purdue SOP-1), which is a checklist included in the SOPs that is used prior to starting the reactor, contains several inconsistencies, noted below, with both the current and the proposed TSs.

RAI #14: Propose updates to the SOPs that will eliminate the inconsistent references and resolve these inconsistencies. In particular, explain the references to non-existent tables and the incorrect references to checks of each reactor safety system measurement channel. Describe how Purdue will maintain consistency with TS 3.2b, which is only for radiation monitors (Table II) or explain why an update is not required.

The Prestart Checklist will be revised prior to full implementation of the amended facility license. Please see RAI #13 for further explanation.

With respect to the operation of both the Radiation Monitors and the Neutron Flux Monitoring Channels, Technical Specification 4.2.b requires, "A channel check on the radiation monitoring equipment shall be completed daily during periods when the reactor is in operation." Additionally, TS 4.2.d requires, "A channel check of each of the Scram capabilities specified in Table I shall be performed prior to each day's startup." Both of these taken together ensure the reactor is operated in a safe manner.

The setpoints provided in Chapter 7, Section 7.4.a, Table 7-6 of the PUR-1 SAR, are not consistent with the values in PUR-1 TS Table I for Channel 1 and 2 Safety Channels.

RAI #15: Explain and justify why these setpoints are different, describe how Purdue will revise them such that they match, or explain why no changes are necessary.

A late change in the proposed Technical Specifications was not fully reflected in the SAR. The revised Table 7-6 and Table I is shown below. These values do not require a change in other sections of the Safety Analysis report as they are a mapping of prior period values to current change rate values. The new change rate limits were then rounded down to the nearest integer value for clarity to the operator. The rounded down value is more conservative than the true value as a change rate of $8\ \%/s$ will induce a smaller power change per second than $8.69\ \%/s$. As a review, the conversion between change rate and period is

$$\frac{1}{\tau} = \ln(1 + \sigma)$$

where τ is the reactor period, $\ln(\,)$ is the natural logarithm, and σ is the change rate. The values now listed represent the final setpoints proposed for the PUR-1.

Channel	Minimum Number Required	Setpoint (c)(d)	Function
Log count rate and change rate	1[a]	2 cps or greater 8 %/s or less 15 %/s or less 6 %/s sec. or less	2 cps rod withdrawal inhibit Setback Scram Rod withdrawal inhibit
Log N and change rate	1[b]	8 %/s or less 15 %/s or less 6 %/s or less 12kW, 120% Operating power level, or less	Setback Scram Rod withdrawal inhibit Scram
Linear	1	0% Selected Range, or greater 110% Selected Range or less 120% Selected Range or less	Setback Setback Scram
Safety	1[b]	11 kW, 110% Operating power level, or less 12 kW, 120% Operating power level, or less	Setback Scram
Manual Scram (console) (hallway)	 1 1		 Scram Scram

(a) Not required after Log N-Period channel comes on scale.
(b) Required to be operable but not on scale at startup.
(c) All percentage based setpoints shall be tripped when the measured value is greater than or equal to the specified value. Counts per second (cps) setpoints are at values less than or equal to the specified value. Exception: Trip point for 0% shall happen as the value goes from the positive to negative value.
(d) Setbacks shall be set such that they will be initiated prior to a Scram

PUR-1 TS 4.2.d describes a channel check of each of the scram capabilities specified in PUR-1 TS Table I prior to each startup.

RAI #16: Identify which SR incorporates the guidance for retest following replacement, repair, or modification provided in the ANSI/ANS-15.1-2007 standard.

Historically, any change in any of the systems detailed in Tables I and II would constitute the need for a recalibration of the equipment. This interpretation stems from TS 4.2.a.1 which states, "an electronic calibration shall be performed annually.." It is unclear how a system could be credited with being "in calibration" if it is new. A new component would require a recalibration of the system which is consistent with responsible operating practices. To clarify, TS 4.2.a.3 has been added which reads, "An electronic calibration shall be performed following replacement, repair, or modification of components impacting Channels in Table I."

7.0 RCS Programmable Logic Controller

The RTP-3000 programmable logic controller (PLC) receives a heartbeat from the data acquisition system/operator supervisory control system to verify communications with the PLC. A watchdog timer is described that will monitor communications and reset the system (causing a reactor scram) for a communications error. The PLC provides data acquisition, data storage, reactivity control (e.g., automatic start up) and operator display and operator/system interfaces for operator monitoring, control and emergency response. The PLC can also shut down the reactor if necessary. The PUR-1 TSs do not propose an LCO or SR associated with the PLC.

RAI #17: If the PLC fails, explain how controls and displays of important parameters will be monitored by the operator and how the controls and displays will keep PUR-1 parameters within a limiting value. Also, explain how those controls and displays, that affect the reactivity of the core, are readily accessible and understandable to the reactor operator.

Sound reactor operation principles dictate the operator continually evaluate available diverse signals against each other. If the PLC and auxiliary indicators don't match, this could indicate a PLC failure. In such an event, the operator has the capability to see critical facility parameters on both the face of the neutron flux monitoring channels and the Yokogowa recorders. This is discussed in the SAR *Section 7.3.f.i(e) Parameter Indication*. While the controls and the displays are designed to help maintain safe operability of the PUR-1, the protection of the Safety Limit is done solely by the neutron flux monitoring channels. In the event of any anomalous condition at the PUR-1, operators are trained to perform a manual scram and verify, if possible, the shutdown process. The indications, in the absence of the main operator display screen, are readily

accessible and understandable to the operator as they are expressed in the same units as in the rest of the system and are located just to the left of the main screens.

RAI #18: If the PLC fails, explain how displays and controls provided to the operator for manual system-level actuation and control of safety equipment will be functional under conditions that may require manual actions or justify why no additional information is needed.

The channel required for manual actuation of the safety system is solely the manual scram button located on the reactor console. By depressing this button, the operator interrupts the magnet current and the rods fall into the core under the force of gravity. In the event of a failure of this button, an auxiliary button is located in the hallway adjacent to the reactor room which may be actuated in an identical manner. The displays and controls have no credited functionality in an emergency shutdown situation. Provided environmental conditions do not dictate the need for evacuation, auxiliary indications are provided to the operator to verify shutdown is progressing as expected.

During the audit, NRC staff noted that Purdue has not defined how to verify operability of the PLC.

RAI #19: Propose a TS and SR associated with the PLC to verify its operability.

Technical Specification 4.2.b and 4.2.d call for channel checks of the radiation and neutron flux monitoring channels. Because the PLC delivers the indicated value of these subsystems to the operator through display screens, “qualitative verification of acceptable performance by observation of channel behavior” (Channel Check definition TS 1.3) is verified during the prestart checklist. Without a properly operating PLC, during the Scram and Radiation Monitor system checks, off normal indications would be discovered by the operator. Therefore, no change is necessary to the Technical Specifications or the Surveillance Requirements as these already cover operation of the PLC.

Operability and calibration performed as part of the annual channel calibration will constitute a check that indicated values on the display screen, Yokogowa recorders, and neutron flux monitoring channels align.

8.0 Other Technical Specification Changes

The proposed TS for this LAR (ADAMS Accession No. ML17061A257) includes a change to the specification wording for TS 4.6, "Fuel Parameters." However, the safety basis for the change was not provided.

RAI #20: Explain the relationship, purpose, and basis for this change, including a safety evaluation of the acceptability of the proposed change; or remove the TS change; or explain why no information or action is necessary.

The change to TS 4.6 is auxiliary to the Instrumentation and Control replacement. Following the prior License Renewal by the PUR-1, it was determined the Maximum Hypothetical Accident involved a fuel handling accident. In an effort to increase the safety margin of the facility, reduce risk to health and safety of the public and conform with ALARA principles, this line change clarifies the fuel integrity technical specification is met through visual verification of the assembly integrity. Formerly, a fuel plate would have been removed from the assembly by hand and a detailed visual inspection performed. This is unnecessary as similar verification can be done through visual inspection while the assembly remains in pool. Additionally, further verification of fuel integrity is ensured as a representative sample of the bulk pool volume is tested for contaminants monthly.

9.0 Mirion Test Switches

The Mirion neutron channels use keyed test switches to control access for test and maintenance of the channels.

RAI #21: Describe the administrative procedural control for access and authorized use of the keys for the test switches (i.e., PUR-1 SOP or TS).

There are two sets of keys which can be used on the Mirion Channels. The first allows for the channel to be placed in test mode. This key is protected at the same level as the reactor console key as an operator will use the Test Key to perform the prestart verification of scram capability for each of the channels. The Test Key (and console key) are kept inside a combination locked cabinet within the reactor room. Only those verified to be Trustworthy & Reliable by the NRC approved reviewing official are given unescorted access to the reactor room and only those who have passed their NRC operations exam may be given access to these keys. The second Mirion Channel key allows for configuration changes to be made to the channel. These keys are protected to the level of facility management (Facility Director, Reactor Supervisor, and Electronics Technician) who are also Trustworthy & Reliable verified and licensed senior reactor operators. This control is maintained by keeping the keys in separate locked cabinetry, in a separate facility location, with separate combinations.

10.0 Configuration Management

PUR-1 SAR, Section 7.6.i – Configuration Management states that "current configuration of the [RPCS] software will be maintained and documented as Appendix II to the Reactor Characteristics and Operations Manual (RCOM), an internal facility document." During the regulatory audit, the NRC staff observed that this Purdue internal facility document did not exist.

RAI #22: Provide an updated excerpt for Appendix II to the RCOM that describes how configuration management for the RCS software will be maintained and controlled in accordance with the PUR-1 SAR or explain why software configuration management is not needed.

The Configuration Management Plan has not yet been created. It will be delivered as a supplement to this submission at a later date.

11.0 Quality Assurance

PUR-1 SAR, Section 7.8, "Quality Assurance," states "[A] quality assurance (QA) program shall be developed, maintained, and utilized in accordance with the guidance of ANS/ANSI 15.8-1995." During the regulatory audit, the NRC staff observed that this Purdue quality assurance (QA) document was not available.

RAI #23: Describe the QA program used as part of this I&C modification or describe the Purdue administrative procedures and processes to be used as part of this modification to ensure components and modules that impact safety-related items are designed, fabricated, installed, modified, and of sufficient quality to minimize the potential for challenges to safety systems.

The description of the Quality Assurance will be delivered as a supplement to this submission at a later date.

12.0 Testing and Inspection Requirements

PUR-1 testing and inspection requirements are provided in Section 4 of the FRS. The FRS specifies the requirements to demonstrate the functionality of the new RPCS and demonstrate conformance to the requirements. FRS Section 4.2 describes a requirement for performing FAT and Section 4.4 describes the site acceptance tests (SAT).

RAI #24: During the regulatory audit, the NRC staff observed that several test procedures for the FAT and SAT were not conducted due to missing hardware, system interfaces, or required connection to the reactor. These procedures were documented

as "can't test." A master list of tests that were not performed does not exist and no test exception records were generated for the missing tests. Explain how these missing tests are being tracked and how and when these previously untested tests will be completed.

The NRC auditors are correct in noting that some of the functionality of the system will not be available until the system has been moved to its final location. These tests were not performed as they would require final installation of the system. For example, actual operation of the control rods was not tested as this would violate the current facility license. In order to complete these tests, the core will be defueled to allow for rod movement without the potential for criticality. The master list of tests not performed is not necessary as the complete FAT and SAT will be comprehensive redone following final installation. Prior to this integral testing, earlier FAT and SAT tests will be reviewed to identify and perform prior skipped or uncompleted sections. Any anomalies during this final integral testing will be resolved via Test Exception Reports (TERs).

The FAT and Test Plan requires that test exception reports (TER) be created to record failures or issues encountered during tests. The TER should, describe changes necessary to pass FAT, and their resolution requires retest before the completion of FAT. During the regulatory audit, the NRC staff observed that several TERs were documented during the FAT. However, it was not apparent to the NRC staff that documentation exists for the resolution and description of changes made to the system to address TERs, or that, if the changes were made, they were made permanent (e.g., as evidenced by a change in the software build number), or that the changes were retested since the FAT documentation still indicated out-of-specification parameters.

RAI #25: Provide evidence that the TERs generated included a description of the changes made to the system, that the changes are permanent, and that they were retested.

The TERs generated during the facility audit as well as those which may be generated during integral testing will be provided to the NRC staff with the proposed Start-Up plan at a later date.

During the regulatory audit, the NRC staff observed a demonstration that revealed that the control functionality for target rod withdrawal (i.e., withdrawal of a rod to a preset height) as related to inhibits for selection and withdrawal of a different rod may have functioned improperly. This error was reported to be corrected by Purdue staff at the exit meeting and a subsequent demonstration to NRC staff was performed satisfactorily. However, it is not apparent to the NRC staff that documentation was created for the description of the changes made to the control functionality for target rod withdrawal.

RAI #26: Provide evidence that a TER or similar document was generated that included a description of the changes made to the system, that the changes are permanent, and that they were formally retested (in accordance with Scientech and Purdue procedures).

This TER, along with other TERs which may be generated, will be provided to the NRC with the proposed start-up plan.

13.0 Fast Scram

The safety review for PUR-1 provided with the amendment describes operation of Channel 4, Safety Channel. This description talks about "fast scram" that is performed by this channel, and states that the "fast scram capability remains in the new I&C." However, during the audit, it was clear that this feature is not included in the new I&C system. Instead, all channels have the same capability to scram the reactor.

RAI #27: Explain what was meant by the sentence "fast scram capability remains in the new I&C."

The "fast scram" functionality mentioned in the Safety Review letter was an error in the submission and should have read, "The fast scram capability does not remain in the new I&C." As will be verified during integral testing, the shim safety rods will continue to drop from full height to full insertion in less than one second as analyzed in the Safety Analysis Report. The fast scram is not required as the time for full insertion remains well below one second.

14.0 Document Request

During the regulatory audit, NRC staff identified several documents that the NRC may consider using as a regulatory basis for use while preparing the safety evaluation.
RAI #28: Docket the following documents or provide an explanation of why it is not necessary:

- **PUR1-SRS-SDD-002 – HMI Functions Software**
- **PUR1-HDD-001 – Hardware Design Document**
- **PUR1-HDD-001-16 Sh. 2 – Second page of the SCRAM wiring diagram**

These documents are supplied in the response to these RAIs.

15.0 Operator Manual

During the regulatory audit, NRC staff reviewed "PUR-1 Operating Principles and Core Characteristics Manual," Revision 0, which describes the reactor, operation, control and system descriptions. Purdue staff noted that they are considering updating this document to describe how to control and operate the new RPCS system. Also, they are considering using Scientech PUR1-OPS-001, "Operator Manual," Revision 1, which describes how

to use the RPCS, Human-Machine Interface display, and physical controls from the operator console.

RAI #29: Identify if Purdue will update the Operating Principles and Core Characteristics Manual, adopt the Scientech PUR1-OPS-001 Operator Manual, or identify what Purdue is planning to do if they are not updating the manual to operate the reactor.

Purdue will update the Operating Principles and Core Characteristics Manual through incorporation of relevant historic text, information from the Scientech PUR1-OPS-001 Operator Manual, and other important facility information required by a Reactor Operator. This updated manual will be reviewed and approved by the CORO prior to full implementation.

TECHNICAL SPECIFICATIONS

FOR THE

PURDUE UNIVERSITY REACTOR, PUR-1

DOCKET NUMBER 50-182

FACILITY LICENSE NO. R-87

PREPARED BY:

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West Lafayette, IN 47907

February 2017

TABLE OF CONTENTS

1. DEFINITIONS

The following frequently used terms are to aid in the uniform interpretation of these specifications:

1.1 Channel – A channel is the combination of sensor, line, amplifier, and output devices that are connected for the purpose of measuring the value of a parameter.

1.2 Channel Calibration - A channel calibration is an adjustment of the channel such that its output corresponds, within acceptable range and accuracy, to known values of the parameter which the channel measures. Calibration shall encompass the entire channel, including equipment actuation, alarm, or trip, and is deemed to include a channel test.

1.3 Channel Check - A channel check is a qualitative verification of acceptable performance by observation of channel behavior. This verification may include comparison of the channel with other independent channels or methods of measuring the same variable.

1.4 Channel Test - A channel test is the introduction of a simulated signal into a channel to verify that it is operable.

1.5 Confinement – Confinement is an enclosure of the overall facility that is designed to limit the release of effluents between the enclosure and its external environment through controlled or defined pathways.

1.6 Core Configuration – The core configuration includes the number, type, or arrangement of fuel assemblies (elements), reflector elements, reflector element configuration, and regulating/control rods occupying the core grid.

1.7 Core Experiment - A core experiment is one placed in the core, in the graphite reflector, or within six inches (measured horizontally) of the reflector. This includes any experiment in the pool directly above or below the core.

1.8 Direct Supervision – In visual and audible contact.

1.9 Excess reactivity – Excess reactivity is that amount of reactivity that would exist if all control rods were moved to the maximum reactive condition from the point where the reactor is exactly critical (k_{eff} = 1) at reference core conditions or at a specified set of conditions.

1.10 Experiment – Any operation, hardware, or target (excluding devices such as detectors, foils, etc.) that is designed to investigate non-routine reactor characteristics or that is intended for irradiation within the pool, on or in a beam port or irradiation facility. Hardware rigidly secured to a core or shield structure so as to be a part of its design to carry out experiments is not normally considered an experiment.

1.11 Experimental Facility - Experimental facilities are:

a. those regions specifically designated as locations for experiments or

b. systems designed to permit or enhance the passage of a beam of radiation to another location.

1.12 Experiment With Movable Parts (Secured or Nonsecured) - An experiment with movable parts is an experiment that contains parts that are intended to be moved while the reactor is operating.

1.13 Explosive Material - Explosive material is any solid or liquid which is categorized as a Severe, Dangerous, or Very Dangerous Explosion Hazard in "Dangerous Properties of Industrial Materials" by N. I. Sax, Tenth Ed. (2000), or is given an Identification of Reactivity (Stability) index of 2, 3 or 4 by the National Fire Protection Association in its publication 704, "Identification System for Fire Hazards of Materials."

1.14 Fueled Experiment - A fueled experiment is any experiment planned for irradiation of uranium 233, uranium 235, plutonium 239, or plutonium 241.

1.15 License – The written authorization, by the US NRC, for an individual or organization to carry out the duties and responsibilities associated with a personnel position, material, or facility requiring licensing.

1.16 Licensed – See licensee.

1.17 Licensee – An individual or organization holding a license.

1.18 Measured Value - The measured value is the value of a parameter as it appears at the output of a channel.

1.19 Movable Experiment - A movable experiment is one where it is intended that all or part of the experiment may be moved in or near the core or into and out of the reactor while the reactor is operating.

1.20 New Experiment - A new experiment is one whose nuclear characteristics have not been experimentally determined.

1.21 Non-secured Experiment – See Unsecured Experiment.

1.22 Operable - A system or component is operable when it is capable of performing its intended function in a normal manner.

1.23 Operating - A system or component is operating when it is performing its intended function.

1.24 Pool Experiment - A pool experiment is one positioned within the pool more than six inches (measured horizontally) from the graphite reflector.

1.25 Power Level – There are three important and separately defined power levels.

a. Instantaneous Power Level shall be the power level of the reactor at any given moment, as indicated by the reactor instrumentation.

b. The Operating Level shall be the power level from which setpoints for scram and setback shall be calculated. The Operating power level shall be 10 kW or less.

c. The Maximum Power Level shall be the maximum instantaneous power level allowed by the PUR-1 License. The Maximum Power Level shall be 12 kW, which shall not be exceeded.

1.26 Protective action – Protective action is the initiation of a signal or the operation of equipment within the reactor safety system in response to a parameter or condition of the reactor facility having reached a specified limit.

1.27 Reactivity worth of an experiment – The reactivity worth of an experiment is the value of the reactivity change that results from the experiment being inserted or removed from its intended position.

1.28 Reactor Facility - The reactor facility is that portion of the ground floor of the Duncan Annex of the Electrical Engineering Building occupied by the School of Nuclear Engineering used for activities associated with the reactor.

1.29 Reactor Operating – The reactor is operating whenever it is not secured or shut down.

1.30 Reactor Operator – An individual who is licensed to manipulate the controls of the reactor.

1.31 Reactor Safety System - The reactor safety system is that combination of measuring channels and associated circuitry which forms the automatic protective system of the reactor, or provides information which requires manual protective action to be initiated.

1.32 Reactor Secured – A reactor is secured when

a. *Either* there is insufficient moderator available in the reactor to attain criticality or there is insufficient fissile material present in the reactor to attain criticality under optimum available conditions of moderation and reflection

b. *Or* the following conditions exist:

1. Both shim-safeties and the regulating rod shall be fully inserted

2. Electrical power to the control rod circuits shall be switched off

3. The reactor key shall be out of the key switch and under control of a licensed operator or locked in an approved location

4. No work shall be in progress involving core fuel, core structure, installed control rods, or control rod drives unless they are physically decoupled from the control rods

5. No experiments shall be moved or serviced that have, on movement, a reactivity worth exceeding the maximum value allowed for a single experiment

6. The control console is placed in a permissions status where the controls are not operable.

1.33 Reactor Shutdown - That subcritical condition of the reactor where the negative reactivity, with or without experiments in place, is equal to or greater than the shutdown margin.

1.34 Readily Available on Call - Readily available on call shall mean the licensed senior operator shall be within a reasonable driving time (1/2 hour) or less than 15 miles from the reactor building, and the operator on duty is currently informed, and can rapidly contact the senior reactor operator by phone.

1.35 Reference core condition - The condition of the core when it is at ambient temperature (cold) and the reactivity worth of xenon is negligible (<0.003 $\Delta k/k$).

1.36 Removable Experiment - A removable experiment is any experiment, experimental facility, or component of an experiment, other than a permanently attached appurtenance to the reactor system, which can reasonably be anticipated to be moved one or more times during the life of the reactor.

1.37 Rod, control - A control rod is a device fabricated from neutron-absorbing material that is used to establish neutron flux changes and to compensate for routine reactivity losses. A control rod can be coupled to its drive unit allowing it to perform a safety function when the coupling is disengaged.

1.38 Rod, regulating - The regulating rod is a low worth control rod used primarily to maintain an intended power level that need not have scram capability. Its position may be varied manually or by a servo-controller.

1.39 Rod, Shim-Safety - The control rods used in PUR-1 as described in the definition for Rod, control.

1.40 Secured Experiment - Any experiment, experimental facility, or component of an experiment is deemed to be secured, or in a secured position, if it is held in a stationary position relative to the reactor by mechanical means. The restraining forces must be substantially greater than those to which the experiment might be subjected by hydraulic, pneumatic, buoyant, or other forces which are normal to the operating environment of the experiment, or by forces which can arise as a result of credible malfunctions.

1.41 Senior Reactor Operator – An individual who is licensed to direct the activities of reactor operators. Such an individual is also a reactor operator.

1.42 Shall, should, and may – The word "shall" is used to denote a requirement; the word "should" is used to denote a recommendation; and the word "may" is used to denote permission, neither a requirement nor a recommendation.

1.43 Shutdown Margin – The shutdown margin is the minimum shutdown reactivity necessary to provide confidence that the reactor can be made subcritical by means of the control and safety systems starting from any permissible operating condition and with the most reactive rod in the most reactive position, and the nonscramable rods in their most reactive positions and that the reactor will remain subcritical without further operator action.

1.44 Surveillance and Test Intervals - These are intervals established for periodic surveillance and test actions. Established intervals shall be maintained on the average. Maximum intervals are allowed to provide operational flexibility, not to reduce frequency.

1.45 Tried Experiment - A tried experiment is:

a. An experiment previously performed in this facility, or

b. An experiment of approximately the same nuclear characteristics as an experiment previously tried. These nuclear characteristics include but are not limited to neutron activation cross-sections, absorption cross-sections, and moderating ability.

1.46 True Value -The true value of a parameter is its exact value at any instant.

1.47 Unscheduled Shutdown - An unscheduled shutdown is defined as any unplanned shutdown of the reactor by actuation of the reactor safety system, operator error, equipment malfunction, or a manual shutdown in response to conditions that could adversely affect safe operation, not including shutdowns that occur during testing or checkout operations.

1.48 Unsecured Experiment - Any experiment, experimental facility, or component of an experiment is considered to be unsecured when it is not secured as defined in this section.

2. SAFETY LIMIT AND LIMITING SAFETY SYSTEM SETTING

2.1 Safety Limit

Applicability - This specification applies to the temperature of the reactor fuel and cladding under any condition of operation.

Objective - The objective is to ensure fuel cladding integrity.

Specification – The fuel and cladding temperatures shall not exceed 530°C (986°F).

Basis – Safety limits for nuclear reactors are limits upon important process variables that are necessary to reasonably protect the integrity of certain physical barriers that guard against the uncontrolled release of radioactivity. The principal physical barrier is the fuel cladding.

In the Purdue University Reactor, the first and principal barrier protecting against release of radioactivity is the cladding of the fuel plates. The 6061 aluminum alloy cladding of the LEU fuel plates has an incipient melting temperature of 582°C. However, measurements (NUREG-1313) on irradiated fuel plates have shown that fission products are first released near the blister temperature (~550°C) of the cladding. To ensure that the blister temperature is never reached, NUREG 1537 concludes that 530°C is an acceptable fuel and cladding temperature limit not to be exceeded under any condition of operation.

2.2 Limiting Safety System Setting

Applicability - This specification applies to the reactor power level safety system setting for operation.

Objective - The objective is to assure that the safety limit is not exceeded.

Specification – The measured value of the power level scram shall be no higher than 12.0 kW.

Basis - The LSSS has been chosen to assure that the automatic reactor protective system will be actuated in such a manner as to prevent the safety limit from being exceeded during the most severe expected abnormal condition.

The function of the LSSS is to prevent the temperature of the reactor fuel and cladding from reaching the safety limit under any condition of operation. During steady-state operation, a power level of 98.6 kW is required to initiate the onset of nucleate boiling. This is far higher than the maximum power of 18 kW, which allows for 50% instrument uncertainties in measuring power level.

For the transients that were analyzed, the temperature of the fuel and cladding reach maximum temperatures of 43.20°C, assuming reactor trip at 18 kW after failure of the first trip. This temperature is far below the safety limit of 530°C.

3. LIMITING CONDITIONS FOR OPERATION

3.1 Reactivity Limits

Applicability - These specifications apply to the reactivity conditions of the reactor, and the reactivity worths of control rods and experiments

Objective - The objective is to assure that the reactor can be shut down at all times, that the safety limits will not be exceeded, and that operation is within the limits analyzed in the SAR.

Specification - The reactor shall not be operated unless the following conditions exist:

a. The shutdown margin, relative to the reference core condition with the most reactive shim rod fully withdrawn, and the regulating rod fully withdrawn shall be at least 0.010 Δk/k.

b. The reactor shall be subcritical by more than 0.03 Δk/k during core loading changes.

c. No shim-safety rod shall be removed from the core if the shutdown margin is less than 0.01 Δk/k with the remaining shim-safety rod fully withdrawn.

d. The reactor shall be shutdown if the maximum positive excess reactivity of the core and any installed experiment exceeds 0.006 Δk/k.

e. The absolute value of the reactivity worth of each experiment shall be limited as follows:

Experiment	Maximum Reactivity Worth
Movable	0.003 Δk/k
Unsecured	0.003 Δk/k
Secured	0.004 Δk/k

f. The sum of the absolute value of the total worth of all movable and unsecured experiments shall not exceed 0.003 Δk/k.

g. The sum of the absolute value of the total worth of all secured experiments shall not exceed 0.005 Δk/k.

Bases - The shutdown margin required by Specification 3.1.a assures that the reactor can be shut down from any operating condition and will remain shut down even if the control rod of the highest reactivity worth should be in the fully withdrawn position.

Specifications 3.1.b and 3.1.c provide assurance that the core will remain subcritical during loading changes and shim-safety rod maintenance or inspection.

Specification 3.1.d limits the allowable excess reactivity to the value assumed in the SAR. This limit assures that the consequences of reactivity transients will not be increased relative to transients previously reviewed, and assures reactor periods of sufficient length so that the reactor may be shutdown without exceeding the safety limit.

Specification 3.1.e limits the reactivity worth of secured experiments to values of reactivity which, if introduced as a positive step change, are calculated not to cause fuel melting. This specification also limits the reactivity worth of unsecured and movable experiments to values of reactivity which, if introduced as a positive step change, would not cause the violation of a safety limit. The manipulation of experiments worth up to 0.003 Δk/k will result in reactor periods longer than 9 seconds. These periods can be readily compensated for by the action of the safety system without exceeding any safety limits.

A limitation of 0.003 Δk/k for the total reactivity worth of all movable and unsecured experiments provides assurance that a common failure affecting all such experiments cannot result in an accident of greater consequences than the maximum credible accident analyzed in the HSR.

Specification 3.1.g along with 3.1.a assures that the reactor is capable of being shut down in the event of a positive reactivity insertion caused by the flooding of an experiment.

3.2 Reactor Safety System

Applicability - This specification applies to the reactor safety system and other safety-related instrumentation.

Objective - The objective is to specify the lowest acceptable level of performance or the minimum number of acceptable components for the reactor safety system and other safety related instrumentation.

Specification – The two shim-safeties shall not be moved more than 6 cm from the fully inserted position unless the following conditions are met:

a. The reactor safety channels and safety-related instrumentation shall be operable in accordance with Tables I and II including the minimum number of channels and the indicated maximum or minimum set points.

b. Both shim-safety rods shall be operable.

c. The time from the initiation of a scram condition in the scram circuit until both shim-safety rods reach the rod lower limit switch shall not exceed one second.

d. The pool top radiation monitor shall be capable of indicating an alarm to off-site reactor staff when a high limit is reached and the reactor has been secured. The alarm may be out of service up to thirty days. Loss of functionality beyond thirty days shall require a visual pool level inspection in intervals of 24 hours, not to exceed 30 hours.

e. Building alternating current power must be supplied to the reactor Instrumentation and Control during normal operation. Loss of power shall require immediate shutdown by the operator to be completed within an interval of 30 minutes.

TABLE I. SAFETY CHANNELS REQUIRED FOR OPERATION

Channel	Minimum Number Required	Setpoint (c)(d)	Function
Log count rate and change rate	1[a]	2 cps or greater 8 %/s or less 15 %/s or less 6 %/s sec. or less	2 cps rod withdrawal inhibit Setback Scram Rod withdrawal inhibit
Log N and change rate	1[b]	8 %/s or less 15 %/s or less 6 %/s or less 12kW, 120% Operating power level, or less	Setback Scram Rod withdrawal inhibit Scram
Linear	1	0% Selected Range, or greater 110% Selected Range or less 120% Selected Range or less	Setback Setback Scram
Safety	1[b]	11 kW, 110% Operating power level, or less 12 kW, 120% Operating power level, or less	Setback Scram
Manual Scram (console) (hallway)	 1 1		 Scram Scram

(a) Not required after Log N-Period channel comes on scale.
(b) Required to be operable but not on scale at startup.
(c) All percentage based setpoints shall be tripped when the measured value is greater than or equal to the specified value. Counts per second (cps) setpoints are at values less than or equal to the specified value. Exception: Trip point for 0% shall happen as the value goes from the positive to negative value.
(d) Setbacks shall be set such that they will be initiated prior to a Scram

TABLE II. SAFETY-RELATED CHANNELS (AREA RADIATION MONITORS)

Channel	Minimum Number Required[e]	Setpoint	Function
Pool top monitor	1	50 mR/hr, 2x full power background, or less than either	Scram
Water process	1	7 ½ mR/hr or less	Scram
Console Monitor	1	7 ½ mR/hr or less	Scram
Continuous air sampler	1	Stated on sampler	Air sampling
(e) For periods of one week or for the duration of a reactor run, a radiation monitor may be replaced by a gamma sensitive instrument which has its own alarm and is observable by the reactor operator.			

<ins>Bases</ins> - The neutron flux level scrams provide redundant automatic protective action to prevent exceeding the safety limit on reactor power, and the period scram conservatively limits the rate of rise of the reactor power to periods which are manually controllable without reaching excessive power levels or fuel temperatures.

The rod withdrawal interlock on the Log Count Rate and Period Channel assures that the operator has a measuring channel operating and indicating neutron flux levels during the approach to criticality.

The manual scram button and the "reactor on" key switch provide two methods for the reactor operator to manually shut down the reactor if an unsafe or abnormal condition should occur and the automatic reactor protection does not function.

The use of the area radiation monitors (Table II) will assure that areas of the Purdue University Reactor (PUR-1) facility in which a potential high radiation area exists are monitored. These fixed monitors initiate a scram whenever the preset alarm point is exceeded to avoid high radiation conditions as well as alert facility personnel when the reactor has been secured and an elevated radiation level exists.

Specifications 3.2.b and 3.2.c assure that the safety system response will be consistent with the assumptions used in evaluating the reactor's capability to withstand the maximum credible accident.

In specification 3.2.c. the rod lower limit switches are positioned to measure, as close as possible, the fully inserted position.

Shielding from radiation is one of the primary reasons for the pool’s level. An offsite alarm from the pool top radiation monitor alerts facility staff of a rising radiation level which must be mitigated or otherwise addressed and this is addressed in 3.2.d.

The Instrumentation and Control system is designed to be capable of performing a normal shutdown in the event of a loss of off-site power. The time period to complete this shutdown is up

to 30 minutes as that is the rating of the UPS units with a maximum power loading. Loss of off-site power starts the power draw from the UPS units which therefore starts the 30 minute timeframe.

3.3 Primary Coolant Conditions

Applicability - This specification applies to the limiting conditions for reactor operation for the primary coolant.

Objective - The objective is to assure a compatible environment, adequate shielding, and a continuous coolant path for the reactor core.

Specification –

a. The primary coolant resistivity shall be maintained at a value less than 3 $\mu Siemens$.

b. The primary coolant shall be maintained at least 13 feet above the core whenever the reactor is operating. The primary coolant shall be maintained at least 13 feet above the top of the core or at a level sufficient for the pool top radiation monitor to indicate less than 1 mRem/hour during non-operational periods.

c. The primary coolant (bulk pool volume) shall be maintained at or below $30\ °C$ while the reactor is operating.

d. The primary coolant radiation levels shall not exceed the levels for water in 10 CFR 20 Appendix B, Table 2.

Bases - Experience at the PUR-1 and other facilities has shown that the maintenance of primary coolant system water quality in the ranges specified in specification 3.3.a will minimize the amount and severity of corrosion of the aluminum components of the primary coolant system and the fuel element cladding.

The height of water in specification 3.3.b is enough to furnish adequate shielding as well as to guarantee a continuous coolant path.

Maintaining the primary coolant temperature in Specification 3.3.c will ensure the margin to the onset of nucleate boiling is maintained and analyses shown in the Safety Analysis Report remain valid.

Limiting the amount of radioactivity in the primary coolant minimizes the health risk to the public as well as to facility personnel.

3.4 Confinement

Applicability - This specification applies to the integrity of the reactor room.

Objective - The objective is to limit and control the release of airborne radioactive material from the reactor room.

Specification -

a. During reactor operation and when radioactive material is being handled with potential for airborne release, the following conditions shall be met:

1. The reactor room shall be maintained at a negative pressure of at least 0.05 inches of water with the operation of the room exhaust fan.

2. All exterior doors in the reactor room shall remain closed except as required for personnel, equipment, or materials access.

b. All inlet and exhaust air ducts and the sewer vent shall contain a HEPA filter or its equivalent.

c. Dampers in the ventilation system inlet and outlet ducts shall be capable of being closed.

d. Concentration of Ar-41 shall not exceed $2.08 \times 10^{-7}\ \mu Ci/cm^3$ at the top of the confinement exhaust stack.

Bases - The PUR- 1 does not rely on a containment building to reduce the levels of airborne radioactive material released to the environment in the event of the maximum hypothetical accident. However, in the event of such an accident, a significant fraction of the airborne material will be confined within the reactor room, and the specifications stated above will further reduce the release to the environment.

The limit on the concentration of Argon at the top of the confinement exhaust stack is the maximum theoretical concentration of the isotope and therefore a fan malfunction ventilating the room would be the only way to violate this technical specification. It is validated by the dose readings obtained through the effluent surveillances in section 4.7.

3.5 Limitations on Experiments

Applicability- This specification applies to experiments installed in the reactor and its experimental facilities.

Objective - The objective is to prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure, and to assure the safe operation of the reactor.

Specification - The reactor shall not be operated unless the following conditions are met:

a. All experiments shall be constructed of material which will be corrosion resistant for the duration of their residence in the pool.

b. All experiments and experimental procedures shall receive approval by the Committee on Reactor Operations.

c. Known explosive materials shall not be placed in the reactor pool.

d. No experiment shall be placed in the reactor or pool that interferes with the safe operation of the reactor.

e. Any failure of an experiment shall not have a consequence that could exceed dose limits as set forth in 10 CFR Part 20, as analyzed and approved by the Reactor Supervisor and the Committee on Reactor Operations.

f. A fueled experiment shall not produce more than 0.5 Curies of radio-iodine.

Bases - Specification 3.5.a through 3.5.f are intended to reduce the likelihood of damage to reactor components and/or radioactivity releases resulting from experiment failure and serve as a guide for the review and approval of new experiments by the facility personnel and the Committee on Reactor Operations.

Limiting the amount of radio-iodine levels in a fueled experiment will ensure that the Maximum Hypothetical Accident analyzed in the Safety Analysis Report remains the bounding incident which could occur at the PUR-1.

3.6 **Fuel Parameters**

Applicability- This specification applies to fuel plates installed in the reactor and in use during the previous surveillance period.

Objective - The objective is to prevent damage to the reactor or excessive release of radioactive materials in the event of a fuel cladding failure, and to assure the safe operation of the reactor.

Specification - The reactor shall only be operated when the following specifications have been met:

a. The inspection of fuel assemblies shall be performed to identify any abnormal or previously undocumented defect present on a fuel plate. These defects may include but are not limited to blistering of the cladding on the fuel plate from elevated temperatures beyond the design of the cladding, deep scratches or gouges on the plate due to debris in the coolant flowing along the face, scratches on the edges of the plate due to insertion and removal from the assembly, discoloration from the deposition of particulates within the coolant or corrosion of the plate itself.

b. The reactor shall not operate with fuel plates that have been determined to be unsound for use as outlined above in 3.6.a. These plates shall be removed from service and the manufacturer consulted to determine possible causes.

Bases – The fuel parameter Limiting Condition on Operation is intended to limit the possibility radioactivity releases resulting from fuel failure by identifying issues prior to potential release.

4. SURVEILLANCE REQUIREMENTS

4.1 Reactivity Limits

Applicability - This specification applies to the surveillance requirements for reactivity limits.

Objective - The objective is to ensure that the reactivity limits of Specification 3.1 are not exceeded.

Specification -

a. The shim-safety rod reactivity worths shall be measured and the shutdown margin calculated biennially with no interval to exceed 2½ years and whenever a core configuration is loaded for which shim-safety rod worths have not been measured. This may be deferred with CORO approval during any extended reactor shutdown. Additionally, if a new rod is used, its worth must be measured on the first start-up following installation. In the case of a deferred measurement, the measurement must be performed prior to resuming routine reactor operations.

b. The shim-safety rods shall be visually inspected biennially with no interval to exceed 2½ years, which may be deferred with CORO approval during any reactor shutdown. If the rod is found to be deteriorated, it shall be replaced with a rod of approximately equivalent or greater worth, meeting the limiting conditions of operation specified in 3.1. In the case of a deferred measurement, the measurement must be performed prior to resuming routine reactor operations.

c. The reactivity worth of experiments placed in the PUR-1 shall be measured during the first startup subsequent to the experiment's insertion and shall be verified if core configuration changes cause increases in experiment reactivity worth which may cause the experiment worth to exceed the values specified in Specification 3.1

Bases - Specification 4.1.a will assure that shim-safety rod reactivity worths are not degraded or changed by core manipulations which cause these rods to operate in regions where their effectiveness is reduced.

The boron stainless steel shim-safety rods have been in use at the PUR-1 since 1962, and over this period of time, no cracks or other evidence of deterioration have been observed. Based on this performance and the experience of other facilities using similar shim-safety rods, the specified inspection times are considered adequate to assure that the control rods will not fail.

4.2 Reactor Safety System

Applicability - This specification applies to the surveillance of the reactor safety system.

Objective - The objective is to assure that the reactor safety system is operable as required by Specification 3.2

Specification -

a. A channel calibration of the reactor safety channels as described in Table I shall be performed as follows:

   1. An electronic calibration shall be performed annually, with no interval to exceed 15 months. The electronic calibration may be deferred with CORO approval during periods of reactor shutdown, but shall be performed prior to startup.

   2. A power calibration by foil activation shall be performed annually, with no interval to exceed 15 months. The power calibration may be deferred with CORO approval during periods of reactor shutdown, but shall be performed prior to startup.

   3. An electronic calibration shall be performed following replacement, repair, or modification of components impacting Channels in Table I.

b. A channel check on the radiation monitoring equipment shall be completed daily during periods when the reactor is in operation. Calibration of the Safety-Related Channels specified in Table II and hand held radiation survey instruments shall be performed annually, with no interval to exceed 15 months. Calibration may be deferred with CORO approval during periods of reactor shutdown, but shall be performed prior to startup.

c. Shim-safety rod drop times shall be measured annually, with no measurement's interval to exceed 15 months. These drop times shall also be measured prior to operation following maintenance which could affect the drop time or cause movement of the shim-safety rod control assembly. Drop times may be deferred with CORO approval during periods of reactor shutdown, but shall be performed prior to startup.

d. A channel check of each of the Scram capabilities specified in Table I shall be performed prior to each day's startup.

e. A channel check of the pool top radiation monitoring equipment's off-site alarm capability shall be done biannually, not to exceed 7 ½ months.

f. A simulated loss of off-site power shall be performed annually with no interval to exceed 15 months to verify the UPS units are capable of providing Instrumentation and Control power for at least 30 minutes.

<u>Bases</u> - A test of the safety system channels prior to each startup will assure their operability, and annual calibration will detect any long-term drift that is not detected by normal intercomparison of channels. The channel check of the neutron flux level channel will assure that changes in core-to-detector geometry or operating conditions will not cause undetected changes in the response of the measuring channels.

Area monitors will give a clear indication when they are not operating correctly. In addition, the operator routinely records the readings of these monitors and will be aware of any reading which indicates loss of function.

The area monitoring system employed at the PUR-1 has exhibited very good stability over its lifetime, and annual calibration is considered adequate to correct long-term drift.

The measured drop times of the shim-safety rods have been consistent since the PUR-1 was built. An annual check of this parameter is considered adequate to detect operation with materially changed drop times. Binding or rubbing caused by rod misalignment could result from maintenance; therefore, drop times will be checked after such maintenance.

A daily check of the scram functionality ensures functionality of the system.

Annual checks of the UPS unit functionality will verify the UPS units are capable of providing power for at least 30 minutes. Changes in battery functionality are expected to be nominal over a period of several years. Therefore the frequency of an annual check is sufficient to verify operability of the controlled shutdown condition during loss of off-site power.

4.3 Primary Coolant System

Applicability - This specification applies to the average surveillance schedules of the primary coolant system.

Objective - The objective is to assure high quality pool water, adequate shielding, and to detect the release of fission products from fuel elements.

Specification -

a. The conductivity of the primary coolant shall be recorded monthly, not to exceed six weeks. This cannot be deferred during reactor shutdown.

b. The primary coolant shall be sampled monthly, not to exceed six weeks, and analyzed for gross alpha and beta activity. This cannot be deferred during reactor shutdown.

c. During reactor shutdown, the primary coolant level or radiation level shall be monitored monthly with an interval not to exceed six weeks. Primary coolant height shall be measured prior to reactor operation.

d. The Primary Coolant temperature shall be recorded in the log book at no interval to exceed four hours if any shim-safety or regulating rod is at a height greater than 6 cm.

Bases - Monthly surveillance of pool water quality provides assurance conductivity changes will be detected before significant corrosive damage could occur.

When the reactor pool water is at a height of 13 feet above the core, adequate shielding during operations is assured. Experience has shown that approximately 35-40 gallons of water will evaporate weekly and weekly water make-up is sufficient to maintain the reactor pool water height. Analysis has shown radiation levels to remain sufficiently low with excessive water loss during non-operational periods.

Analysis of the reactor water for gross alpha and beta activity assures against undetected leaking fuel assemblies.

4.4 **Confinement**

Applicability - This specification applies to the surveillance requirements for maintaining the integrity of the reactor room and fuel clad.

Objective - The objective is to assure that the integrity of the reactor room and the fuel clad is maintained, by specifying average surveillance intervals.

Specification -

a. The negative pressure of the reactor room shall be recorded weekly.

b. Operation of the inlet and outlet dampers shall be checked semiannually, with no interval to exceed 7 1/2 months.

c. Operation of the air conditioner shall be checked semiannually, with no interval to exceed 7 1/2 months.

Bases - Specification a, b, and c check the integrity of the reactor room. Based upon past experience these intervals have been shown to be adequate for ensuring the operation of the systems affecting the integrity of the reactor room.

4.5 **Experiments**

Applicability - This specification applies to the surveillance of limitations on experiments.

Objective – To assure compliance with the provision of the utilization license, the Technical Specifications, and 10 CFR Parts 20 and 50.

Specification – No experiments shall be performed unless:

a. It is a tried experiment.

b. The experiment has been properly reviewed and approved according to Section 6 of the technical specifications.

    1. Proposed experiments shall be approved by the Committee on Reactor Operations

    2. Submitted proposed experiments shall provide a comprehensive list of steps to be performed, quantities to be measured, hazards to be considered, limiting initial conditions of the reactor, and required available personnel.

Bases - The basis for this specification is to ensure the safety of the reactor and associated components, personnel, and the public by verification of proper review and approval of experiments as specified in Section 6 of these technical specifications.

4.6 **Fuel Parameters**

Applicability - This specification applies to the surveillance requirements for fuel integrity.

Objective - The objective is to assure that the fuel clad remains unblemished and there has been no release of radioactivity to the reactor coolant or facility.

Specification - Representative fuel plates shall be inspected annually, with no interval to exceed 15 months through visual inspection of the assembly. Representative is set forth to mean at least one plate from the assembly expected to have the highest burn as well as a plate from one of the 12 remaining, non-control assemblies.

Bases - Specification 4.6 will ensure reactor fuel integrity is not compromised. The inspection period is set forth to verify the integrity of the fuel cladding thereby ensuring there are no unexpected releases of fission products exposing facility workers or members of the public. Inspection of an assembly from the highest power region (as outlined in the PUR-1 SAR) ensures those plates under the largest thermal stress are considered. Inspection of another assembly ensures that a single plate passing inspection does not provide a single false negative data point representing the entire core. Non-control assemblies are chosen to inhibit undue burden on the facility.

4.7 Effluents

Applicability - This specification applies to the surveillance requirements for radioactive effluents which may leave the facility through the confinement system.

Objective - The objective is to assure requirements set forth in 10 CFR 20.110(d) and 10 CFR 20.1301 are not exceeded and public safety is maintained.

Specification –

a. Dosimetry shall be placed at the following locations

   1. The location inside the reactor room which represents the hypothetical minimum distance a member of the public could reach to the reactor pool.

   2. At the exhaust location of the reactor facility which is representative of effluent release from the reactor facility.

b. Dosimetry shall be changed out according to the guidance of the Purdue Radiological Management on the same time period as facility personnel or semiannually, not to exceed 7 ½ months, whichever is lesser.

Bases - Specification 4.7 will ensure that the dose given to member of the public is measured to be below those set forth in 10 CFR 20.110(d) and 10 CFR 20.1301.

5. DESIGN FEATURES

5.1 Site Description

Applicability – This specification applies to the general design and areas under which the PUR-1 Technical Specifications shall have jurisdiction.

Objective – This section is to clarify those areas which are involved with the PUR-1 Facility.

Specifications –

a. The reactor shall be located on the ground floor of the Duncan Annex of the Electrical Engineering Building, Purdue University, West Lafayette, Indiana.

b. The School of Nuclear Engineering shall control approximately 5000 square feet of the Duncan Annex ground floor, which includes the reactor room. Access to the Nuclear Engineering controlled area shall be restricted except when classes are held there.

c. The licensed areas shall include the reactor room, and a fuel storage room. Both of these areas shall be restricted to authorized personnel, or those escorted by authorized personnel.

d. The reactor room shall remain locked at all times except for the entry or exit of authorized personnel or those escorted by authorized personnel, equipment, or materials.

e. The PUR-1 reactor room shall be a closed room designed to restrict leakage.

f. The minimum free volume of the reactor room shall be approximately 15,000 cubic feet.

g. The ventilation system shall be designed to exhaust air or other gases from the reactor room through an exhaust vent at a minimum of 50 feet above the ground.

h. Openings into the reactor room shall consist of no more than the following:

   1. Three personnel doors
   2. One door to a storage room with no outside access.
   3. Air intake
   4. Air exhaust
   5. Sewer vent

Bases

The bases for the above specifications are the naming of the buildings, city and state at the time of the enactment of this amendment to the PUR-1 Technical Specifications. The access to the restricted areas is controlled to inhibit the removal of materials, information, or other import aspects of the facility to maintain confidence in safe operation under which the Safety Analysis was completed.

The volume of the reactor room and its leakage properties are so set forth to further ensure safety to facility workers and the general public is maintained during all operational circumstances.

5.2 Reactor Coolant System

Applicability – This specification outlines the make-up and properties of the PUR-1 Reactor Coolant System.

Objective – By outlining the systems which are required to be in place during operations, the validity of the Safety Analysis Report calculations is ensured.

Specifications -

a. Primary Cooling System – The PUR-1 primary cooling system shall be a pool containing approximately 6,400 gallons of water.

b. Process Water System – The process water system shall be assembled in one unit and contain a pump, filter, demineralizer, valves, flow meters, and a heat exchanger (see 5.2.d). The demineralizer shall contain a removable cartridge that is monitored continuously for radioactivity buildup.

c. Primary Coolant Makeup Water System – Makeup water for the pool shall be taken batchwise from the Purdue University water line and passed through the demineralizer enroute to the pool. A vacuum breaker shall exclude any possibility of siphoning pool water into the supply line. The pool makeup water system, in addition to the demineralizer, also shall include a normally closed manual shutoff and throttle valve and a check valve.

d. Primary Coolant Chiller System – The chiller shall be designed with three loops. Pool water shall pass through the primary loop, a Freon refrigerant in the secondary loop, and water from the building water supply shall be used to remove heat, which shall then be discharged to the building sewer system. The heat-removal capacity of the heat exchanger shall be 10.5 kW or greater.

Bases – The basis of having a reactor pool with the listed volume is to ensure there is an adequate cooling path for the PUR-1 core as well as providing a shield to direct shine from the reactor's standard operation. The make-up water to the pool has a set of processing and monitoring equipment to ensure the long-term operation of the facility and fuel integrity by suppressing corrosion and other effects due to submersion in water. This system shall limit, by the use of filters and ion-exchange resin, the aluminum corrosion rate, corrosion product buildup, and neutron activation of impurities in the coolant.

The chiller system must maintain the reactor pool temperature to be lower than the specified value while operating to ensure the margin to the onset of nucleate boiling does not go beyond the values determined in the PUR-1 Safety Analysis Report. It shall be capable of maintain the reactor pool temperature at or below $30°C$ during steady state operation at 10 kW.

5.3 Reactor Core and Fuel

Applicability – This specification outlines the limits on the design and loading of the PUR-1 Core.

Objective – The standard loading, fuel type, and inspection period is given to ensure the shutdown margin, accident analysis, and operational characteristics are maintained and remain valid.

Specifications -

a. The fuel assemblies shall be MTR type consisting of U_3Si_2-Al, 6061 Aluminum clad plates enriched up to 20% in the U-235 isotope.

b. A standard fuel assembly shall consist of up to 14 fuel plates containing a maximum of 180 grams of U-235.

c. A control fuel assembly shall consist of up to 8 fuel plates containing a maximum of 103 grams of U-235.

d. Partially loaded fuel assemblies in which some of the fuel plates are replaced by aluminum plates containing no uranium may be used.

e. The core configuration shall consist of 13 standard fuel assemblies as described in b, and 3 control fuel assemblies as described in c.

f. The core shall include two shim-safety rods and one regulating rod placed within a control assembly. The two shim-safeties shall be made of solid borated 304 stainless steel. The Regulating Rod shall be stainless steel in composition. Each control blade shall be protected by an aluminum guide plate on each side within the control fuel assemblies.

Bases – The basis of enriching the MTR fuel up to 20% is to allow a core loading compact enough to fit within existing structures as well as to continue historic operations with approximately the same reactor characteristics while keeping the strategic significance of the material as low as possible.

Limiting the amount of grams of U-235 in each plate and assembly keeps the expected shutdown margin and accident analyses valid.

Those types of fuel plate defects listed in the specification have been exhibited in other facilities but the inspector should be cognizant of any change in plate appearance. Changes in cladding appearance may be indicative of larger issues within the core and be precursors to failure of cladding integrity.

5.4 Fuel Storage

Applicability – The specification for fuel storage shall apply to the placement of fuel when it is not in the core configuration.

Objective – Ensuring that fuel outside of the highly analyzed reactor core does not go critical is desirable to maintain safety to facility workers and members of the public.

Specifications -

a. All reactor fuel and fueled devices shall be stored in a geometric array where k_{eff} is less than 0.8 for all conditions of moderation and reflection.

b. Irradiated fuel assemblies and fueled devices shall be stored in an array which will permit sufficient natural convection cooling by water or air such that the fuel integrity is maintained per the Safety Analysis Report.

Bases - The requirement to store fuel in such a way that the k_{eff} is less than 0.8 will be adequate to provide reasonable certainly that an accidental criticality event is not possible.

Placing fuel in an array which allows for adequate cooling will ensure that those elements which have experienced high burnup and have elevated levels of decay heat do not undergo loss of cladding integrity by blistering or other means due to high temperature.

6. ADMINISTRATIVE CONTROLS

6.1 Organization

The PUR-1 Facility is managed and run by members of the university's College of Engineering, specifically the School of Nuclear Engineering. The Dean of the College of Engineering shall be the final authority on all PUR-1 matters. The Laboratory Director is responsible to the Dean for the administration and proper and safe operation of the facility. Figure 6.1 shows the administration chart for the PUR-1. The Committee on Reactor Operations advises the director of the PUR-1 on all matters or policy pertaining to safety. The Radiological Safety Officer provides advice concerning personnel and radiological safety and provides technical assistance and review in the area of radiation protection.

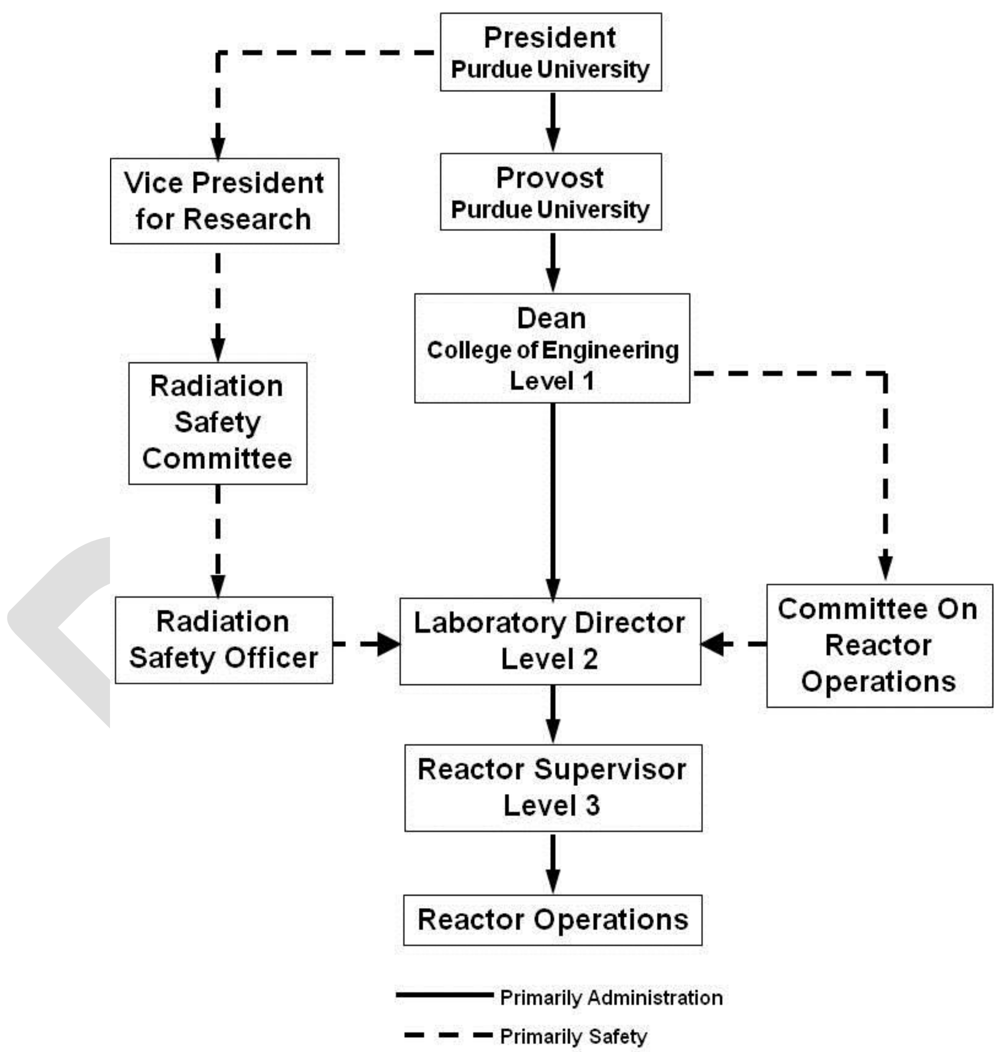

Figure 6.1: Organization Chart for Reactor Administration

a. Structure

1. A line management organizational structure provides for personnel who shall administrate and operate the reactor facility.

2. The Dean and the Facility Director shall have line management responsibility for adhering to the PUR-1 license and Technical Specifications and for safeguarding the public and facility personnel from undue radiation exposure.

3. Management Levels:

   a) Level 1: Dean of the College of Engineering: Responsible for the PUR-1.

   b) Level 2: PUR-1 Facility Director: Responsible for reactor facility operation and shall report to Level 1.

   c) Level 3: Reactor Supervisor: Responsible for the day-to-day operation of the PUR-1 including shift operation and shall report to Level 2.

   d) Level 4: Reactor Operating Staff: Licensed reactor operators and senior reactor operators and trainees. These individuals shall report to Level 3.

   e) The reporting structure of Figure 6.1 is such that those personnel below shall report up and those personnel listed above may communicate down.

4. Committee on Reactor Operations (CORO):

   The CORO shall be responsible to the licensee for providing an independent review and audit of the safety aspects of the PUR-1.

b. Responsibility

Responsibility for the safe operation of the reactor facility shall be in accordance with the line organization established in Section 6.1.a. In all instances, responsibilities of one level may be assumed by designated alternates or by higher levels, conditional upon appropriate qualifications.

The reactor facility shall be under the direct control of the Reactor Supervisor, a Senior Reactor Operator, or Reactor Operator (RO). The RO shall be responsible for ensuring that all operations are conducted in a safe manner and within the limits prescribed by the facility license, procedures and requirements of the Radiation Safety Officer and the CORO.

c. Staffing

1. The minimum staffing when the reactor is not secured shall be as follows:

a) At least two individuals shall be present at the facility complex and shall consist of at least a licensed reactor operator and a second person capable of calling 911. Unexpected absence for as long as 2 hours to accommodate a personal emergency are acceptable provided immediate action is taken to obtain a replacement. During periods when the reactor is not secured, it shall be under the direct control the of the reactor operator;

b) During periods of reactor maintenance the two individuals who shall be present at the facility complex shall consist of a licensed senior reactor operator and a second individual capable of calling 911.

c) A licensed reactor operator or senior reactor operator shall be in the reactor room;

d) A Senior Reactor Operator shall be readily available for emergencies or on call (the individual can be rapidly reached by phone or radio and is within 30 minutes or 15 miles of the reactor facility); and

e) A list of reactor facility personnel by name and telephone number shall be readily available for use in the reactor room. The list shall include:

   i. Senior Reactor Operator on Call,
   ii. Radiation Safety Officer
   iii. Other operations personnel, as deemed by the Facility Director

2. Events requiring the presence at the facility of the senior reactor operator:

   a) Initial startup and approach to power,

   b) A Senior Reactor Operator shall direct any loading or unloading of fuel or control rods within the reactor core region,

   c) A senior reactor operator shall direct the recovery from an unplanned shutdown, unscheduled shutdown, or unplanned power reduction of more than 5%.

d. Selection and Training of Personnel

The selection and training of operations personnel shall be in accordance with the following:

1. Responsibility: The Reactor Supervisor is responsible for the selection, training, and requalification of the facility reactor operators and senior reactor operators.

2. Selection: The selection of operations personnel shall be consistent with the standards related to selection in ANSI/ANS-15.4-2007

3. Training Program: The Training Program shall be consistent with the standards related to training in ANSI/ANS-15.4-2007.

4. Requalification Program: The Requalification Program shall be consistent with the standards related to requalification in ANSI/ANS-15.4-2007.

6.2 Review and Audit

a. Committee on Reactor Operations (CORO)

The CORO shall be comprised of at least 3 voting members knowledgeable in fields which relate to Nuclear Safety. One of these members, the Radiation Safety Officer, will serve as the Chair. If the Chair is unable to attend one or a number of committee meetings, then the Chair may designate a committee member as Chair *pro tem*. The members are appointed by the Dean of the College of Engineering to serve three year terms. It is expected that the members will be reappointed each term as long as they are willing to serve so that their experience and familiarity with the past history of the PUR-1 will not be lost to the committee.

b. CORO Charter and Rules

The operations of the CORO shall be in accordance with a written charter, including provisions for:

1. Meeting Frequency: The CORO shall meet annually at intervals not to exceed 15 months. (Note: The facility license requires a meeting at least once per year and as frequently as circumstances warrant consistent with effective monitoring of facility activities);

2. Quorum: A quorum shall be comprised of not less than one-half of the voting membership where the operating staff does not constitute a majority;

3. Voting Rules: On matters requiring a vote, if only a quorum is present a unanimous vote of the quorum shall be required; otherwise a majority vote shall be required;

4. Subcommittees: The Chair may appoint subcommittees comprised of members of the CORO to perform certain tasks. Subcommittees or members of the CORO may be authorized to act for the committee; and

5. Meeting Minutes: The Chair shall designate one individual to act as recording secretary. It shall be the responsibility of the secretary to prepare the minutes which shall be distributed to the CORO, including the Dean of the College of Engineering, within three months. The CORO shall review and approve the minutes of the previous meetings. A complete file of the meeting minutes shall be maintained by the Chair of the CORO and by the Facility Director.

c. CORO Review Function

The review responsibilities of the CORO or a designated subcommittee shall include, but are not limited to the following:

1. Review and evaluation of determinations of whether new tests or experiments and proposed changes to equipment, systems, or procedures can be made under 10 CFR 50.59 or would require a change in Technical Specifications or license conditions;

2. Review of new procedures, major revisions of procedures, and proposed changes in reactor facility equipment or systems which have significant safety impact to reactor operations;

3. Review of new experiments or classes of experiments that could affect reactivity or result in the release of radioactivity;

4. Review of proposed changes to the Technical Specifications and U.S. NRC issued license;

5. Review of the PUR-1 radiation protection program;

6. Review of violations of Technical Specifications, U.S. NRC issued license, and violations of internal procedures or instructions having safety significance;

7. Review of operating abnormalities having safety significance;

8. Review of reportable occurrences listed in Section 6.6.a and 6.6.b of these Technical Specifications; and

9. Review of audit reports.

d. CORO Audit Function

The audit function shall include selective (but comprehensive) examination of operating records, logs, and other documents. Discussions with cognizant personnel and observation of operations should be used also as appropriate. In no case shall the individual immediately responsible for an area perform an audit in that area. Audits shall include but are not limited to the following:

1. Facility operations, including radiation protection, for conformance to the Technical Specifications, applicable license conditions, and standard operating procedures: at least every 12 months (interval between audits not to exceed 15 months);

2. The results of action taken to correct those deficiencies that may occur in the reactor facility equipment systems, structures, or methods of operations that affect reactor safety: at least once every 12 months (interval between audits not to exceed 15 months);

3. The retraining and requalification program for the operating staff: at least once every other calendar year (interval between audits not to exceed 30 months);

4. The reactor facility emergency plan and implementing procedures: at least once

every other calendar year (interval between audits not to exceed 30 months); and

5. The reactor facility security plan and implementing procedures: at least once every other calendar year (interval between audits not to exceed 30 months).

   Deficiencies uncovered that affect reactor safety shall immediately be reported to the Dean of the College of Engineering (Level 1 Management). A written report of the findings of the audit shall be submitted to the Dean of the College of Engineering (Level 1 Management) and the review and audit group members within 3 months after the audit has been completed.

e. Audit of ALARA Program

The Chair of the CORO or designated alternate (excluding anyone whose normal job function is within the operating staff) shall conduct an audit of the reactor facility ALARA program annually. The auditor shall transmit the results of the audit to the CORO at the next scheduled meeting for its review and approval.

6.3 Radiation Safety

The Radiation Safety Officer shall be responsible for implementing the radiation safety program for the PUR-1. The requirements of the radiation safety program are established in 10 CFR 20. The Program should use the guidelines of the ANSI/ANS-15.11-1993; R2004, "Radiation Protection at Research Reactor Facilities."

6.4 Procedures

Written operating procedures shall be prepared, reviewed, and approved before initiating any of the activities listed in this section. The procedures shall be reviewed and approved by the Facility Director, the CORO, and shall be documented in a timely manner. Procedures shall be adequate to ensure the safe operation of the reactor but shall not preclude the use of independent judgment and action should the situation require such. Operating procedures shall be used for the following items:

a. Startup, operation, and shutdown of the reactor;

b. Fuel loading, unloading, and movement within the reactor;

c. Control rod removal or replacement;

d. Routine maintenance of the control rod, drives and reactor safety and interlock systems or other routine maintenance of major components of systems that could have an effect on reactor safety;

e. Surveillance checks, calibrations, and inspections of reactor instrumentation and controls, control rod drives, area radiation monitors, facility air monitors, the central exhaust system and other systems as required by the Technical Specifications;

f. Administrative controls for operations, maintenance, and conduct of irradiations and experiments, that could affect reactor safety or core reactivity;

g. Implementation of required plans such as emergency or security plans;

h. Radiation protection program to maintain exposures and releases as low as reasonably achievable (ALARA);

i. Use, receipt, and transfer of by-product material, if appropriate; and

j. Surveillance procedures for shipping radioactive materials.

6.5 Experiment Review and Approval

Approved experiments shall be carried out in accordance with established and approved procedures.

a. All new experiments or class of experiments shall be reviewed by the CORO as required by TS 6.2.c and implementation approved in writing by the Facility Director or designated alternate.

b. Substantive changes to previously approved experiments shall be made only after review by the CORO and implementation approved in writing by the Facility Director or designated alternate.

6.6 Required Actions

a. Action to be Taken in the Event of a Safety Limit Violation

1. The reactor shall be shut down and reactor operation shall not be resumed until authorized by the U.S. NRC;

2. An immediate notification of the occurrence shall be made to the CORO Chair and the Facility Director, and reports shall be made to the U.S. NRC in accordance with Section 6.7.b of these specifications; and

3. A report shall be prepared which shall include:

    a) Applicable circumstances leading to the violation including, when known, the cause and contributing factors,

    b) Effect of the violation upon reactor facility components, systems, or structures and on the health and safety of personnel and the public,

    c) Corrective action to be taken to prevent recurrence.

This report shall be submitted to the CORO for review and then submitted to the U.S. NRC when authorization is sought to resume operation of the reactor.

b. Action to be Taken in the Event of a Reportable Occurrence Other Than A Safety Limit Violation

1. PUR-1 staff shall return the reactor to normal operating via the approved PUR-1 procedure or shut down conditions. If it is necessary to shut down the reactor to correct the occurrence, operations shall not be resumed unless authorized by the Facility Director or a designated alternate;

2. The Facility Director or designated alternate shall be notified and corrective action taken with respect to the operations involved;

3. The Facility Director or designated alternate shall notify the CORO Chair who shall arrange for a review by the CORO;

4. A report shall be made to the CORO which shall include an analysis of the cause of the occurrence, efficacy of corrective action, and recommendations for measures to prevent or reduce the probability of recurrence; and

5. A report shall be made to the U.S. NRC in accordance with Section 6.7.b of these specifications.

6.7 Reports

a. Annual Operating Report

An annual report covering the operation of the reactor facility during the previous calendar year shall be submitted to the NRC before March 31 of each year providing the following information:

1. A narrative summary of (1) reactor operating experience (including experiments performed), (2) changes in facility design, performance characteristics, and operating procedures related to reactor safety and occurring during the reporting period, and (3) results of surveillance tests and inspections;

2. Tabulation of the energy output of the reactor, hours reactor was critical, and the cumulative total energy output since initial criticality;

3. The number of unscheduled shutdowns and inadvertent scrams, including, where applicable corrective action to preclude recurrence;

4. Discussion of the major maintenance operations performed during the period, including the effect, if any, on the safety of the operation of the reactor and the reasons for any corrective maintenance required;

5. A brief description, including a summary of the safety evaluations of changes in the facility or in procedures and of tests and experiments carried out pursuant to Section 50.59 of 10 CFR Part 50;

6. A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee as measured at or before the point of such release or discharge. The summary shall include to the extent practicable an estimate of individual radionuclides present in the effluent. If the estimated average release after dilution or diffusion is less than 25% of the concentration allowed or recommended, a statement to this effect is sufficient:

   a) Liquid Waste (summarized on a monthly basis)

      i. Radioactivity discharged during the reporting period.

         I. Total radioactivity released (in Curies),

         II. The effluent concentration used and the isotopic composition if greater than 1×10^{-7} μCi/cc for fission and activation products,

         III. Total radioactivity (in Curies), released by nuclide during the reporting period based on representative isotopic analysis, and

         IV. Average concentration at point of release (in μCi/cc) during the reporting period.

      ii. Total volume (in gallons) of effluent water (including dilution) during periods of release.

   b) Airborne Waste (summarized on a monthly basis)

      i. Radioactivity discharged during the reporting period (in Curies) for:

         I. ^{41}Ar, and

         II. Particulates with half-lives greater than eight days.

   c) Solid Waste

      i. The total amount of solid waste transferred (in cubic feet),

      ii. The total activity involved (in Curies), and

      iii. The dates of shipment and disposition (if shipped off site).

7. A summary of radiation exposures received by facility personnel and visitors, including dates and time where such exposures are greater than 25% of that allowed or recommended; and

8. A description and summary of any environmental surveys performed outside the facility.

b. Special Reports

In addition to the requirements of applicable regulations, reports shall be made to the NRC Document Control Desk and special telephone reports of events should be made to the Operations Center as follows:

1. There shall be a report not later than the following working day by telephone and confirmed in writing by fax or similar conveyance to the NRC Headquarters Operation Center, and followed by a written report that describes the circumstances of the event and sent within 14 days to the U.S. Nuclear Regulatory Commission, Attn: Document Control Desk, Washington, DC 20555, of any of the following:

   a) Violation of safety limit (see TS 6.6.a);

   b) Any release of radioactivity from the site above allowed limits; and

   c) Any of the following:

      i. Operation with actual safety system settings for required systems less conservative than the limiting safety system settings specified in the technical specifications.

      ii. Operation in violation of limiting conditions for operation established in the technical specifications.

      iii. A reactor safety system component malfunction that renders or could render the reactor safety system incapable of performing its intended safety function. If the malfunction or condition is caused by maintenance, then no report is required.

      Note: Where components or systems are provided in addition to those required by the technical specifications, the failure of the extra components or systems is not considered reportable provided that the minimum numbers of components or systems specified or required perform their intended reactor safety function.

      iv. An unanticipated or uncontrolled change in reactivity greater than $0.006\ \Delta k/k$.

      v. Abnormal and significant degradation in reactor fuel or cladding, or both, coolant boundary, or confinement boundary (excluding minor leaks).

      vi. An observed inadequacy in the implementation of administrative or procedural controls such that the inadequacy causes or could have caused the existence or development of an unsafe condition with regard to reactor operations.

2. A written report within 30 days to the U.S. Nuclear Regulatory Commission, Attn: Document Control Desk, Washington, DC, 20555, of:

   a) Permanent changes in the facility organization involving Level 1 and Level 2; and

   b) Significant changes in the transient or accident analysis as described in the Safety Analysis Report.

6.8 Records

Records of facility operations in the form of logs, data sheets, or other suitable forms shall be retained for the period indicated as follows:

a. Records to be Retained for a Period of at Least Five Years or for the Life of the Component Involved if Less Than Five Years

   1. Normal reactor facility operation (but not including supporting documents such as checklists, log sheets, etc. which shall be maintained for a period of at least one year),

   2. Principal maintenance operations,

   3. Reportable occurrences,

   4. Surveillance activities required by the Technical Specifications,

   5. Reactor facility radiation and contamination surveys where required by applicable regulations,

   6. Experiments performed with the reactor,

   7. Fuel inventories, receipts, and shipments,

   8. Approved changes in operating procedures, and

   9. Records of meeting and audit reports of the CORO.

b. Records to be Retained for at Least One Certification Cycle

   Records of retraining and requalification of licensed operations personnel shall be maintained at all times the individual is employed or until the license is renewed.

c. Records to be Retained for the Lifetime of the Reactor Facility

   1. Gaseous and liquid radioactive effluents released to the environs,

   2. Radiation exposure for all personnel monitored,

   3. Drawings of the reactor facility, and

4. Reviews and reports pertaining to a violation of the safety limit, the limiting safety system setting, or a limiting condition of operation.

Purdue University

Research Reactor

PUR-1

Reactor Protection / Control System

HMI Functions Software

Revision 4

December 2016

Document - PUR1-SRS-SDD-002

Nuclear Division

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Revisions

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1 INTRODUCTION

1.1 Purpose

This Software Requirements Specification and Software Design Description (SRS/SDD) document provides the functional requirements and design for the Purdue University, PUR-1 Research Reactor, Reactor Control System (RCS) HMI Functions Software. The HMI Functions Software provides a variety of HMI display capabilities on the Reactor Operator Console Display Workstation. This document describes the displays, any display calculations that are used with the display screens, operator actions and the basic function and organization of display screens.

The SRS section of the document (Section 1 – 3) describes in detail all data inputs and outputs, annunciation, control functions, human-machine interfacing and other information pertinent to the proper and valid operation of the RCS software. It is an expansion of the system functional requirements specified in the Functional Requirements Specification (FRS), Reference 5.

The SDD section of the document (Section 4) describes in detail the composition of algorithms and functional logic that make up the RCS software that implements the requirements. The RCS software must satisfy all requirements from the SRS and so all requirements from the SRS section may be traced to implementation in the SDD section.

1.2 Definitions, Acronyms and Abbreviations

1.2.1 Definitions

House Alarm	Site evacuation
Class 0 Alarm	Reactor Room Evacuation
Class 1 Alarm	Annunciator alarm from console
Class 2 Alarm	Alarm which does not activate the annunciator and only appears in the RCS Alarm Summary display screen.
Display	The Digital R*TIME display screen arrangement of data.
Gang Insert / Gang Lower	Simultaneous insertion of Shim Safety Rod #1, Shim Safety Rod #2 and the Regulating Rod using the drive motors.
PUR-1	Purdue University Research Reactor Number One
R*TIME	R*TIME Server and R*TIME Viewer software functioning as an integrated system.
R*TIME Server	Portion of the R*TIME software that operates on a server computer. This portion of the R*TIME software collects and archives data, performs alarming and calculations and makes the data available to display workstation users executing the R*TIME Viewer software.
R*TIME Viewer	Portion of the R*TIME software that runs on the personal computer based display workstation. This program displays selected data and handles almost all of the user interactions.
Reactor SCRAM / Reactor Trip	Insertion of Shim Safety Rod #1 and Shim Safety Rod #2 by removing power to the drive coupler magnets causing the control rods to insert into the reactor core via the force of gravity.
Reactor Setback	Automatic Gang Lower action initiated by the Reactor Control System when any Setback signal is active.
Reactor Operator	Individual licensed to control a nuclear reactor from a control panel within regulatory requirements.
RTP NetArrays	Portion of the RTP NetSuite software that runs on the RTP 3000 I/O Controllers. This program implements the control algorithms for the RPCS system.
Senior Reactor Operator	Individual licensed to control a nuclear reactor from a control panel within regulatory requirements and perform fuel alterations within the reactor vessel among other duties, responsibilities, and actions.

Authorized by law to depart from regulations during emergencies.

GOOD	An R*TIME quality indication of good results.
SUSPECT	An R*TIME quality indication of “not all inputs good”.
BAD	An R*TIME quality indication of abnormal and non-calculated results.
SDZTIME	An R*TIME database point containing the current GMT time of the R*TIME Server.
POOR	An R*TIME quality indication of “conflicting values”. Is used to indicate that the quality of both redundant inputs is good but the value of the redundant inputs does not agree numerically within a specified tolerance.
DAS_BAD	An R*TIME quality indication that all inputs are not good. Is used to indicate that both redundant inputs have an I/O error.

1.2.2 Acronyms and Abbreviations

ASI	Analog Signal Input (also referred to as AI)
ASO	Analog Signal Output (also referred to as AO)
CAM	Continuous Air Monitor
COS	Change of State (synonym for SOE)
CR	Control Rod (includes SS1, SS2 and RR)
CVT	Current Value Table
DAS	Data Acquisition System
DSI	Digital Signal Input (also referred to as DI)
DSO	Digital Signal Output (also referred to as DO)
DOE	Department of Energy
EMI/RFI	Electromagnetic Interference/Radio Frequency Interference
EU	Engineering Units
FC	Fission Chamber Drive
GUI	Graphical User Interface
HDD	Hardware Design Document
HMI	Human-Machine Interface
HVAC	Heating, Ventilation, Air Conditioning
ICD	Instrument Configuration Document
I/O	Input/Output
IEEE	Institute of Electrical and Electronic Engineers
kW	Kilowatt
mA	Milliampere
mR/hr	milliRem per hour

MTR	Materials Test Reactor
mV	Millivolt
NFMS	Neutron Flux Monitoring System
NS	Neutron Source Drive
PCS	Power Conditioning System
PDU	Power Distribution Unit
RAM	Radiation Area Monitor
RCS	Reactor Control System
RDS	Rod Drive System
RMS	Radiation Monitoring System
RO	Reactor Operator
ROC	Reactor Operator Console
RR	Regulating Rod Drive
RPS	Reactor Protection System
RPCS	Reactor Protection / Control System
RTD	Resistance Temperature Detector
RWMS	Reactor Water & Makeup System
RWS	ROC Workstation
SDD	Software Design Description
SOE	Sequence of Events (synonym for COS)
SOP	Standard Operating Procedure
SRS	Software Requirement Specification
SS1	Shim Safety Rod #1 Drive
SS2	Shim Safety Rod #2 Drive
T/C	Thermocouple
VAC	Volts Alternating Current
VDC	Volts Direct Current
WCVT	Working Current Value Table

1.3 References

1.3.1. Purdue, Technical Specification for the Purdue University Reactor, May 1988.

1.3.2. Purdue, Safety Analysis Report for the Conversion of the Purdue University Research Reactor from HEU to LEU Fuel, July 2006.

1.3.3. Purdue, Instruction Manual for Shim-Safety Control Rod Drive, Regulating Control Rod Drive, Fission Chamber Drive, Source Drive, Diamond Power Specialty Corporation, March 1962.

1.3.4. Purdue, Specifications and Technical Requirements for the Instrumentation and Control Upgrade of the Purdue University Nuclear Reactor, PUR-1, PUR-1 Controls Pre-Bid Document Final.pdf, April 2015.

1.3.5. Purdue, Scientech, Mirion, Functional Requirements Specification (<latest rev>), March 2016, (PUR1-FRS-001 - Functional Requirements Specification <latest rev>.docx).

1.3.6. Scientech, Mirion, Hardware Design Document (<latest rev>), April 2016, (PUR1-HDD-001 – Hardware Design Document (<latest rev>).docx).

1.3.7. Scientech, Software Requirements Specification (SRS) and Software Design Description (SDD) (<latest rev>), May 2016, (PUR1-SRS-SDD-001 – Control Algorithm (<latest rev>).docx)

1.3.8. Scientech, Software Requirements Specification (SRS) and Software Design Description (SDD) (<latest rev>), May 2016, (PUR1-SRS-SDD-003 – Rod Drop Timing (<latest rev>).docx)

1.3.9. Scientech, R*TIME User's Manual, SCI-RTIME-DOC-1002, R*TIME Version 14.0.

***NOTE**: In the references above, revision / dates for non-project documents should be treated as specific document references. For project documents, any revision / date indicated as part of the reference should be treated as that revision or later.*

1.4 Document Organization

Sections 1 through 3 of this document comprise the Software Requirements Specification (SRS) and detail the functional requirements of the HMI functions. Specifically, the functional requirements of the HMI functions shall include:

- The purpose of the display screen.
- Navigation to and from the display screen.
- The operator functions provided by the display screen.
- Specific functional requirements identified in Reference 1.3.5.
- The data points and their attributes used on the display.
- Additional necessary information.

Section 4 will contain completed screen shots and additional implementation details not covered in Section 3 for each specific display screen. Each display screen listed will include:

- The design and layout of the display.
- How the display works – this includes (and is not limited to) descriptions of the title, elements, display calculations, operator actions, local & global variables and settings.
- Any assumptions and dependencies.
- Input and output analog and digital points used or visible on the display.
- Screenshots of the display.

2 GENERAL DESCRIPTION

The purpose of the HMI Functions Software component of the PUR-1 Reactor Control System is to provide HMI functions to the Reactor Operator Console (ROC) Reactor Operators on the ROC Display Workstation (RWS).

The HMI functions on the RWS provide:

- Supervisory control displays
- Display control and indication functions
- Control status displays which display details of the current status of the RCS system
- Alarm status displays which provide the ability to view details of any RCS system alarms
- R*TIME User displays which provide some general purpose system reporting functions

The HMI functions of the RWS also provide the following System Administrator functions:

- RCS System Displays that display the RCS control alarm setpoints, tuning constants and system dependent parameters
- R*TIME System Administrator displays which provide some general purpose system administrative functions

2.1 Perspective

The RCS system HMI Functions Software are computer-based data presentation and supervisory control functions intended to provide the reactor operator with the ability to monitor operation of the reactor and provide supervisory control functions. The graphical displays provide data and controls, via electronic display hardware, in streamlined and simple layouts for ease of use.

The HMI Functions Software package shall consist of the GUI displays described herein, with display calculations, hierarchy, and security defined as needed. The displays shall interface with the R*TIME system and provide monitoring and supervisory control abilities to the Reactor Operators.

2.2 Product Functions

The HMI Functions Software shall consist of display screens with both data presentation and control functionality. Display screens are organized in a logical hierarchical fashion, and shall include features to ensure data is still available even during a failure, such as failure of a display computer.

Displays can include display calculations, navigation options, and some automated features. Displays shall be built to be viewed on any workstation or server in a non-zoomable format. Displays will receive data at a rate of once per second.

2.3 User Characteristics

Security for displays is configurable in two capacities in the HMI Functions Software system:

- Geographic Security. Geographic security restricts availability of the display screen or certain display screen features (like update access) to specific HMI workstations. Some workstations can use certain displays, while others cannot.
- Access Security. This security configuration is configurable on a display-by-display basis, as well as feature-by-feature within the display. Only users logged into a sufficient security level defined in the R*TIME system have access to display screens or display screen features. The features that can be locked down for lower security levels are things like controls, display navigation, or point information and manipulation.

Security will be defined with each display described herein, as well as general definitions in Section 3.7.

2.4 General Constraints

The scope of this document is limited to design activities associated with development of the Reactor Operator Console (ROC) Workstation HMI displays that are presented to the reactor operator intended for use in monitoring or controlling portions of the PUR-1 reactor controls.

The HMI Functions Software display screens shall be created and modified, when required, using the R*TIME Display Builder and other display tools.

2.5 Assumptions and Dependencies

The HMI Functions Software display screens and software shall reside on the RCS operator console workstation.

The HMI Functions Software display screens are dependent upon the proper functioning of:

- The data acquisition sub-system.
- The base R*TIME software, specifically the scan and alarm functions.
- The R*TIME Server software.
- The R*TIME Display Viewer software.

No additional interfaces will be required for the displays described herein.

3 SPECIFIC REQUIREMENTS

3.1 Functional Requirements

Functional requirements for the HMI Functions Software are applicable to the Reactor Operator Console (ROC) display workstation.

3.1.1 Alarm Requirements

The Reactor Control System (RCS) shall support the logging and managing of process alarms and control system status notifications. This document provides requirements for the development and management of alarms. The requirements in this section apply primarily to the control system's overall monitoring and diagnostic capabilities and alarm management via the RWS.

3.1.1.1 Alarm Development

The existing logic functions (e.g. energize/de-energize on high/low signal) and alarm setpoints shall be replicated in the replacement control system. When an alarm setpoint is exceeded, a descriptive entry shall be generated in the alarm log to support historical analysis and comparison against system alarms for diagnostic purposes. The system shall support online configuration of alarm setpoints by an authorized user without requiring firmware to be replaced. Manual enabling and disabling of any alarm masking or suppression feature shall be the subject of administrative controls, and the control system shall support the control of access to these functions.

3.1.1.2 System Status Monitoring

The ROC Display Workstation shall provide a means to access detailed system status information. Status notifications shall be recorded in the alarm log and historian and time-stamped to the highest resolution supported by the control system.

3.1.2 Data Historian

The data historian shall be capable of recording information for each process parameter in the control system. The data historian shall be configurable via the ROC Display Workstation so as to allow an authorized user to define the following parameters:

- The data points to be retained.
- The time period for which each data point is retained
- Additional information associated with the data point to be retained (e.g., alarm status/signal quality).
- Alarm-related information including timestamps (Section 3.1.1.2).

Point sampling shall be performed at the highest frequency supported by the control system.

The data historian shall be implemented using the base R*TIME Archival system.

The RWS shall provide the ability to display the historical data using user specific data and time selection criteria to a user defined display format including time trends, X/Y plots and tabular data retrievals.

3.1.3 Access Control

Access to the configuration settings on the ROC Display Workstation and the control system shall be restricted to authorized users. Multiple levels of access shall be defined and user rights profiles shall be established for the following users: Engineering, Operations, and Administrators.

3.1.4 General HMI Display Requirements

3.1.4.1 Grouping and Organization

Related data and controls shall be grouped in a logical fashion that facilitates operator interaction with the system. The arrangement of control and navigation elements on the screen shall facilitate manipulation of these elements and minimize the potential for misoperation.

Common organizational principles include grouping of related elements by proximity on the screen or within a common region of the screen. Indications related to a particular piece of equipment, such as valve position, shall be located in close proximity to the controls for that device. The location of such indications relative to the associated control device shall be consistent across screens wherever possible.

Control elements shall be delineated as such using some highlighting scheme, such as a distinct border.

Mirroring of display elements between equipment divisions shall not be done.

3.1.4.2 Data Flow

Display data shall flow Left to Right and Top to Bottom wherever possible.

3.1.4.3 Navigation

Where required, navigation shall be performed using page buttons. Navigational controls may provide the capability to move sequentially between logical pages in a series, or provide an immediate link to a predefined display. Graphic elements that provide linking capabilities (i.e. navigational “touch zone”) shall be delineated as such using some highlighting scheme, such as a distinct border. Navigational controls shall include means to directly return to the display where the touch zone was selected.

Navigation functionality shall be used primarily to access and navigate amongst screens providing information not provided on indication displays, such as secondary trend display screens.

The operator shall be able to navigate from any one control screen to any other control screen within a maximum of three actions (mouse clicks, keystrokes, or screen pokes). Keystroke commands shall be clearly indicated to the operator.

Access to maintenance and configuration screens (available from the ROC Display Workstation) shall be password protected, in accordance with site security guidance.

Displays shall be sized and oriented to facilitate use without scrolling or resizing.

3.1.4.4 Information

Display elements shall be selected appropriately for the types of information to be presented (text, numerical values, graphs, etc.).

Each process parameter shall be presented with appropriate engineering units and precision.

Each process parameter shall also be identified with a tag, matching that of the physical component being replaced (where applicable).

The display element shall indicate to the user the usability of data. When data input for a process parameter becomes “BAD” quality (limits off scale, etc.) the data is considered unusable and this shall be communicated to the user via visual cues. These visual cues shall change color based on alarm colors (unusable quality generally being magenta), as well as the use of replacement characters (e.g. ***** or ?????) to accommodate users who may be visually impaired and have difficulty discerning the color cue. Guidelines for the use of color to convey data quality and status are provided in Table 3-2.

Refer to Section 3.1.7 for HMI color conventions.

3.1.4.5 Control

Control displays shall incorporate the presentation and grouping principles discussed in Section 3.1.4.1. All control elements and supplementary information (e.g. displayed setpoint) shall be grouped in a logical manner consistent with how the user interacts with the equipment or system.

The screen showing the main reactor controls (rod location and movement) shall always be visible to the operator.

The left monitor display screen will be configured to just show the Drive Position Indication display screen and all ability to change the display screen hidden.

3.1.5 Interaction

The HMI shall provide feedback to the user when actions are initiated. This is accomplished by switching to the destination display (if a navigation action is initiated) or presenting an hourglass cursor or a progress bar. The hourglass cursor is presented when the display is waiting for data to load. Progress bars show user that archive is loading on trend displays and indicate percent complete where display space is available. Progress bars shall only be visible when in use.

3.1.5.1 Buttons

When a button display element is not available for use it shall be “grayed” out and when it is actuated it shall change color shading to indicate it is “depressed.” Buttons shall have a text or symbolic label on the button that clearly communicates to the user the function of the button. The labeling shall conform to industry and facility standards for the function, where applicable.

3.1.5.2 Data Entry

Data entry boxes shall be obvious to the user. When information is entered into the box, the underlying script or configuration shall validate the data is in the correct format and range. When an entry is rejected, the user shall be presented with a meaningful message, including format or range requirements.

3.1.6 Fonts and Readability

Use of fonts shall be consistent within HMI displays. The selected font must be San Serif and not stylized (Old English, Script, Comic…). The font face shall not be 3D, Shadow, Patterned, Italicized, or otherwise embellished.

Text for labels and titles shall be in all capital letters.

The selected font must allow the user to easily discern; X and K, T and Y, I and L, I and 1, O and Q, S and 5, and U and V. The preferred fonts are;

- Verdana (XKTYILI1OQS5UV, xktyili1oqs5uv)
- Arial (XKTYILI1OQS5UV, xktyili1oqs5uv)
- Tahoma (XKTYILI1OQS5UV, xktyili1oqs5uv).

Physical measurements are made on the screen of the display device and account for the character area including ascender and descender space. Therefore, individual characters may be slightly smaller than the specified dimensions.

<u>Header & Footer</u>
Minimum Height: 2 Points larger than Display Section Titles
Maximum Height: 1/2”

<u>Display Section Title</u>
Minimum Height: 3/8”
Maximum Height: 2 Points smaller than Header & Footer

<u>Labels & Scales</u>
Minimum Height: 3/16”
Maximum Height: 1/4”

<u>Data</u>

The Data font shall be sized such that it is smaller than the Title font but equal to or larger than the font size of the Label, Scale, and Note.

<u>Notes</u>

Font used for Notes shall be sized such that it is smaller than the Title font and it shall be equal to or smaller than the Data font.

Note: The overarching consideration with regards to selecting font size is readability. Readability shall not be sacrificed solely to meet the guidance described in this section.

3.1.7 Use of Color

Color conventions for quality, status, extended quality, extended status, and valves, as well as general color assignments shall follow conventions identified in Table 3-1 through Table 3-2.

Note: In addition to the alarm colors, the PUR-1 color sceme also uses colors like yellow and orange for function specific coloring (eg. yellow for servo control and orange for automatic startup). Also, for drive limit indications, the PUR-1 color scheme uses a dark color / bright color indication scheme rather than Red / Green.

Table 3-1 - General Color Assignments

Color	Color Assignment
Green	Breaker Open, Motor Stop, Pump Stop, GOOD Quality, No Alert, No Alarm, Value within Green / Non coded Zone Code Limits
Red	Breaker Closed, Motor Run, Pump Run, 1st Priority Alarm, Signal within Red Zone Code Limits
Magenta	BAD Quality, Unknown or Indeterminate State, Failed Sensor, Failed Hardware
Yellow	Suspect Quality, Signal within Yellow Zone Code Limits
Orange	Poor Quality, Degraded Accuracy or Reliability of data, 2nd Priority Alarm
Lt. Blue	User Entered Value
Gray	Display background
Black	Display background
White	Static text and symbols

Table 3-2 - Quality and Status

Mnemonic	Description	Color
DEL	Deleted (removed) from processing	Magenta
INVL	Invalid; Database configuration error or hardware channel error	Magenta
BAD	Sensor is outside the configured valid signal limits	Magenta
HRL	High reasonability limits have been exceeded	Magenta
LRL	Low reasonability limits have been exceeded	Magenta
HIHI	Point is above the High High Alarm limit	Red
LOLO	Point is below the Low Low Alarm limit	Red
HALM	Point is above the High Alarm limit	Orange/Amber
LALM	Point is below the Low Alarm limit	Orange/Amber
ALM	State or Change of State alarm for bi-stable inputs	Red
SUB	Substituted value	Lt. Blue
DALM	Point whose alarm processing is currently suppressed because the point has been manually taken off-alarm processing by an operator or engineer.	Cyan
GOOD	Point passed all quality checks and is not in alarm	Green

3.1.8 Scales and Resolution

Scale demarcations shall be consistent with the intended purpose of the indication. Lower and upper range values shall be consistent with the calibrated range of the input or the range of interest in the indication and how it is interpreted. Intermediate markers shall follow the 1, 2, 5 sequence with major divisions falling on values that are integer multiples. In cases where a value is narrow ranged, an out of range HI and LO status indication shall be provided.

The resolution of information shall not exceed the precision of the measurement. The display screen shall only show only digits to the right of the decimal place that can be relied upon and are necessary for the intended use. A precision of up to a tenth (0.1) of a unit is generally acceptable, but the system shall support display of each individual point to a precision of up to a hundredth (0.01) of a unit.

3.1.9 Charts and Graphs

The control interface displays shall provide the capability to display graphs or charts developed from user selected parameters (type of graph, process variable(s), time frame, etc.). The types of charts and graphs to be supported and their associated requirements are discussed in the following sections.

3.1.9.1 Trend Graphs

Trend chart scales shall conform to the normal scaling requirements. If the chart has dynamically assigned process variables, the scaling may be automatically generated based upon scaling of the process variable point definition in order to establish a range and scale divisions that present the displayed data clearly.

The chart shall have the means to zoom both the X and Y axis. The chart shall also have the means to mark a point in time to indicate the value of each trended parameter during that time slice. It shall also have a second time marker that can be used to calculate pertinent changes between the two markers, including at least maximum and minimum values within the selected range along with standard deviation and a regression slope. Data used for a trend shall be exportable for detailed analysis in a commercial spreadsheet program.

The trend chart shall identify the displayed time period and uniquely identify each trended parameter. Parameters may be identified using color. However, they shall include a unique symbol (such as: ● ■ ◆ ✸) and line pattern to identify the trend when printed on a black and white printer or other display.

Points of interest (valve open, etc.) may be shown on a trend chart if they are pertinent to the intent of the display. These shall be shown as horizontal lines spanning the entire chart period or specific time frame. The line shall be visually keyed to the associated process variable either by grouping or symbols and line pattern.

All trend charts must provide a legend. The legend shall include the tag name, current value with Quality and Status, and the identification key. These legend attributes can be altered depending upon the intent and needs of the trend.

3.1.9.2 Column or Bar

Scaling shall follow normal scaling requirements providing demarcations and numeric values to facilitate reading and to convey the desired meaning. If it is necessary to determine the parameter value with a high degree of certainty, a digital readout of the parameter shall be included.

The parameters shall be arranged to facilitate ready identification of the parameter. Column and Bar charts shall change color consistent with the Quality and Status of the input parameter. A Quality text field shall be associated with the column or bar chart to communicate the Quality of the input parameter.

3.1.10 Specific HMI Display Requirements

3.1.10.1 Display Header

Headers for the displays shall include a title and a means of indicating that an abnormal condition (i.e., process alarm or control system trouble status) is active.

The header of each display shall contain a display title, unique identification number, page number of multi-page displays, and provide a general indication of control system health.

The control system health indicator shall clearly identify the current state of the system. The control system health indicator icon shall function as a clickable zone to access detailed system status information.

3.1.10.2 Display Footer

The footer for each display shall contain as a minimum general status information (e.g. date and time), navigation icons and controls (if required), and function buttons in support of HMI management (e.g. access trend graph functions, or access maintenance or configuration functions).

The configuration capabilities accessible by this interface shall consist only of those that can be used to make simple changes to the immediate display presentation (e.g. creation activation of trend graphs, etc.) as appropriate for the local user. Advanced system configuration will be performed at the ROC Display Workstation.

3.1.11 Recording/Monitoring Requirements

The supplied equipment shall include a historian that is capable of capturing a time-based sequence of events for all I/O points. The historian shall keep a rolling record of data for a minimum of 180 days for all points and a minimum of 720 days for critical points so that significant events are not lost (overwritten or dropped) before they can be logged by operators / technicians or by automatic action. In the event of a total power loss, data acquired prior to a power loss shall be retained regardless of the length of time without station power.

Means of access to the historian shall be provided via the RWS. The RWS shall have the capability of downloading the historian data to writable media (e.g. USB Flash drive).

3.2 Control Functions

3.2.1 Radiation Area Monitor #1

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the logic requirements for this function.

3.2.1.1 Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- RAM#1 Dose Rate (RAM-POOL-LVL)
- RAM#1 Failure Indicator (RAM-POOL-FAIL)
- RAM#1 Alarm Indicator (RAM-POOL-ALM)
- Pool Level RAM Alert Indicator (RAM-POOL-ALRT)

RAM#1 Failure Indicator, RAM#1 Alarm Indicator and RAM#1 Alert Indicator will be displayed as soft indicators on the display screen while RAM#1 Dose Rate will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.1.2 Operator Functions

None.

3.2.2 Radiation Area Monitor #2

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the logic requirements for this function.

3.2.2.1 Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- RAM#2 Dose Rate (RAM-WTR-LVL)
- RAM#2 Failure Indicator (RAM-WTR-FAIL)
- RAM#2 Alarm Indicator (RAM-WTR-ALM)
- RAM#2 Alert Indicator (RAM-WTR-ALRT)

RAM#2 Failure Indicator, RAM#2 Alarm Indicator and RAM#2 Alert Indicator will be displayed as soft indicators on the display screen while RAM#2 Dose Rate will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.2.2 Operator Functions

None.

3.2.3 Radiation Area Monitor #3

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the logic requirements for this function.

3.2.3.1 Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- RAM#3 Dose Rate (RAM-CON-LVL)
- RAM#3 Failure Indicator (RAM-CON-FAIL)
- RAM#3 Alarm Indicator (RAM-CON-ALM)
- RAM#3 Alert Indicator (RAM-CON-ALRT)

RAM#3 Failure Indicator, RAM#3 Alarm Indicator and RAM#3 Alert Indicator will be displayed as soft indicators on the display screen while RAM#3 Dose Rate will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.3.2 Operator Functions

None.

3.2.4 Continuous Air Monitor

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- CAM Count Rate (CAM-CNT)
- CAM Failure Indicator (CAM-FAIL)
- CAM Alarm Indicator (CAM-ALARM)

CAM Failure Indicator and CAM Alarm Indicator will be displayed as soft indicators on the display screen while CAM Count Rate will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.4.1 Operator Functions

None.

3.2.5 Neutron Flux Channel #1

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the logic requirements for this function.

3.2.5.1 Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- Neutron Flux Channel #1 Reactor Period (NFD-1-CR)
- Neutron Flux Channel #1 Log Count Rate (NFD-1-CPS)
- Neutron Flux Channel #1 Period Alarm (NFD-1-CR-ALM)
- Neutron Flux Channel #1 Period Setback Indicator (NFD-1-CR-STBK)
- Neutron Flux Channel #1 Withdraw Interlock (NFD-1-CR-INLK)
- Neutron Flux Channel #1 High Count Rate Indicator (NFD-1-CR-HI)
- Neutron Flux Channel #1 Source Missing Indicator (NFD-1-SRS-MSNG)
- Neutron Flux Channel #1 Test Indicator (NFD-1-TEST)
- Neutron Flux Channel #1 Fault Indicator (NFD-1-FAULT)

NFD#1 Period Alarm, NFD#1 Period Setback Indicator, NFD#1 Withdraw Interlock, NFD#1 High Count Rate Indicator, NFD#1 Source Missing Indicator, NFD#1 Failure Indicator and NFD#1 Alarm Indicator will be displayed as soft indicators on the display screen while NFD#1 Reactor Period and NFD#1 Log Count Rate will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.5.2 Operator Functions

None.

3.2.6 Neutron Flux Channel #2

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the logic requirements for this function.

3.2.6.1 Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- Neutron Flux Channel #2 Reactor Period (NFD-2-CR)
- Neutron Flux Channel #2 Log Power (NFD-2-LOG)
- Neutron Flux Channel #2 Period Alarm (NFD-2-CR-ALM)
- Neutron Flux Channel #2 Log Power Alarm (NFD-2-LOG-ALM)
- Neutron Flux Channel #2 Period Setback Indicator (NFD-2-CR-STBK)
- Neutron Flux Channel #2 Withdraw Interlock (NFD-2-CR-INLK)
- Neutron Flux Channel #2 High Voltage PS Alarm Indicator (NFD-2-HV-ALM)
- Neutron Flux Channel #2 Test Indicator (NFD-2-TEST)
- Neutron Flux Channel #2 Fault Indicator (NFD-2-FAULT)
- Neutron Flux Channel #2 Not On Scale Indicator (NFD-2-NOS)

NFD#2 Period Alarm, NFD#2 Power Alarm, NFD#2 Period Setback Indicator, NFD#2 Withdraw Interlock, NFD#2 High Voltage PS Alarm Indicator, NFD#2 Test Indicator, NFD#2 Fault Indicator and NFD #2 Not On Scale Indicator will be displayed as soft indicators on the display screen. NFD#2 Reactor Period and NFD#2 Log Power will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.7 Neutron Flux Channel #3

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.7.1 Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- Neutron Flux Channel #3 Linear Power (NFD-3-PWR)
- Neutron Flux Channel #3 Linear Power Range (NFD-3-PWR-RNG)
- Neutron Flux Channel #3 Power Alarm (NFD-3-PWR-ALM)
- Neutron Flux Channel #3 Power Setback Indicator (NFD-3-STBK)
- Neutron Flux Channel #3 Test Indicator (NFD-3-TEST)
- Neutron Flux Channel #3 Fault Indicator (NFD-3-FAULT)
- Neutron Flux Channel #3 Not On Scale Indicator (NFD-3-NOS)

NFD#3 Power Alarm, NFD#3 Power Setback Indicator, NFD#3 Test Indicator, NFD#3 Fault Indicator and NFD #3 Not On Scale Indicator will be displayed as soft indicators on the display screen. NFD#3 Linear Power will be displayed as a user configurable time trend and as the numeric value of the current value. NFD #3 Linear Power Range will be displayed as a numeric value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.7.2 Operator Functions

None.

3.2.8 Neutron Flux Channel #4

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.8.1 Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- Neutron Flux Channel #4 Linear Power (NFD-4-FLUX)
- Neutron Flux Channel #4 Power Alarm (NFD-4-ALM)

- Neutron Flux Channel #4 Setback Indicator (NFD-4-STBK)
- Neutron Flux Channel #4 Test Indicator (NFD-4-TEST)
- Neutron Flux Channel #4 Fault Indicator (NFD-4-FAULT)

NFD#4 Power Alarm, NFD#4 Setback Indicator, NFD#4 Test Indicator and NFD#4 Fault Indicator will be displayed as soft indicators on the display screen while NFD#4 Flux will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.8.2 Operator Functions

None.

3.2.9 HVAC and Environmental

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.9.1 Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- HVAC Status Indicator (HVAC-ST)
- HVAC Power Switch (HVAC-ON-OFF)
- HVAC Power Verification (HVAC-ON-OFF-VER)
- Isolate Confinement Alarm (ISOLATE-CONF)
- Isolate Confinement Switch (ROC-CONF-ST)
- Isolate Confinement Status (ROC-CONF-REL)
- Isolate Confinement Verification (ROC-CONF-VER)
- Pool Level RAM Environmental Health Status (RAM-POOL-ENV)
- Makeup Water RAM Environmental Health Status (RAM-WTR-ENV)
- Console RAM Environmental Health Status (RAM-CON-ENV)

HVAC Status Indicator, HVAC Power Switch, HVAC Power Verify, Isolate Confinement Alarm, Isolate Confinement Switch, Isolate Confinement Status, Isolate Confinement Verify, Pool Level RAM Environmental Health Status, Makeup Water RAM Environmental Health Status, and Console RAM Environmental Health Status will be displayed as soft indicators on the display.

3.2.9.2 Operator Functions

None.

3.2.10 Photohelic Sensors

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

See Section 3.2.9 for the HMI requirements for this function.

3.2.11 Makeup Water

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.11.1 Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- Makeup Water Pump Status Indicator (MU-PUMP-ON)
- Makeup Water Pump Power Switch (MU-PUMP-SW)
- Makeup Water Pump Relay Status (MU-PUMP-REL)
- Makeup Water Pump Verification (MU-PUMP-VER)
- Makeup Water Chiller ON/OFF Status (MU-CHIL-ON)
- Makeup Water Chiller Ready Indicator (MU-CHIL-READY)
- Makeup Water Chiller Power Switch (MU-CHIL-SW)
- Makeup Water Chiller Relay Status (MU-CHIL-REL)
- Makeup Water Chiller Verification (MU-CHIL-VER)
- Upstream Makeup Water Conductivity (CHEM-COND-UP)
- Downstream Makeup Water Conductivity (CHEM-COND-DN)
- Upstream Makeup Water Temperature (CHEM-TEMP-UP)
- Downstream Makeup Water Temperature (CHEM-TEMP-DN)

Makeup Water Pump Status Indicator, Makeup Water Pump Power Switch, Makeup Water Pump Relay Status, Makeup Verification, Makeup Water Chiller ON/OFF Status, Makeup Water Chiller Ready Indicator, Makeup Water Chiller Power Switch, Makeup Chiller Verification, Makeup Water Chiller Relay Status will be displayed as soft indicators on the display while Upstream Makeup Water Conductivity, Downstream Makeup Water Conductivity, Upstream Makeup Water Temperature, Downstream Makeup Water Temperature and Reactor Pool Temperature will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.11.2 Operator Functions

None.

3.2.12 Water Chiller

See PUR1-SRS-SDD-001 for the software requirements for this function.

See Section 3.2.11 for the HMI requirements for this function.

3.2.13 Water Chemistry Sensors

See PUR1-SRS-SDD-001 for the software requirements for this function.

See Section 3.2.11 for the HMI requirements for this function.

3.2.14 Manual SCRAM

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.14.1 Display Functions

None.

3.2.14.2 Operator Functions

None.

3.2.15 Key Switch

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.15.1 Display Functions

None.

3.2.15.2 Operator Functions

None.

3.2.16 Control Room Alarm

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.16.1 Display Functions

None.

3.2.16.2 Operator Functions

None.

3.2.17 House Alarm

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.17.1 Display Functions

None.

3.2.17.2 Operator Functions

None.

3.2.18 Operator Console Recorders

3.2.18.1 Display Functions

None.

3.2.18.2 Operator Functions

The R*TIME Pen Trend display screen provides the operator the ability to select which operator selected parameters are displayed on the reactor operator console Recorder #1 and Recorder #2.

3.2.19 UPS #1

3.2.19.1 Display Functions

The UPS Status display screen will display the following data for the UPS units:

- upsBatteryStatus (UPS1BATSTATUS)
- upsBatteryVoltage (UPS1BATVOLT)
- upsBatteryTemperature (UPS1BATTEMPERATURE)
- upsInputFrequency (UPS1INFREQUENCY)
- upsInputVoltage (UPS1INVOLT)
- upsOutputSource (UPS1OUTSOURCE)
- upsOutputFrequency (UPS1OUTFREQ)
- upsOutputVoltage (UPS1OUTVOLT)
- upsOutputCurrent (UPS1OUTCURR)
- upsOutputPercentLoad (UPS1OUTPCTLOAD)

The following parameters will be displayed as soft indicators on the display

- upsBatteryStatus (UPS1BATSTATUS)
- upsOutputSource (UPS1-OUTPUT-ST)

The following parameters will be displayed as a user configurable time trend and as the numeric value of the current value.

- upsBatteryVoltage
- upsBatteryTemperature

The following parameters will be displayed as a user configurable time trend and as the numeric value of the current value.

- upsInputFrequency
- upsInputVoltage

The following parameters will be displayed as a user configurable time trend and as the numeric value of the current value.

- upsOutputFrequency
- upsOutputVoltage
- upsOutputCurrent

- upsOutputPercentLoad

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.19.2 Operator Functions

None.

3.2.20 UPS #2

See Section 3.2.19 for the HMI requirements for this function.

3.2.21 Withdrawal Interlock

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.21.1 Display Functions

The Withdraw Interlock display screen will display the following parameters:

- NFD Channel #1 Withdraw Interlock (NFD-1-CR-INLK)
- NFD Channel #1 Source Missing (NFD-1-SRS-MSNG)
- NFD Channel #2 Withdraw Interlock (NFD-2-CR-INLK)
- Source Drive In Operation (SRC-DRIVE-MOVE)

NFD Channel #1 Withdraw Interlock status, NFD Channel #1 Source Missing status, NFD Channel #2 Withdraw Interlock and Source Drive in Operation status will be displayed as soft indicators on the display.

3.2.21.2 Operator Functions

None.

3.2.22 Fission Chamber Drive Control

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.22.1 Display Functions

The Fission Chamber Drive Status display screen will display the following parameters:

- Fission Chamber Drive “safe (jam)” switch status (FISS-SAFE-NO)
- Fission Chamber Drive upper limit switch status (FISS-UPPER-NO)
- Fission Chamber Drive lower limit switch status (FISS-LOWER-NO)
- Fission Chamber Drive position (FISS-POSITION)

Fission Chamber Drive Safe Switch status, Fission Chamber Drive Upper Limit Switch status, Fission Chamber Drive Lower Limit Switch status will be displayed as soft indicators on the

display while Fission Chamber Drive Position will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.22.2 Operator Functions

See Section 3.2.38 for the Rod Motion Control display screen requirements.

3.2.23 Source Drive Control

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.23.1 Display Functions

The Source Drive Status display screen will display the following parameters:

- Source Drive "safe" (jam) Switch status (SRC-SAFE-NO)
- Source Drive Upper Limit Switch (SRC-UPPER-NO)
- Source Drive Lower Limit Switch (SRC-LOWER-NO)
- Source Drive Position (SRC-POSITION)

Source Drive Safe Switch status, Source Drive Upper Limit Switch status, Source Drive Lower Limit Switch status will be displayed as soft indicators on the display.

3.2.23.2 Operator Functions

See Section 3.2.38 for the Rod Motion Control display screen requirements.

3.2.24 Shim Safety #1 Rod Drive Control

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.24.1 Display Functions

The Shim Safety #1 Drive Status display screen will display the following parameters:

- Shim Safety #1 Drive Jam Switch Status (SS1-JAM-NO)
- Shim Safety #1 Drive Upper Limit Switch Status (SS1-UPPER-NO)
- Shim Safety #1 Drive Lower Limit Switch Status (SS1-LOWER-NO)
- Shim Safety #1 Drive 2/3 Switch Status (SS1-23UP-NO)
- Shim Safety #1 Drive Engage Switch Status (SS1-ENG-NO)
- Shim Safety #1 Drive Bottom Switch Status (SS1-BOT-NC)
- Shim Safety #1 Drive Position (SS1-POSITION)

Shim Safety #1 Drive Jam Switch status, Shim Safety #1 Drive Upper Limit Switch status, Shim Safety #1 Drive Lower Limit Switch status, Shim Safety #1 Drive 2/3 Switch Status, Shim Safety #1 Drive Engage Switch Status and Shim Safety #1 Drive Bottom Switch Status will be displayed as soft indicators on the display while Shim Safety #1 Drive Position will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.24.2 Operator Functions

See Section 3.2.38 for the Rod Motion Control display screen requirements.

3.2.25 Shim Safety #2 Rod Drive Control

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.25.1 Display Functions

The Shim Safety #2 Drive Status display screen will display the following parameters:

- Shim Safety #2 Drive Jam Switch Status (SS2-JAM-NO)
- Shim Safety #2 Drive Upper Limit Switch Status (SS2-UPPER-NO)
- Shim Safety #2 Drive Lower Limit Switch Status (SS2-LOWER-NO)
- Shim Safety #2 Drive 2/3 Switch Status (SS2-23UP-NO)
- Shim Safety #2 Drive Engage Switch Status (SS2-ENG-NO)
- Shim Safety #2 Drive Bottom Switch Status (SS2-BOT-NC)
- Shim Safety #2 Drive Position (SS2-POSITION)

Shim Safety #2 Drive Jam Switch status, Shim Safety #2 Drive Upper Limit Switch status, Shim Safety #2 Drive Lower Limit Switch status, Shim Safety #2 Drive 2/3 Switch Status, Shim Safety #2 Drive Engage Switch Status and Shim Safety #2 Drive Bottom Switch Status will be displayed as soft indicators on the display while Shim Safety #2 Drive Position will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.25.2 Operator Functions

See Section 3.2.38 for the Rod Motion Control display screen requirements.

3.2.26 Regulating Rod Drive Control

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.26.1 Display Functions

The Regulating Rod Drive Status display screen will display the following parameters:

- Regulating Rod Drive Jam Switch Status (RR-JAM-NO)
- Regulating Rod Drive Upper Limit Switch Status (RR-UPPER-NO)
- Regulating Rod Drive Lower Limit Switch Status (RR-LOWER-NO)
- Regulating Rod Drive 2/3 Switch Status (RR-23UP-NO)
- Regulating Rod Drive Position (RR-POSITION)

Regulating Rod Drive Jam Switch status, Regulating Rod Drive Upper Limit Switch status, Regulating Rod Drive Lower Limit Switch status and Regulating Rod Drive 2/3 Switch Status will be displayed as soft indicators on the display while Regulating Rod Drive Position will be displayed as a user configurable time trend and as the numeric value of the current value.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.26.2 Operator Functions

See Section 3.2.38 for the Rod Motion Control display screen requirements.

3.2.27 Servo Control

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.27.1 Display Functions

The HMI Functions will provide a dedicated display screen to display the values of the following parameters:

- Servo Control Enable / Disable (ROD-SERVO-ENAB-STA)
- Servo Control Power Level (ROD-SERVO-PWR)
- NFD Channel #3 Reactor Power (NFD-3-PWR)
- Regulating Rod Position (RR-POSITION)
- Regulating Rod Jam Switch Status (RR-JAM-NO)
- Regulating Rod Upper Limit Switch Status (RR-UPPER-NO)
- Regulating Rod Lower Limit Switch Status (RR-LOWER-NO)

Servo Control Enable / Disable Indicator will display the current servo control mode (Enabled / Disabled).

Servo Control Power Level will display the reactor operator entered target power level for servo control. The current value will be displayed as a numeric value and the value will also be shown on a time trend display along with NFD Channel #3 Reactor Power and Regulating Rod Position.

NFD Channel #3 Reactor Power will display the reactor power level from NFD Channel #3. The current value will be displayed as a numeric value and the value will also be shown on a time trend display along with Servo Control Power Level and Regulating Rod Position.

Regulating Rod Position will display the position of the regulating rod. The current value will be displayed as a numeric value and the value will also be shown on a time trend along with NFD Channel #3 Reactor Power and Servo Control Power Level.

Regulating Rod Jam Switch Status will display the status of the regulating rod jam switch. Regulating Rod Upper Limit Switch Status will display the status of the regulating rod upper limit switch. Regulating Rod Lower Limit Switch Status will display the status of the regulating rod lower limit switch.

The trend display shall provide the reactor operator the ability to select a user defined time range and user defined scales for the parameters that are trended.

3.2.27.2 Operator Functions

The Servo Control display screen will provide the reactor operator the ability to perform the following functions:

The Servo Control Enable / Disable Indicator will display the current servo control mode while a separate button will provide the operator the ability to change the servo control mode by clicking on it. Before making the servo control mode change, the Servo Control display screen will prompt the reactor operator for verification of the servo control mode change. To Enable servo control, the display screen will SET RCS logical point ROD-SERVO-ENAB-REQ. To Disable servo control, the display screen will RESET RCS logical point ROD-SERVO-ENAB-REQ.

The Enable Indicator will be disabled if the difference between NFD #3 Power and the operator selected Servo Control Power Level is greater than 5%.

The Servo Control Power Level field will provide the operator the ability to enter a power level for automatic servo control. If the servo control mode is enabled when the Servo Control display screen is first opened, the Servo Control Power Level field will be initialized to the current servo control power level. Otherwise, the value displayed in the Servo Control Power Level field will be the current reactor power level from NFD #3 Power.

3.2.28 Jam Indication

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.28.1 Display Functions

The Fission Chamber Drive Status display screen will display the following parameters:

- Fission Chamber Drive “safe” switch status (FISS-SAFE-NO)
- Source Drive Safe Switch status (SRC-SAFE-NO)
- Shim Safety #1 Drive Jam Switch Status (SS1-JAM-NO)
- Shim Safety #2 Drive Jam Switch Status (SS2-JAM-NO)

- Regulating Rod Drive Jam Switch Status (RR-JAM-NO)

3.2.28.2 Operator Functions

None.

3.2.29 Magnet Power Control

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.29.1 Display Functions

The Magnet Current Status display screen will display the following parameters:

- Magnet Power Operating Current (MAG-OP-CURR)
- Magnet Power Non-Operating Current (MAG-NOP-CURR)
- Magnet Power Enable (MAG-OP-ENABLE)
- Magnet Power Switch Status (MAG-PWR-SW)
- Magnet Power Setpoint (MAG-PWR-SP)
- Non-Operating Magnet Current High Alarm (MAG-NOP-CUR-HI-ALM)
- Operating Magnet Current High Alarm (MAG-OP-CUR-HI-ALM)
- Operating Magnet Current Low Alarm (MAG-OP-CUR-LO-ALM)
- Magnet Current (MAG-CURRENT)

Magnet Power Enable / Disable Indicator will display the magnet current control mode (Enabled / Disabled).

Magnet Current will display the magnet current level. The current value will be displayed as a numeric value and the value will also be shown on a time trend display.

Magnet Power Operating Current, Magnet Power Non-Operating Current and Magnet Power Setpoint will display the current value as a numeric value.

Magnet Power Switch Status and Magnet Current Alarms will be displayed as indicators.

3.2.29.2 Operator Functions

None.

3.2.30 Annunciator

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.30.1 Display Functions

The Annunciator display screen will display the following parameters:

- Pool Level RAM SCRAM (RAM-POOL-SCRAM)

- Makeup Water RAM SCRAM (RAM-WTR-SCRAM)
- Console RAM SCRAM (RAM-CON-SCRAM)
- CAM SCRAM (CAM-SCRAM)
- Channel #1 Test and Fault Indicators (NFD-1-TEST and NFD-1-FAULT)
- Channel #2 Test and Fault Indicators (NFD-2-TEST and NFD-2-FAULT)
- Channel #2 High Voltage PS Alarm (NFD-2-HV-ALM)
- Channel #3 Test and Fault Indicators (NFD-3-TEST and NFD-3-FAULT)
- Channel #4 Test and Fault Indicators (NFD-4-TEST and NFD-4-FAULT)
- Channel #1 Period SCRAM (NFD-1-CR-SCRAM)
- Channel #2 Period SCRAM (NFD-2-CR-SCRAM)
- Channel #2 Power SCRAM (NFD-2-LOG-SCRAM)
- Channel #3 Power SCRAM (NFD-3-SCRAM)
- Channel #4 Power SCRAM (NFD-4-SCRAM)
- Console Manual SCRAM (OC-SCRAM)
- Hallway Manual SCRAM (HALL-SCRAM)
- Keyswitch Manual SCRAM (KSW-SCRAM)
- Channel #1 Period SETBACK (NFD-1-STBK)
- Channel #2 Period SETBACK (NFD-2- STBK)
- Channel #3 Power SETBACK (NFD-3-STBK)
- Channel #4 Power SETBACK (NFD-4- STBK)
- Channel #1 Period WITHDRAW INTERLOCK (NFD-1-CR-INLK)
- Channel #1 SOURCE MISSING (NFD-1-SRS-MSNG)
- Channel #2 Period WITHDRAW INTERLOCK (NFD-2-INLK)
- Servo Trouble (ANN-SERV-STBK-IND)

Pool Level RAM SCRAM, Makeup Water RAM SCRAM, Console RAM SCRAM, CAM SCRAM, Channel #1 Test and Fault Indicators, Channel #2 Test and Fault Indicators, Channel #2 High Voltage PS Alarm, Channel #3 Test and Fault Indicators, Channel #4 Test and Fault Indicators, Channel #1 Period SCRAM, Channel #2 Period SCRAM, Channel #2 Power SCRAM, Channel #3 Power SCRAM, Channel #4 Power SCRAM, Console Manual SCRAM, Hallway Manual SCRAM, Keyswitch Manual SCRAM Channel #1 Period Setback, Channel #2 Period Setback, Channel #3 Power Setback, Channel #4 Power Setback, Channel #1 Period Withdraw Interlock, Channel #1 Source Missing, and Channel 2 Period Withdraw Interlock will be displayed as soft indicators on the display screen.

3.2.30.2 Operator Functions

None.

3.2.31 Joystick

See PUR1-SRS-SDD-001 (Reference 1.3.7) for the software requirements for this function.

3.2.31.1 Display Functions

None.

3.2.31.2 Operator Functions

None.

3.2.32 SCRAM

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.32.1 Display Functions

None.

3.2.32.2 Operator Functions

None.

3.2.33 Setback

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.33.1 Display Functions

None.

3.2.33.2 Operator Functions

None.

3.2.34 Isolate Confinement

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.34.1 Display Functions

None.

3.2.34.2 Operator Functions

None.

3.2.35 Environmental Health

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.35.1 Display Functions

The Environmental Health display screen will display the following requirements:

- Pool Level RAM Environmental Status (RAM-POOL-ENV)
- Makeup Water RAM Environmental Status (RAM-WTR-ENV)
- Console RAM Environmental Status (RAM-CON-ENV)
- CAM Isolation Status (CAM-ISO)
- HVAC Isolation Status (HVAC-ISO)
- Negative Air Pressure Monitor (NEG-AIR-ENV)

Pool Level RAM Environmental Status, Makeup Water RAM Environmental Status, Console RAM Environmental Status, CAM Isolate Status, HVAC Isolate Status and Negative Air Pressure Status will be displayed as soft indicators on the display screen.

3.2.35.2 Operator Functions

None.

3.2.36 Rod Drop Timing

See PUR1-SRS-SDD-003 for the software requirements for this function.

3.2.37 Workstation Trouble Watchdog

3.2.37.1 Display Functions

None.

3.2.37.2 Operator Functions

None.

3.2.38 Drive Position Indication

3.2.38.1 Display Functions

The Rod Motion Control display screen will display the following parameters:

- Fission Chamber Drive Selection Indicator (RODS-FISS-SEL)
- Source Drive Selection Indicator (RODS-SRC-SEL)
- Shim Safety #1 Drive Selection Indicator (RODS-SS1-SEL)
- Shim Safety #2 Drive Selection Indicator (RODS-SS2-SEL)

- Regulating Rod Drive Selection Indicator (RODS-RR-SEL)
- Source Drive Position (SRC-POSITION)
- Fission Chamber Drive Position (FISS-POSITION)
- Shim Safety #1 Drive Position (SS1-POSITION)
- Shim Safety #2 Drive Position (SS2-POSITION)
- Regulating Rod Drive Position (RR-POSITION)
- Fission Chamber Drive Upper and Lower Limit Indicator (FISS-UPPER and FISS-LOWER)
- Source Drive Selection Upper and Lower Limit Indicator (SRC-UPPER and SRC-LOWER)
- Shim Safety #1 Drive Upper Limit, Lower Limit, and 2/3 Indicator (SS1-UPPER, SS1-LOWER, SS1-23UP)
- Shim Safety #2 Drive Upper Limit, Lower Limit, and 2/3 Indicator (SS2-UPPER, SS2-LOWER, SS2-23UP)
- Regulating Rod Drive Upper Limit, Lower Limit, and 2/3 Indicator (RR-UPPER, RR-LOWER, RR-23UP)
- Selected Rod Target Position (RODS-TARGET)
- Fission Chamber Drive Raise and Lower Indicator
- Source Drive Raise and Lower Indicator
- Shim Safety #1 Drive Raise and Lower Indicator
- Shim Safety #2 Drive Raise and Lower Indicator
- Regulating Rod Drive Raise and Lower Indicator
- RCS SCRAM Indicator
- Rod Setback Indicator
- Servo Control Indicator
- Automatic Startup Indicator

The Fission Chamber Drive Selection Indicator will display the selected / not selected status of the Fission Chamber drive.

The Source Drive Selection Indicator will display the selected / not selected status of the Source drive.

The Shim Safety #1 Drive Selection Indicator will display the selected / not selected status of the Shim Safety #1 drive.

The Shim Safety #2 Drive Selection Indicator will display the selected / not selected status of the Shim Safety #2 drive.

The Regulating Rod Drive Selection Indicator will display the selected / not selected status of the Regulating Rod drive.

The Source Drive Position will display the current position of the Source drive.

The Fission Chamber Drive Position will display the current position of the Fission Chamber drive.

The Shim Safety #1 Drive Position will display the current position of the Shim Safety #1 drive.

The Shim Safety #2 Drive Position will display the current position of the Shim Safety #2 drive.

The Regulating Rod Drive Position will display the current position of the Regulating Rod drive.

The Fission Chamber Drive Upper and Lower Limit Indicators will display the status of the respective indicators.

The Source Drive Selection Upper and Lower Limit Indicators will display the status of the respective indicators.

The Shim Safety #1 Drive Upper Limit, Lower Limit, and 2/3 Indicators will display the status of the respective indicators.

The Shim Safety #2 Drive Upper Limit, Lower Limit, and 2/3 Indicators will display the status of the respective indicators.

The Regulating Rod Drive Upper Limit, Lower Limit, and 2/3 Indicators will display the status of the respective indicators.

The Selected Rod Target Position field will display the reactor operator entered target position value.

3.2.38.2 Operator Functions

The Rod Motion Control display screen will display the following operator controls:

- Fission Chamber Drive Selection button (RODS-FISS-SEL)
- Source Drive Selection button (RODS-SRC-SEL)
- Shim Safety #1 Drive Selection button (RODS-SS1-SEL)
- Shim Safety #2 Drive Selection button (RODS-SS2-SEL)
- Regulating Rod Drive Selection button (RODS-RR-SEL)
- Clear Selection button
- Selected Rod Target Position (RODS-TARGET)
- Selected Rod Fine Withdraw button (RODS-FINE-WITH)
- Selected Rod Fine Insert button (RODS-FINE-INSERT)
- Selected Rod Coarse Withdraw button (RODS-COARSE-WITH)
- Selected Rod Coarse Insert button (RODS-COARSE-INSERT)
- Gang Lower button (RODS-GANG-REQ)

- Automatic Rod Insert Start button (RODS-INSERT-REQ)
- Automatic Rod Withdraw Start button (RODS-WITH-REQ)
- Automatic Rod Movement Stop button

Clicking on the Fission Chamber Drive Selection button will select the Fission Chamber drive and automatically unselect all other drives. If automatic rod motion is in progress, it will also terminate the automatic rod motion if the Fission Chamber drive has been unselected (same as clicking on the Automatic Rod Movement Stop button).

Clicking on the Source Drive Selection button will select the Source drive and automatically unselect all other drives. If automatic rod motion is in progress, it will also terminate the automatic rod motion if the Source drive has been unselected (same as clicking on the Automatic Rod Movement Stop button).

Clicking on the Shim Safety #1 Drive Selection button will select the Shim Safety #1 drive and unselect all other drives. If automatic rod motion is in progress, it will also terminate the automatic rod motion if the Shim Safety #1 drive has been unselected (same as clicking on the Automatic Rod Movement Stop button).

Clicking on the Shim Safety #2 Drive Selection button will select the Shim Safety #2 drive and unselect all other drives. If automatic rod motion is in progress, it will also terminate the automatic rod motion id the Shim Safety #2 drive has been unselected (same as clicking on the Automatic Rod Movement Stop button).

Clicking on the Regulating Rod Drive Selection button will select the Regulating Rod drive and unselect all other drives. If automatic rod motion is in progress, it will also terminate the automatic rod motion if the Regulating Rod drive has been unselected (same as clicking on the Automatic Rod Movement Stop button).

Clicking on the Selected Drive Target Position field will provide a value entry field for the reactor operator to enter a target position value for automatic drive movement.

Clicking on the Selected Drive Fine Withdraw button requests the selected drive(s) be withdrawn one “fine step”. The position change for one “fine step” is unique to each drive and a programmed setting parameter in the control algorithm. Each press of the Selected Drive Fine Withdraw button withdraws the drives only one step, the button must be pressed for each “fine step” to be withdrawn. The Selected Drive Fine Withdraw button will be disabled if no drives are selected or more than one drive is selected.

Clicking on the Selected Drive Coarse Withdraw button requests the selected drive(s) be withdrawn one “coarse step”. The position change for one “fine step” is unique to each drive and a programmed setting parameter in the control algorithm. Each press of the Selected Drive Coarse Withdraw button withdraws the drives only one step, the button must be pressed for each “coarse step” to be withdrawn. The Selected Drive Coarse Withdraw button will be disabled if no drives are selected or more than one drive is selected.

NOTE: Clicking on the Selected Drive Coarse / Fine Withdraw button requests the control algorithm withdraw the selected drives one “course / fine step”. Whether the selected drives are actually withdrawn is determined by the control algorithm. For example, if any of the selected drives have encountered a limit switch, the drive will not change position.

Clicking on the Selected Drive Fine Insert button requests the selected drive(s) be inserted one "fine step". The position change for one "fine step" is unique to each drive and a programmed setting parameter in the control algorithm. Each press of the Selected Drive Fine Insert button inserts the drives only one step, the button must be pressed for each "fine step" to be inserted. The Selected Drive Fine Insert button will be disabled if no drives are selected.

Clicking on the Selected Drive Coarse Insert button requests the selected drive(s) be inserted one "coarse step". The position change for one "coarse step" is unique to each drive and a programmed setting parameter in the control algorithm. Each press of the Selected Drive Coarse Insert button inserts the drives only one step, the button must be pressed for each "coarse step" to be inserted. The Selected Drive Coarse Insert button will be disabled if no drives are selected.

NOTE: Clicking on the Selected Drive Fine / Coarse Insert button requests the control algorithm insert the selected drives one "fine / coarse step". Whether the selected drives are actually inserted is determined by the control algorithm. For example if any of the selected drives have encountered a limit switch, the drive will not change position.

Clicking on the Gang Lower button automatically selects Shim Safety #1 Drive, Shim Safety #2 Drive and Regulating Rod Drive and deselects the Source Drive and the Fission Chamber Drive. It also sets the Selected Drive Target Position field to 0 and selects the Automatic Drive Movement Start button.

Clicking on the Automatic Drive Withdraw Start button begins drive motion for the selected drive. The selected drive is automatically withdrawn until it reaches the Selected Drive Target Position. Once the selected drive reaches the Selected Drive Target Position, the automatic drive motion is terminated. The exception is the Source drive. The source drive will withdraw until it reaches the upper limit when Automatic Drive Withdraw is selected. The Automatic Drive Withdraw Start button is disabled if more than one drive is selected.

Clicking on the Automatic Drive Insert Start button begins drive motion for the selected drives. The selected drives are automatically inserted until they reach the Selected Drive Target Position. Once the selected drives reach the Selected Drive Target Position, the automatic drive motion is terminated. The exception is the Source drive. The source drive will insert until it reaches the lower limit when Automatic Drive Withdraw is selected.

Clicking on the Automatic Drive Movement Stop button stops all automatic drive motion at the current position.

Note: Fine and coarse step rod movement is not interrupted until the step change has been completed (a step change cannot be interrupted while it is in progress).

3.2.39 Class 1 Horn

See PUR1-SRS-SDD-001 for the software requirements for this function.

See Section 3.2.14 for the HMI requirements for this function.

3.2.40 Indicator Test / Reset

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.40.1 Display Functions

The Annunciator Test / Reset display screen will display the following parameters:

- Chiller On Indicator (CH-ON-OFF-IND)
- Environmental Health Indicator (ENV-HLTH-IND)
- Pump On Indicator (MU-IND)
- Chiller Ready Indicator (CH-POWER-IND)
- Annunciator Acknowledge Indicator (ANN-ACK-IND)
- Magnet Power Indicator (MAG-PWR-IND)
- Control Room Alarm Indicator (CR-ALM-IND)
- House Alarm Indicator (HOUSE-ALM-IND)
- Isolate Confinement Indicator (ISO-CONF-IND)
- Annunciator Spare #1 Indicator (ANN-SPARE-1-IND)
- Annunciator Spare #2 Indicator (ANN-SPARE-2-IND)
- Annunciator DAS Trouble Indicator (ANN-DAS-IND)
- Annunciator CAM SCRAM Indicator (ANN-CAM-IND)
- Annunciator RAM SCRAM Indicator (ANN-RAM-IND)
- Annunciator Channel Fault Indicator (ANN-CH-FLT-IND)
- Annunciator Power SCRAM Indicator (ANN-PWR-SCR-IND)
- Annunciator Period SCRAM Indicator (ANN-PER-SCR-IND)
- Annunciator Workstation Health Indicator (ANN-WKS-IND)
- Annunciator Manual SCRAM Indicator (ANN-MAN-SCR-IND)
- Annunciator Servo Control Setback Indicator (ANN-SERV-STBK-IND)
- Annunciator Withdraw Interlock Indicator (ANN-INTLCK-IND)
- Annunciator Power Setback Indicator (ANN-PWR-STBK-IND)
- Annunciator Period Setback Indicator (ANN-PER-STBK-IND)
- Annunciator Class 1 Alarm Horn (ANN-HORN)
- Test Indicator (IND-TEST)
- Reset Indicator (IND-RESET)

Chiller On Indicator, Environmental Health Indicator , Pump On Indicator , Chiller Ready Indicator , Annunciator Acknowledge Indicator , Magnet Power Indicator , Control Room Alarm Indicator , House Alarm Indicator , Isolate Confinement Indicator, Annunciator Spare #1 Indicator, Annunciator Spare #2 Indicator, Annunciator DAS Trouble Indicator, Annunciator CAM SCRAM Indicator, Annunciator RAM SCRAM Indicator, Annunciator Channel Fault Indicator, Annunciator Power SCRAM Indicator, Annunciator Period SCRAM Indicator, Annunciator Workstation Health Indicator, Annunciator Manual SCRAM Indicator, Annunciator Servo Control Setback Indicator, Annunciator Withdraw Interlock Indicator, Annunciator Power Setback Indicator, Annunciator Period Setback Indicator, Annunciator Class 1 Alarm Horn, and Annunciator Test Indicator will be displayed as soft indicators on the display screen.

3.2.40.2 Operator Functions

The Indicator Test / Reset display screen will display the following operator controls:

- Indicator Test button

- Indicator Reset button

Clicking on the Indicator Test button will SET the value of RCS logical data point IND-TEST which will cause the Control Algorithm to light all operator console indicators, annunciator tiles, and the Class 1 Alarm Horn.

Clicking on the Indicator Reset button will SET the value of RCS logical data point IND-RESET which will reset any latches set for the annunciator digital output signals. This will also RESET IND-TEST to remove any previous test selection.

3.2.41 Resettable Timer

The Resettable Timer Function will utilize the Windows 10 built-in Stopwatch and Timer in Alarm Application.

3.2.42 Temporary Setback Limits

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.42.1 Display Functions

The Setback Limits display screen will display the following parameters:

- Temporary Period Setback Limit (PER-STBK-TMP-HI-LMT)
- Temporary Power Setback Limit (PWR-STBK-TMP-HI-LMT)
- Current Period Setback Limit (PER-STBK-HI-LMT)
- Current Power Setback Limit (PWR-STBK-HI-LMT)
- Enable / Disable Temporary Setback Limits (STBK-TMP-ENAB)

Enable / Disable Temporary Setback Limits will be displayed as a soft indicator on the display screen.

Temporary Period Setback Limit and Temporary Power Setback Limit will be displayed as data entry fields on the display screen.

Current Period Setback Limit and Current Power Setback Limit will be displayed as numeric values on the display screen.

3.2.42.2 Operator Functions

The Setback Limits display screen will display the following operator controls:

- Temporary Period Setback Limit data entry field
- Temporary Power Setback Limits data entry field
- Enable / Disable Temporary Setback Limits button

Clicking either the Temporary Period Setback Limit data entry field or the Temporary Power Setback Limit data entry field will provide the operator the ability to enter a temporary limit for Period Setback or Power Setback.

Data entry to the Temporary Period Setback Limit field will be limit to 0.0 to 8.3333. Data entry to the Temporary Power Setback Limit field will be limited to 0 to 110.0. Values outside of those ranges will be rejected and display an error.

Clicking on the Enable / Disable Temporary Setback Limits button will SET the value of RCS logical data point STBK-TMP-ENAB which will enable the temporary setback limits entered by the operator.

3.2.43 Automatic Startup

See PUR1-SRS-SDD-001 for the software requirements for this function.

3.2.43.1 Display Functions

The Automatic Startup display screen will display the following parameters:

- Current Reactor Period (NFD-1-CR)
- Current Reactor Power Level (NFD-3-PWR)
- Target Startup Power Level (AUTO-START-PWR)
- Automatic Startup Status (AUTO-START-STA)
- Start / Pause / Stop Automatic Startup (AUTO-START-REQ)
- All Rods At Bottom (SS1-ROD-BOT and SS2-ROD-BOT)
- Magnet Power Engaged (MAG-PWR-CTL)

Disable Automatic Startup will be displayed as button on the display screen.

Target Startup Power Level will be displayed as data entry fields on the display screen.

Current Reactor Power Level will be displayed as a numeric value and as a trend plot on the display screen.

Current Reactor Change Rate will be displayed as a numeric value and on the same trend plot as Current Reactor Power Level on the display screen.

3.2.43.2 Operator Functions

The Automatic Startup display screen will display the following operator controls:

- Target Startup Power Level data entry field
- Disable Automatic Startup button

Clicking on the Target Startup Power Level data entry field will provide the operator the ability to enter a power level for Automatic Startup. Data entry to the Target Startup Power Level field will be limited to 0.0 to 100.0. Values outside of those ranges will be rejected and display an error.

The appearance of the Start button will be enabled if the following conditions are true:

- Operator Security Level >= 15
- All Rods at Bottom condition set
- Magnet Power Enabled condition set

- Automatic Startup Status set to 0

Clicking on the Start button will SET the value of RCS logical data point AUTO-START-REQ to 1 which will activate the automatic startup sequence.

3.3 RCS System Displays

3.3.1 Alarm Summary Screen

The alarm summary screen shall be accessible from any other screen by use of a navigation button on the top of the screen. The navigation button shall flash when an unacknowledged alarm is active. The screen shall display a list of all alarm conditions that exist in the control system, time-stamped and dated with the most recent on top. New alarms (not acknowledged) will be flashing in the list. Touching/clicking a function button on the screen to acknowledge alarms stops the flashing. This action also causes the Alarm Screen navigation button to stop flashing on the top of the other screens. A feature shall be provided to allow the operator to display only unacknowledged alarms. Function buttons are provided to “Page Up” and “Page Down” in the alarm listing.

The bottom of this screen shows the number of active alarms that exist and the status of the alarm currently displayed. The message should read 100% to indicate that all active alarms have been populated on the screen’s visible area.

The alarm summary screen will allow the operator to generate alarm history reports. The contents of the “Alarm History Report” shall be configurable by the operator and shall support filtering by specific alarms or by a selected time period.

System events that may be significant to the rector operator will also be included on the Alarm Summary display screen but will not cause the navigation button on the top of all display screens to flash nor will they require acknowledgement by the operator.

3.3.2 Control System Health

Control system status screens shall provide indication of various status alarms generated by diagnostic programs within the control system or external inputs from system components. These screens shall allow an operator to diagnose failure conditions.

Screens shall be provided for detailed analysis of the health and status of each control system chassis and I/O card. These screens shall display the analog value or digital state of each I/O point. The screens will also display a FAIL status for each point if one exists. The control system logic checks each point and determines if the signal quality is acceptable for use in the downstream program(s). If the value is outside of specific criteria, the point is flagged with a fault condition.

3.4 R*TIME System Administrator Displays

The R*TIME system administrator displays will be available on the ROC workstation. The R*TIME system administrator displays provide additional capability to view RCS system data and events. The following are the R*TIME system administrator displays that will be provided. To access any of these displays requires the user to logon to an elevated System Administrator password. Each of the following is illustrated and described in more detail in the SDD portion of this document:

- Archive Subsystem Displays
  - Backup
  - Monitor
  - Edit
- Database
  - Analog Point Attribute
  - Digital Point Attribute
- Message Subsystem Displays
  - Backup
- Scheduler
- RTP I/O
  - Addressing
  - Health
- System Calculations
- Point Group Update
- Password Update
- Test Database Manipulator (TDBM – Development and Testing only)

3.5 R*TIME User Displays

The R*TIME user displays will be available on the ROC workstation. The R*TIME user displays provide additional capability to view RCS system data and events for all display workstation users. The following are the R*TIME user displays that will be provided. Each of the following is illustrated and described in more detail in the SDD portion of this document:

- Alarm Summary
- Message Subsystem Displays
  - Summary
  - Retrieval
- Point Summaries
- Generic Trends
- System Health and Monitoring
- Tabular (Current Value)

NOTE: While these displays will be available to all users, certain display functions will only be available from the ROC workstation. For example, external workstations will be able to view alarms from the Alarm Summary display screen, but the alarm acknowledge functions will be restricted to only the ROC workstation.

3.6 Performance Requirements

There are no further performance requirements.

3.7 Security Requirements

3.7.1 Geographic Security Requirements

N/A.

3.7.2 Security Level Access Requirements

All access level security requirements for the HMI Functions Software will be defined in the SDD document (Section 4).

4 DISPLAY DESIGN

This section contains the design description for the RPCS HMI display screens used on the Reactor Operator Console (ROC) and Secondary workstations. It includes the design and layout of the display screen, how the display screen works, any assumptions and dependencies, input and output analog and digital points used or visible on the display screen, and a screen shot of the display screen.

4.1 Display Frames

Display frames are special display screens that are designed to be an overlay on multiple display screens. They can be used as a header or footer where the same information is needed on multiple display screens.

For the RPCS project, a "header" frame has been created as described below. The header frame is included on all display screens to provide information common to all displays.

4.1.1 Display Header

The headers for the display screens contain common information about the RPCS system. The data in the header provides general information about the RPCS system and its status. These headers are built to the resolution of the display screens. Most display screens include a header. A few pop-up support displays do not include header or footer overlays.

There is a general header frame used when accessing displays. Access to these displays occurs at the Operator Console Work Station (O2-WKS), which has two 19" monitors.

The header includes a page indicator, unit specification, date and time, alarm indicator button, and control system status indicators. This is the same across all display screens that are linked to the header. The ALM button will be immediately to the right of the date and time, while the control system status indicator graphic is at the far right of the header. The central area will show the display title and name, which are part of the display file.

Additionally, the reactor linear power and change rate will be displayed immediately to the left of the control system status.

Figure 4-1 – Header Frame Screenshot RCS System OK

Figure 4-2 – Header Frame Screenshot RCS System Trouble Alarm

Figure 4-3 – Header Frame Screenshot RCS System Failure Alarm

4.1.1.1 Header Frame Functionality

The header contains similar information from display to display. This information is detailed in the following table. The only exceptions are display elements "A", "B", "C", and "F", which are elements that lay on top of the frame display, allowing the displays to be customizable.

Table 4-1– Header Display Elements

Display Element	Functionality	Description
A	Indication / Navigation	Displays current Alarm Status. Provides direct, or indirect, navigation to the Alarm Summary display. Button will appear as follows: •  Solid Green – No alarms in the system •  Flashing Green – Unacknowledged Return to Normal alarms exist •  Solid Red – Acknowledged Alarms exist in the system •  Flashing Red – Unacknowledged Alarms exist in the system The indication of alarms does not distinguish between the types of alarm. For example, Flashing Red indicates there is at least one unacknowledged alarm regardless of whether it is a class 1 or class 2 alarm. Clicking on the ALM button on these display screens navigates to the Alarm\Event Summary display from which the user can see the alarm status of the RCS. *NOTE: System events will not affect the color or flashing status of the ALM button.*
B	Current Date	Date in format MM/DD/YY.
C	Current Time	Time in format HH:MM:SS.
D	Display Title	Space for Display Title as defined on the display. *Different on display-by-display basis.
E	Display file name	Space for display filename as defined on the display. *Different on display-by-display basis.
F	Control System Health Indicator	Alerts user to trouble or failure of Control System. Shape disappears and text says “Control Sys OK” when system is normal. Shape and text (“Control Sys Trbl”) blink yellow when in trouble state, and red when in a failure state (“Control Sys Fail”).

4.1.2 Menus

4.1.2.1 Main Menu

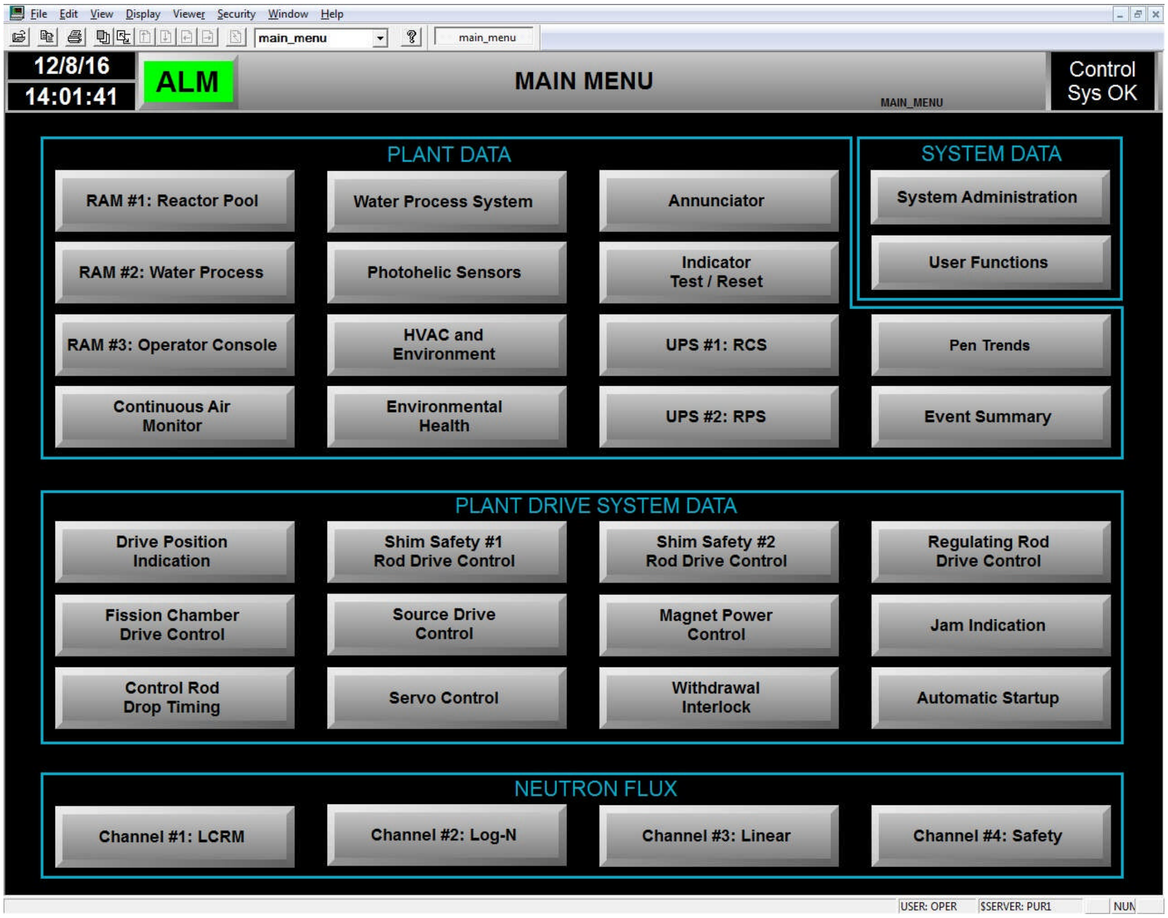


Figure 4-4 – Main Menu

Note: *The user can always return to the workstation's Main Menu display screen by clicking on the display title text in the center of the display header, pressing the <Home> button, or by pressing <Ctrl> + <T>.*

4.1.2.2 R*TIME User Functions Menus

The R*TIME User Functions Menu (Figure 4-5) provides access to the various base R*TIME user displays and PUR-1 specific displays.

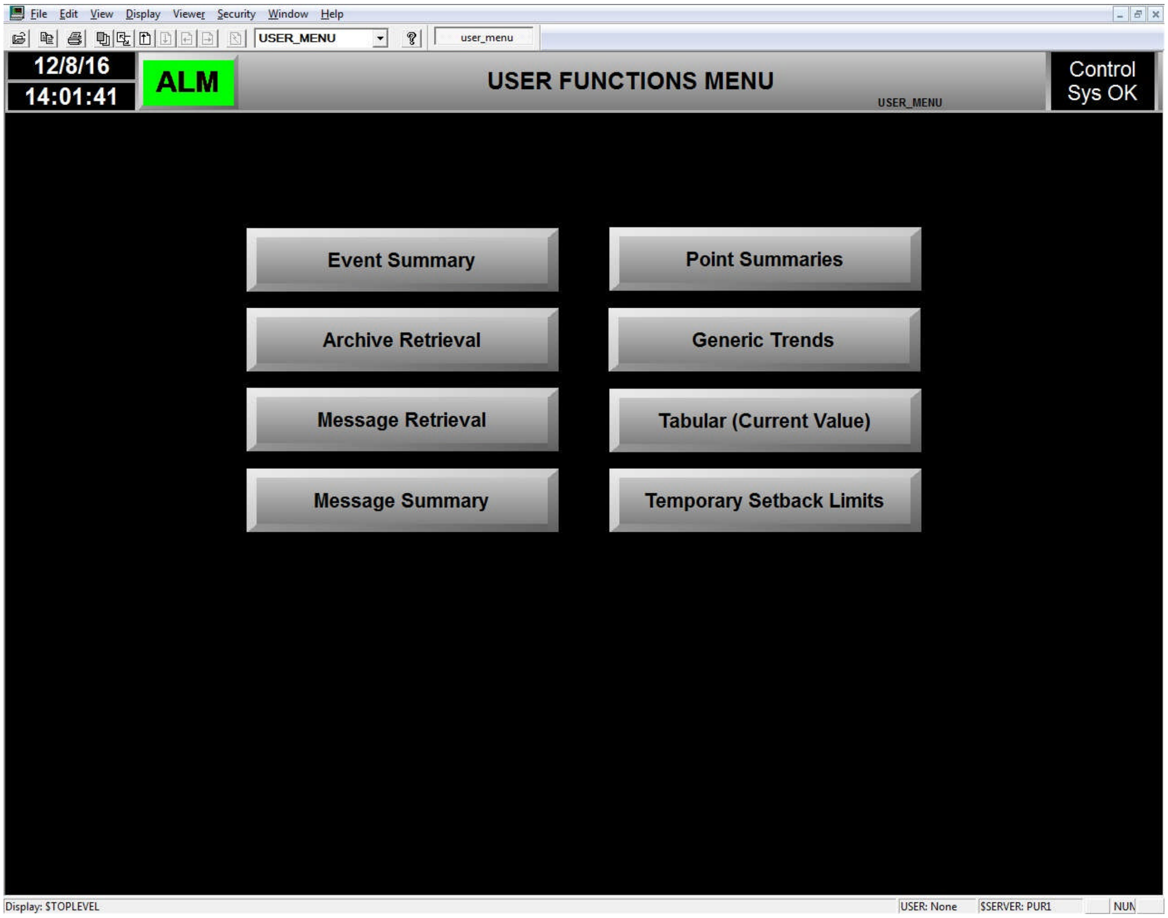


Figure 4-5 – R*TIME User Functions Menu

4.1.2.3 R*TIME Administrator Menu

The R*TIME Administrator Menu (Figure 4-6), provides access to base R*TIME system administrator displays and functions. Descriptions of the R*TIME Administrator displays may be found in the R*TIME User's Manual (Reference 1.3.9).

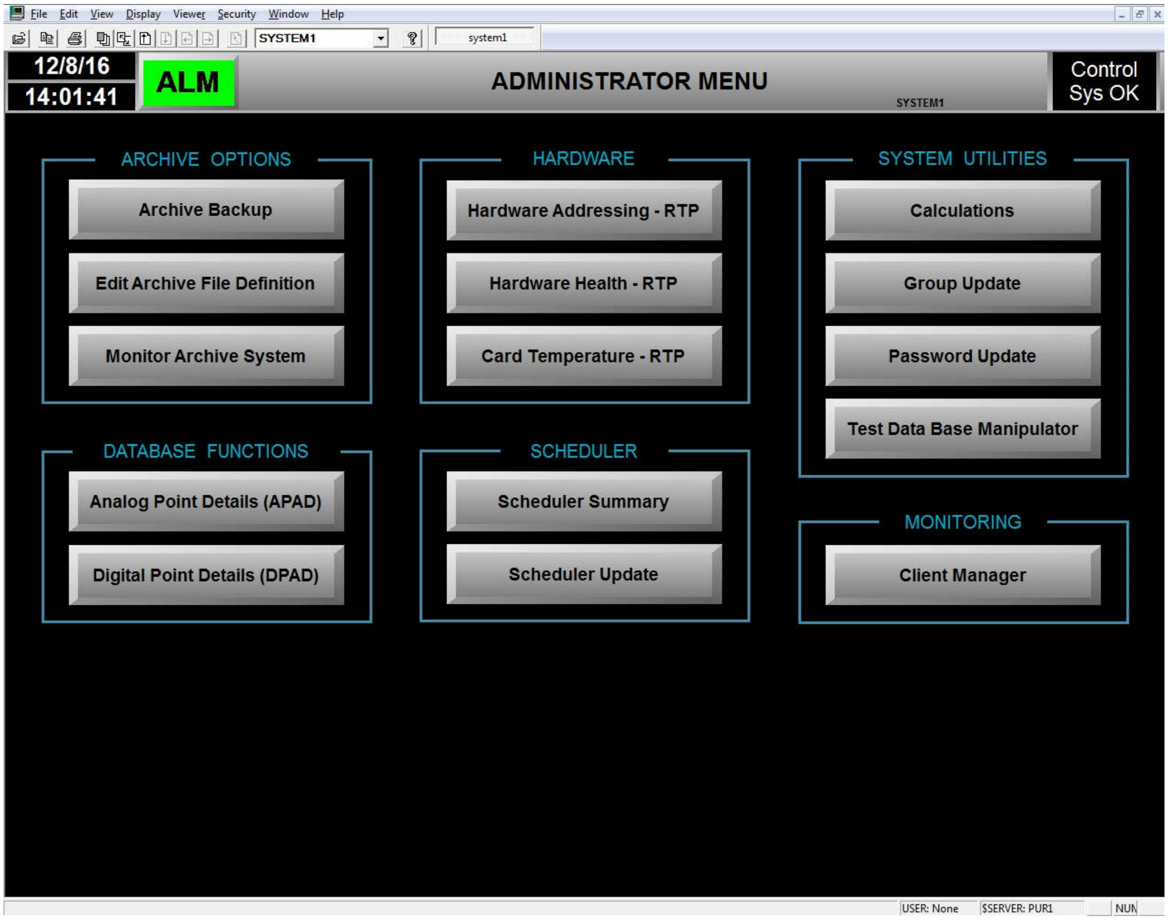


Figure 4-6 – R*TIME Administrator Menu

4.2 Control Status Displays

4.2.1 Radiation Area Monitor #1

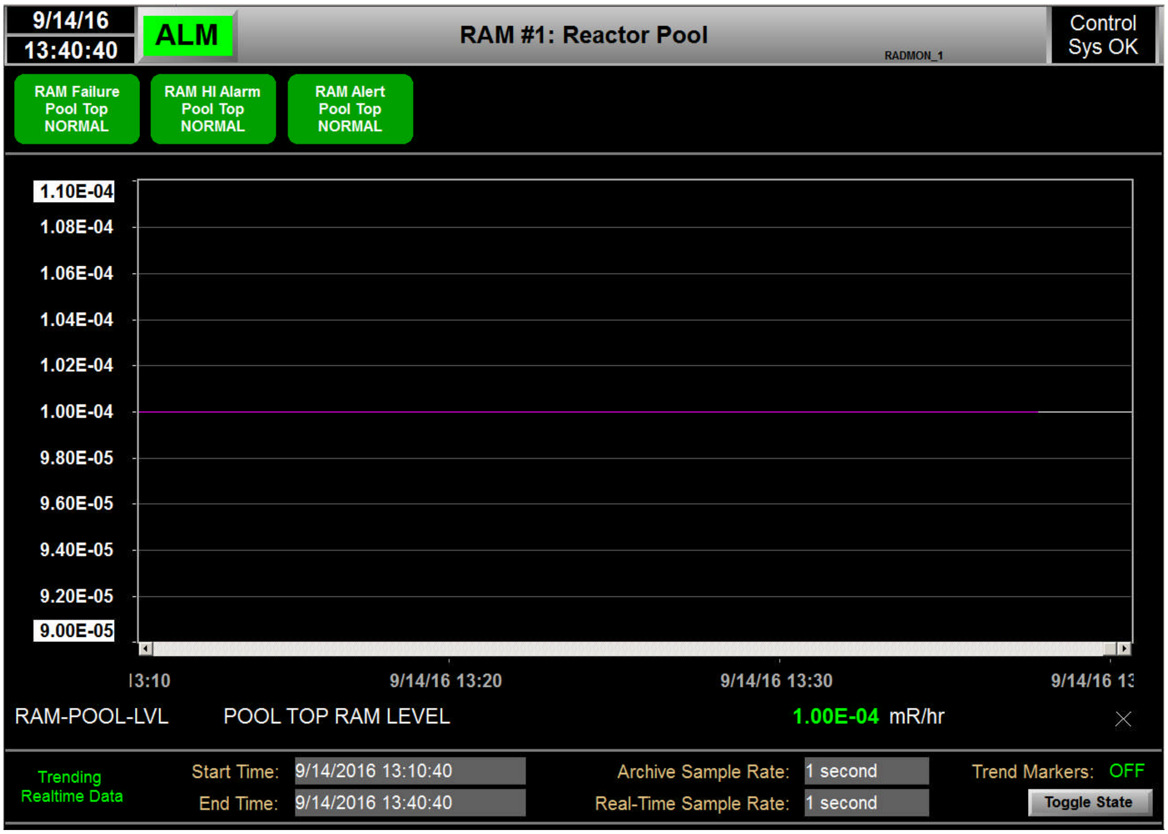


Figure 4-7 – Radiation Area Monitor #1 Display

4.2.1.1 Display Functions

The display has three (3) indicators below the top frame. There is a single point trend for "RAM-POOL-LVL". Below the trend are indications of the point name, description, value and engineering units for the point or points plot on the display.

4.2.1.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a 'Start Time' and 'End Time' to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.2 Radiation Area Monitor #2

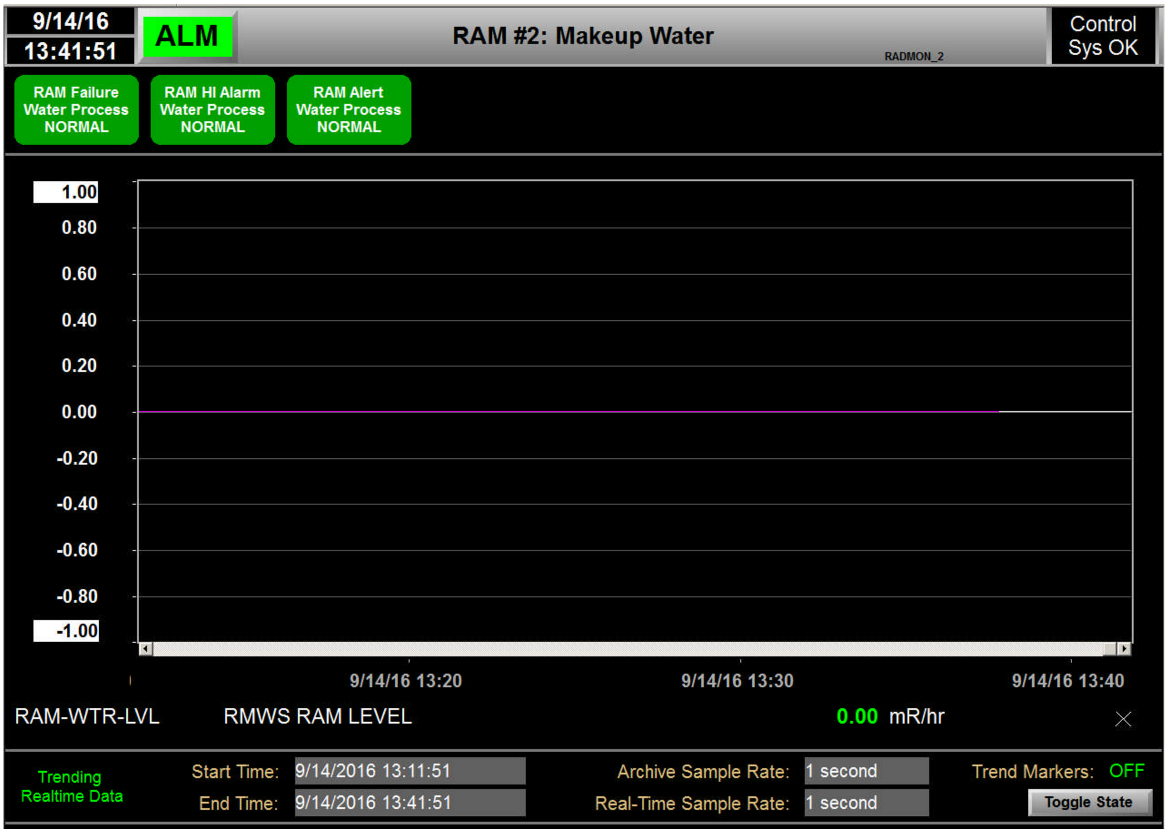


Figure 4-8 – Radiation Area Monitor #2 Display

4.2.2.1 Display Functions

The display has three (3) indicators below the top frame. There is a single point trend for "RAM-WTR-LVL". Below the trend are indications of the point name, description, value and engineering units for the point or points plot on the display.

4.2.2.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the

left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a 'Start Time' and 'End Time' to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.3 Radiation Area Monitor #3

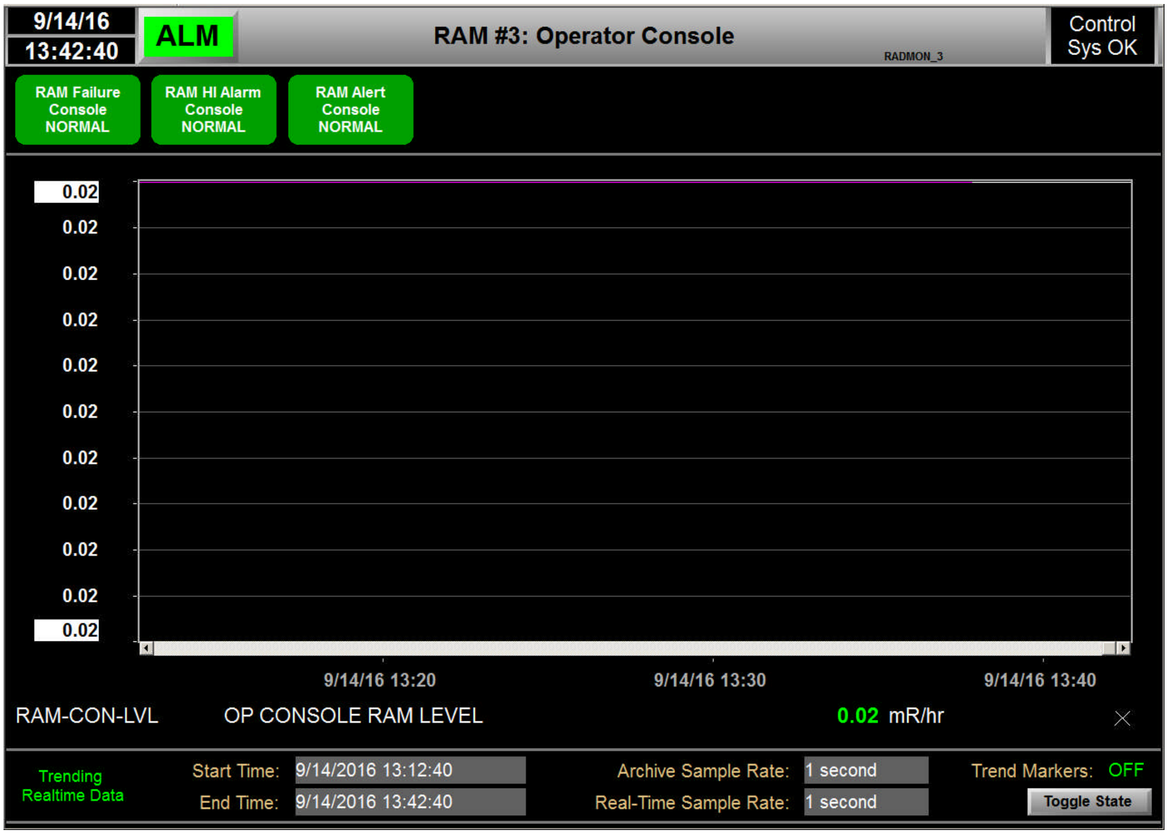


Figure 4-9 – Radiation Area Monitor #3 Display

4.2.3.1 Display Functions

The display has three (3) indicators below the top frame. There is a single point trend for "RAM-CON-LVL". Below the trend are indications of the point name, description, value and engineering units for the point or points plot on the display.

4.2.3.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can ‘drag’ the time location line to any point on the timeline, or use the left and right arrows in the ‘Trend Info’ pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a ‘Start Time’ and ‘End Time’ to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.4 Continuous Air Monitor

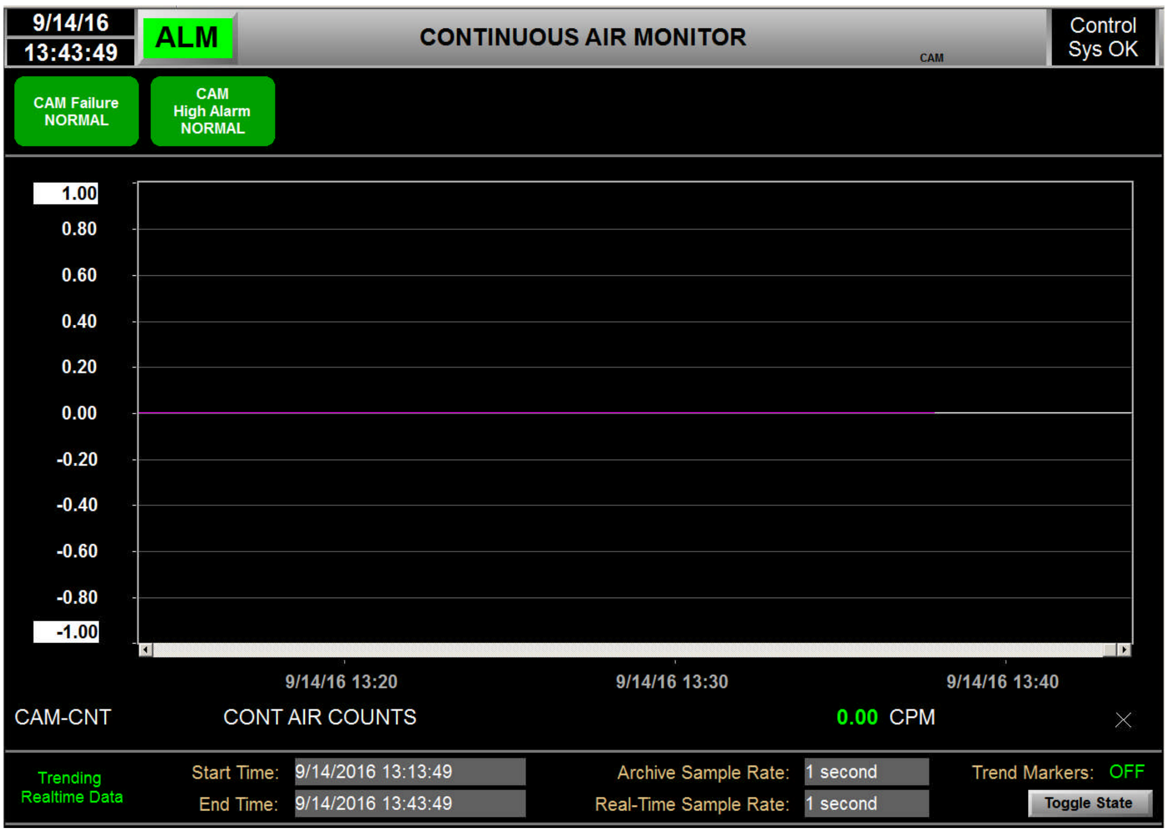


Figure 4-10 – Continuous Air Monitor Display

4.2.4.1 Display Functions

The display has two (2) indicators below the top frame. There is a single point trend for “CAM-CNT”. Below the trend are indications of the point name, description, value and engineering units for the point or points plot on the display.

4.2.4.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a 'Start Time' and 'End Time' to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.5 Neutron Flux Channel #1

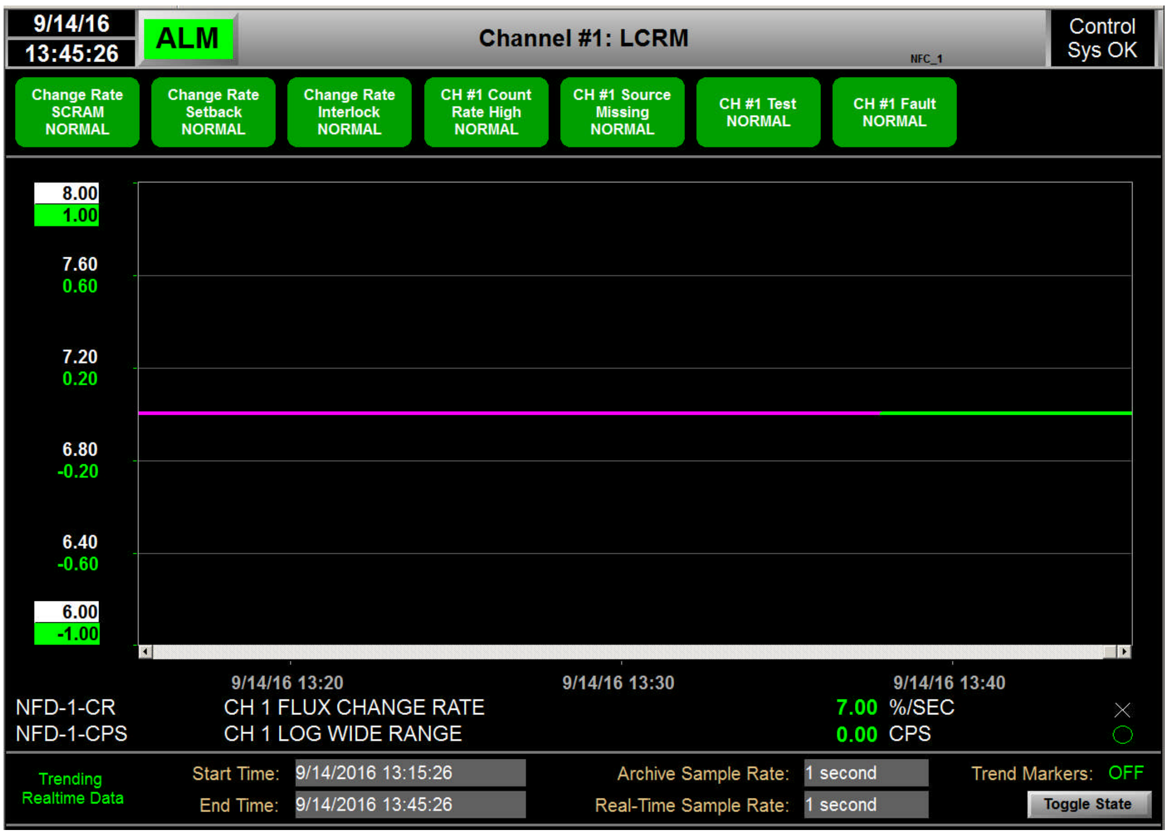


Figure 4-11 – Neutron Flux Channel #1 Display

4.2.5.1 Display Functions

The display has seven (7) indicators below the top frame. There is a two point trend for “NFD-1-CR” and “NFD-1-CPS”. Below the trend are indications of the point names, descriptions, values and engineering units for the point or points plot on the display.

4.2.5.2 Operator Functions

The operator can ‘left-click’ on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can ‘drag’ the time location line to any point on the timeline, or use the left and right arrows in the ‘Trend Info’ pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a ‘Start Time’ and ‘End Time’ to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.6 Neutron Flux Channel #2

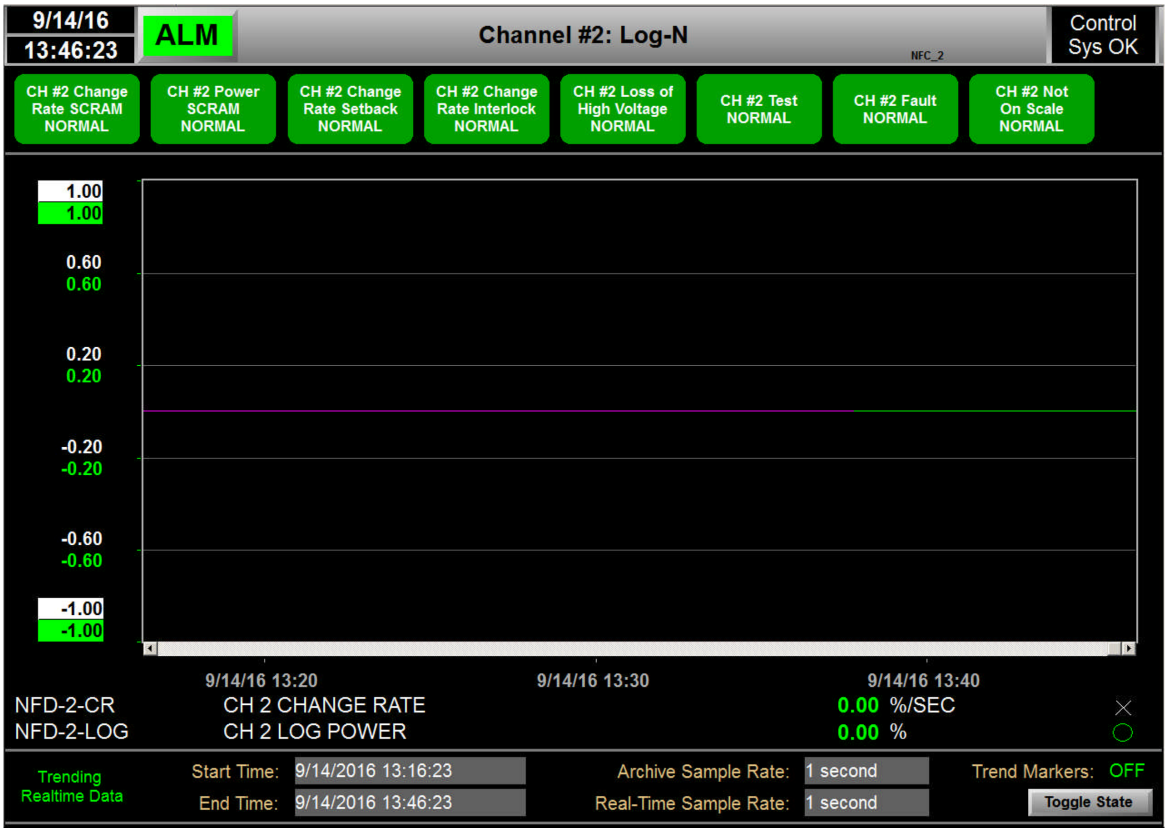


Figure 4-12 – Neutron Flux Channel #2 Display

4.2.6.1 Display Functions

The display has eight (8) indicators below the top frame. There is a two point trend for "NFD-2-CR" and "NFD-2-LOG". Below the trend are indications of the point names, descriptions, values and engineering units for the point or points plot on the display.

4.2.6.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a 'Start Time' and 'End Time' to allow working with archive data and or real-time data. The time can be a scrolling window, with

current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.7 Neutron Flux Channel #3

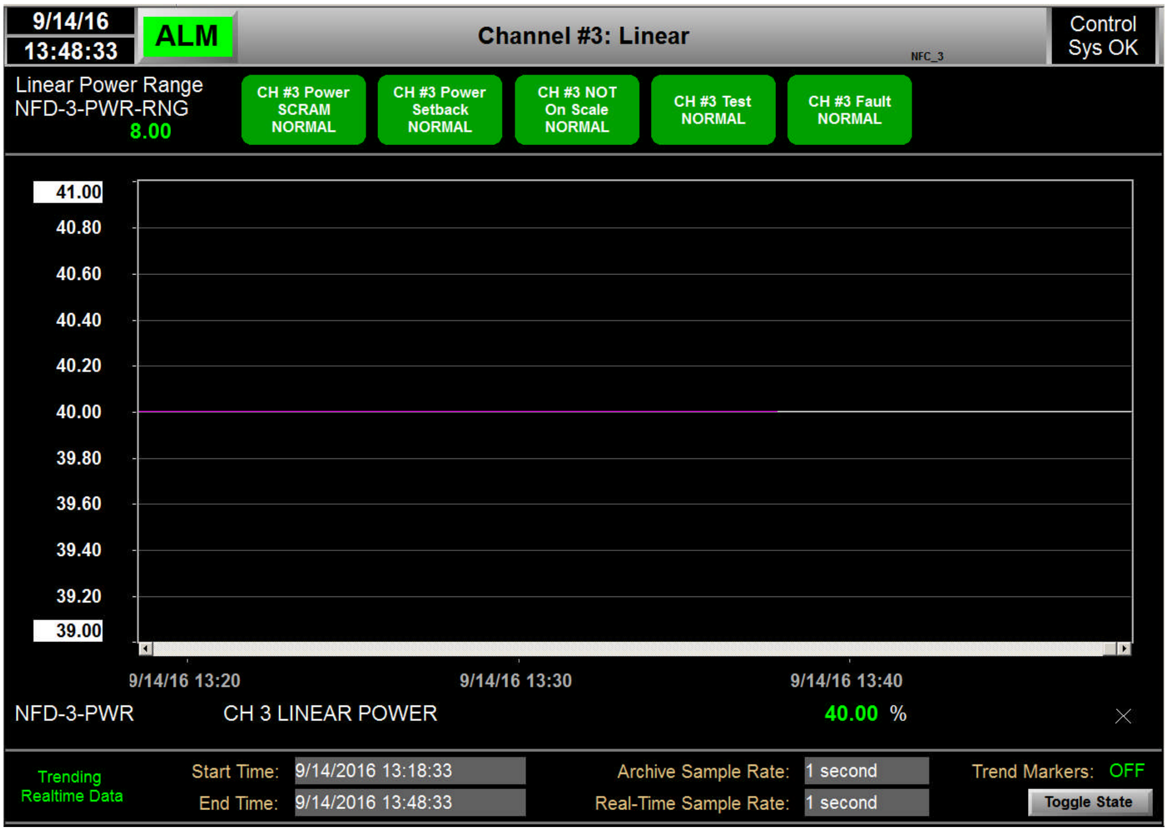


Figure 4-13 – Neutron Flux Channel #3 Display

4.2.7.1 Display Functions

The display has five (5) indicators below the top frame and one point (NFD-3-PWR-RNG) and value showing the current "Linear Power Range". There is a single point trend for "NFD-3-PWR". Below the trend are indications of the point name, description, value and engineering units for the point plot on the display.

4.2.7.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second

increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a ‘Start Time’ and ‘End Time’ to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.8 Neutron Flux Channel #4

Figure 4-14 – Neutron Flux Channel #4 Display

4.2.8.1 Display Functions

The display has four (4) indicators below the top frame. There is a single point trend for “NFD-4-FLUX”. Below the trend are indications of the point name, description, value and engineering units for the point plot on the display.

4.2.8.2 Operator Functions

The operator can ‘left-click’ on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a 'Start Time' and 'End Time' to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.9 HVAC and Environmental

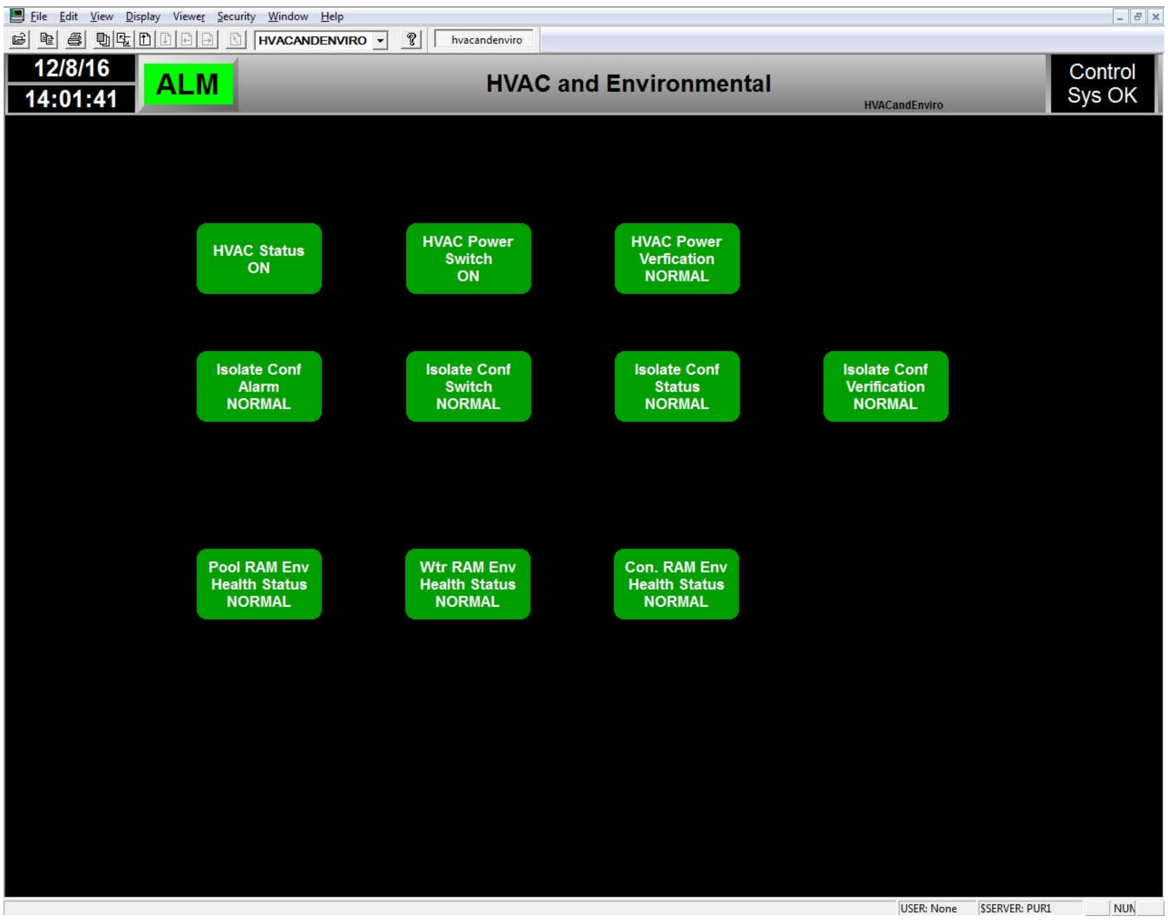


Figure 4-15 – HVAC and Environmental Display

4.2.9.1 Display Functions

The display has ten (10) indicators below the top frame.

4.2.9.2 Operator Functions

The operator can ‘left-click’ on the indicators to see a single point display of the underlying point.

4.2.10 Photohelic Sensors

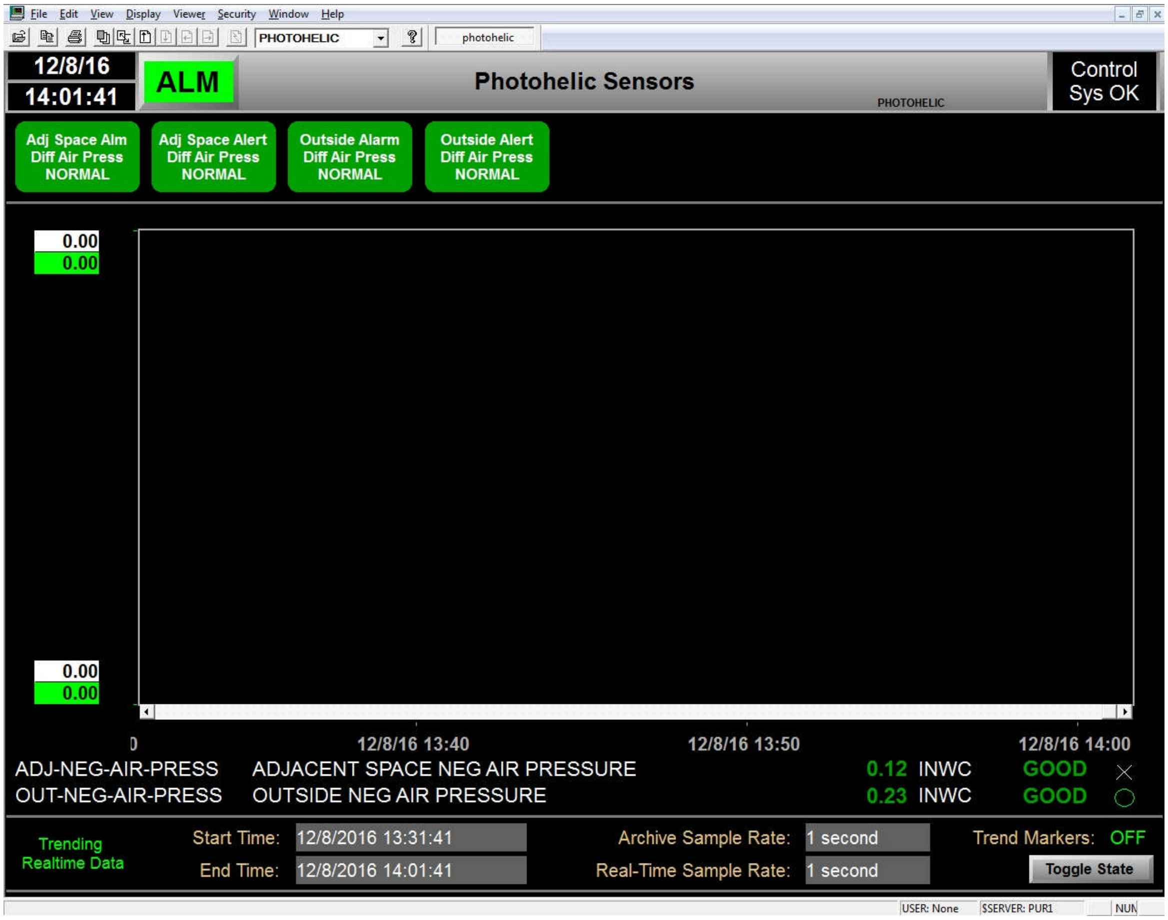


Figure 4-16 – Photohelic Sensors Display

4.2.10.1 Display Functions

The display has four (4) indicators below the top frame. There is a two point trend for “ADJ-NEG-AIR-PRESS” AND “OUT-NEG-AIR-PRESS”. Below the trend are indications of the point names, descriptions, values and engineering units for the point plot on the display.

4.2.10.2 Operator Functions

The operator can ‘left-click’ on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can ‘drag’ the time location line to any point on the timeline, or use the left and right arrows in the ‘Trend Info’ pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a ‘Start Time’ and ‘End Time’ to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.11 Makeup Water

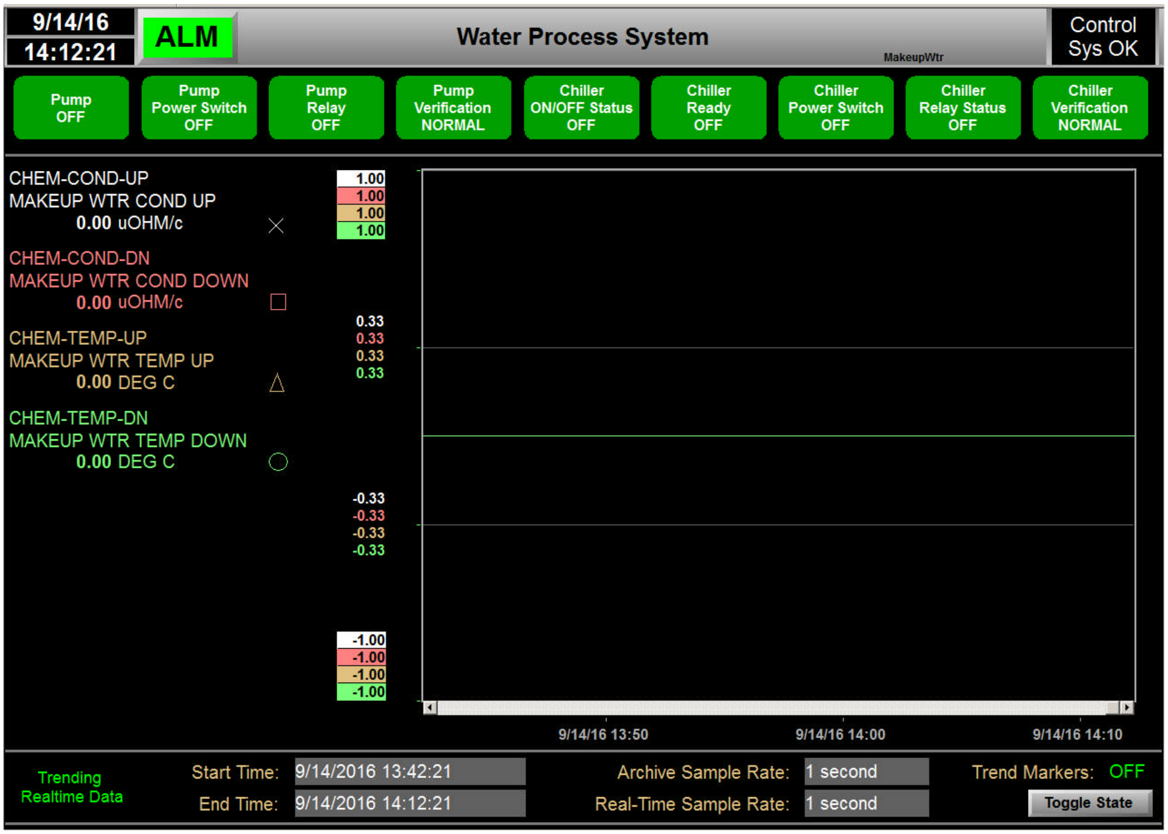


Figure 4-17 – Makeup Water Display

4.2.11.1 Display Functions

The display has nine (9) indicators below the top frame. There is a four point trend for “CHEM-COND-UP”, “CHEM-COND-DN”, “CHEM-TEMP-UP” and “CHEM-TEMP-DN”. To the left of the trend are indications of the point names, descriptions, values and engineering units for the point plot on the display.

4.2.11.2 Operator Functions

The operator can ‘left-click’ on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can ‘drag’ the time location line to any point on the timeline, or use the left and right arrows in the ‘Trend Info’ pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a ‘Start Time’ and ‘End Time’ to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.12 Water Chiller

See Section 4.2.11 for the HMI implementation for this function.

4.2.13 Water Chemistry Sensors

See Section 4.2.11 for the HMI implementation for this function.

4.2.14 Manual SCRAM

This function does not have an HMI implementation.

4.2.15 Key Switch

This function does not have an HMI implementation.

4.2.16 Control Room Alarm

This function does not have an HMI implementation.

4.2.17 House Alarm

This function does not have an HMI implementation.

4.2.18 Operator Console Recorders

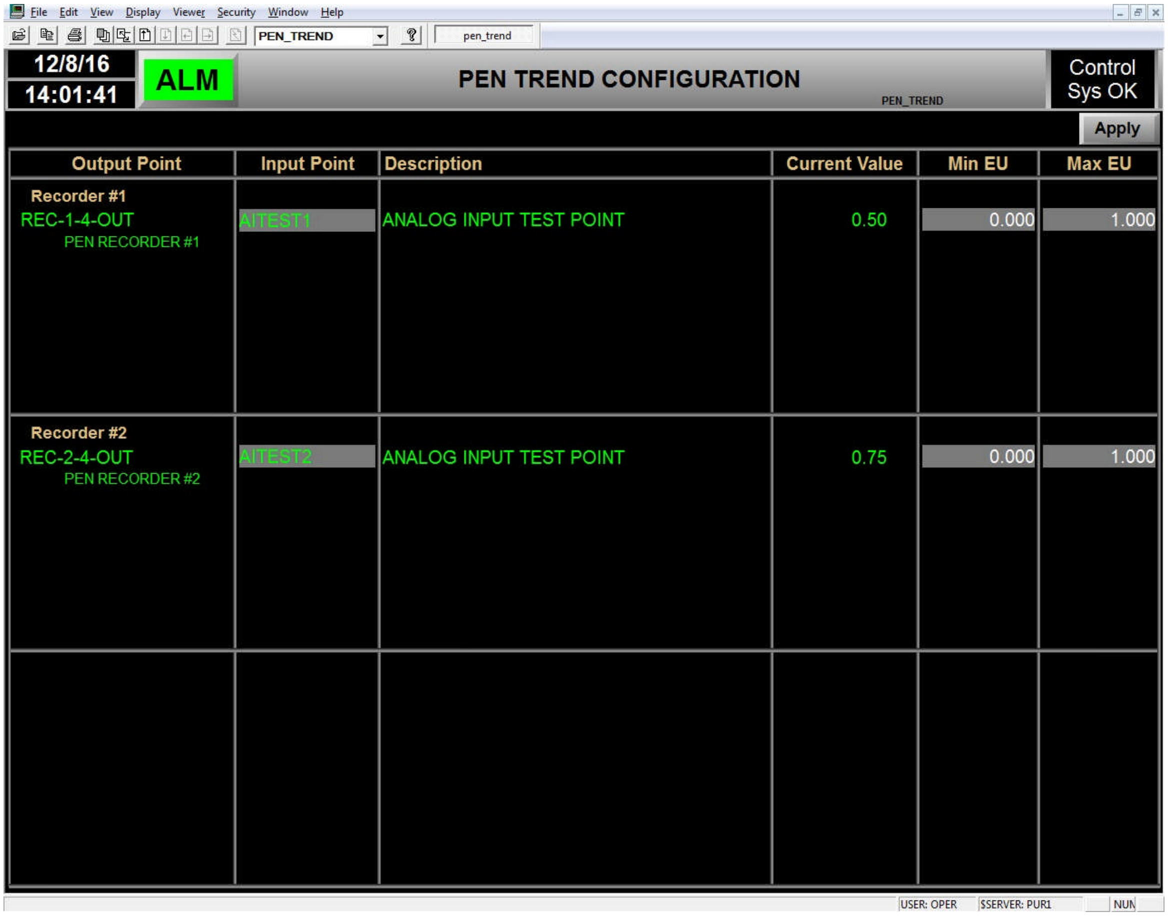


Figure 4-18 – Pen Trends Display

4.2.18.1 Display Functions

The Pen Trends display allows the operator to select two signals that will be output to channel 4 of either O1-REC-1 and O1-REC-2, the operator console recorders. The user must also enter minimum and maximum values for EU. The selected point(s) name, description, and current value will be displayed as well.

4.2.18.2 Operator Functions

The user will select an analog input point by left-clicking within an Input Point field. After the point is selected, the operator must enter a minimum and maximum EU value for the trend. The trend value will be 0-100% of the entered scale. Once all the desired information is entered, the operator must left-click the Apply button to apply the settings to the trend recorders.

4.2.19 UPS #1

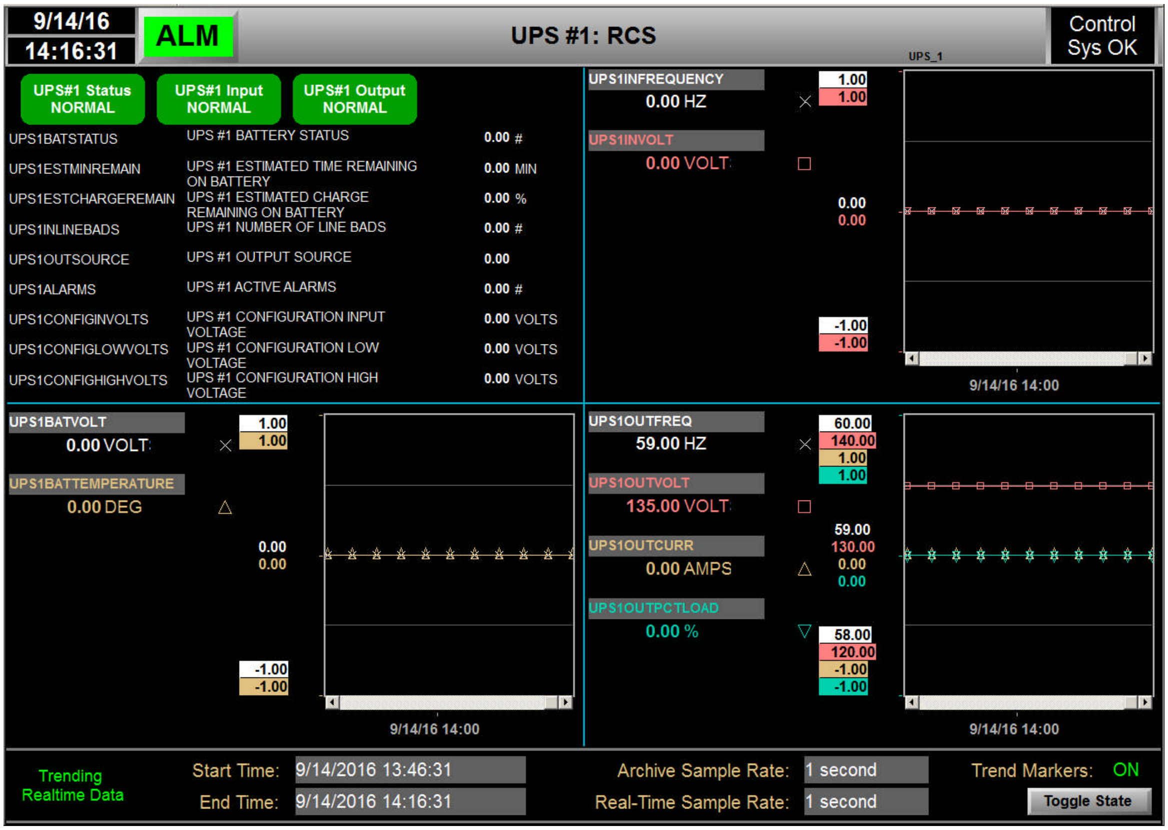


Figure 4-19 – UPS #1 Display

4.2.19.1 Display Functions

The display has three (3) indicators below the top frame. Below the status indicators there are nine (9) points with point description, digital values, and engineering units. There are three (3) trends on the display. On the bottom left is a trend showing UPS Battery voltage and temperature. On the upper right is a trend showing UPS input frequency and input voltage. And, on the lower right, is a trend showing UPS output frequency, output voltage, output current, and percentage of available output load. To the left of each trend are indications of the point names, descriptions, values and engineering units for the trend plots on the display.

4.2.19.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second

increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a 'Start Time' and 'End Time' to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.20 UPS #2

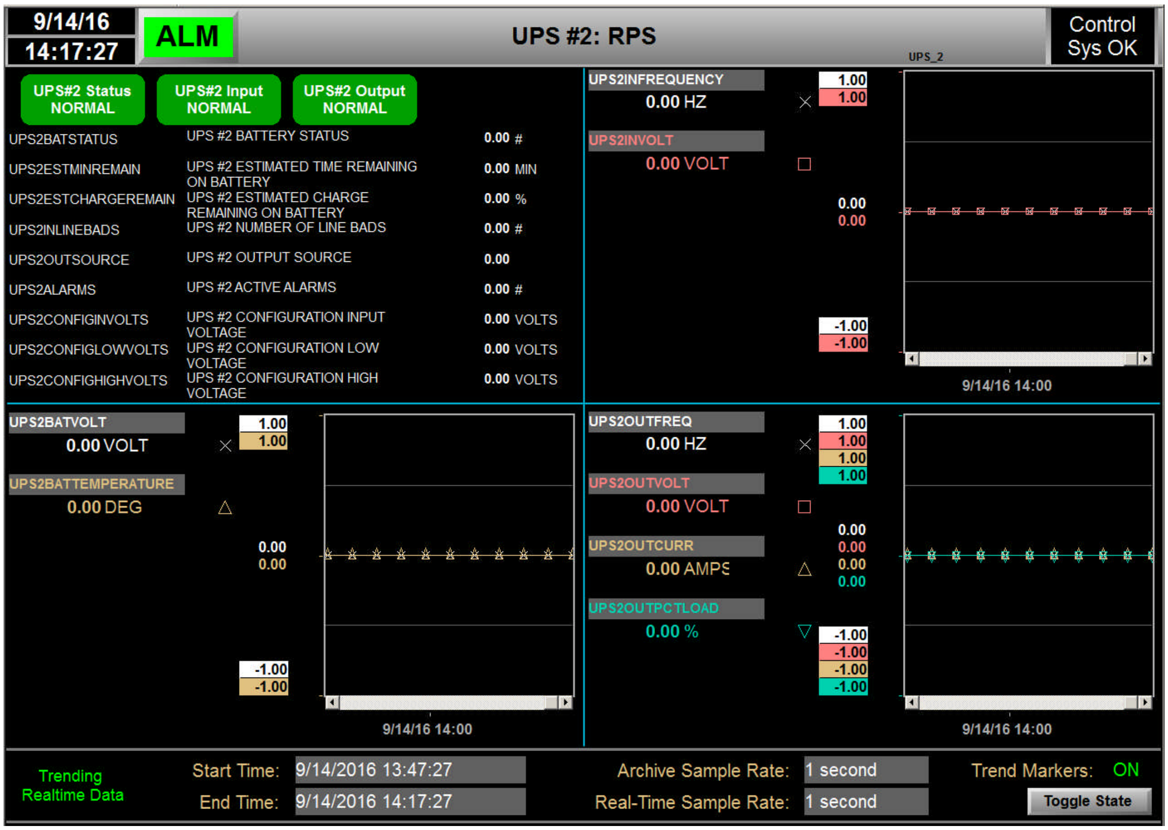


Figure 4-20 – UPS #2 Display

4.2.20.1 Display Functions

The display has three (3) indicators below the top frame. Below the status indicators there are nine (9) points with point description, digital values, and engineering units. There are three (3) trends on the display. On the bottom left is a trend showing UPS Battery voltage and temperature. On the upper right is a trend showing UPS input frequency and input voltage. And, on the lower right, is a trend showing UPS output frequency, output voltage, output current, and percentage of available output load. To the left of each trend are indications of the point names, descriptions, values and engineering units for the trend plots on the display.

4.2.20.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a 'Start Time' and 'End Time' to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.21 Withdrawal Interlock

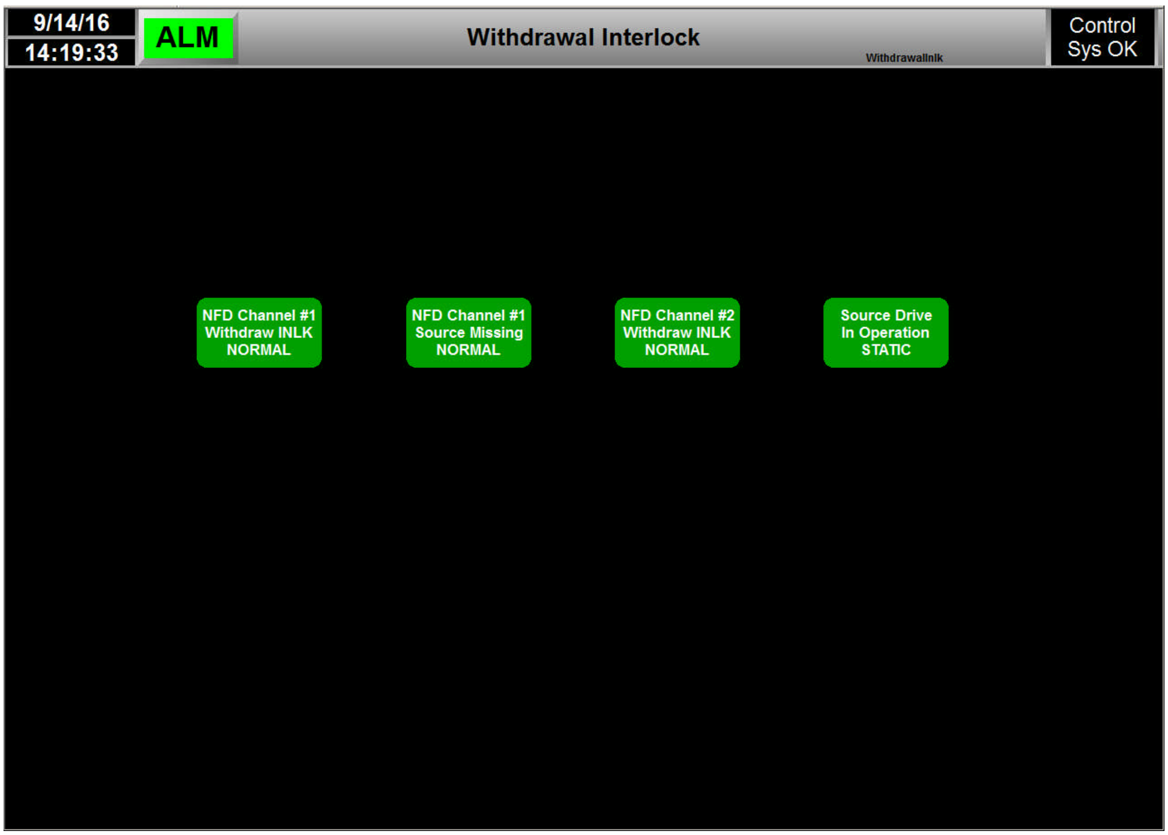


Figure 4-21 – Withdrawal Interlock Display

4.2.21.1 Display Functions

The display has four (4) indicators below the top frame. There are no trends on the display.

4.2.21.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

4.2.22 Fission Chamber Drive Control

Figure 4-22 – Fission Chamber Drive Control Display

4.2.22.1 Display Functions

The display has three (3) indicators below the top frame. There is a single point trend for "FISS-POSITION". Below the trend are indications of the point name, description, value and engineering units for the point plot on the display.

4.2.22.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can ‘drag’ the time location line to any point on the timeline, or use the left and right arrows in the ‘Trend Info’ pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a ‘Start Time’ and ‘End Time’ to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

See Section 3.2.38 for the rod motion control display screen requirements.

4.2.23 Source Drive Control

Figure 4-23 – Source Drive Control Display

4.2.23.1 Display Functions

The display has three (3) indicators below the top frame. There is a single point trend for "SRC-POSITION". Below the trend are indications of the point name, description, value and engineering units for the point plot on the display.

4.2.23.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a 'Start Time' and 'End Time' to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

See Section 3.2.38 for the rod motion control display screen requirements.

4.2.24 Shim Safety #1 Rod Drive Control

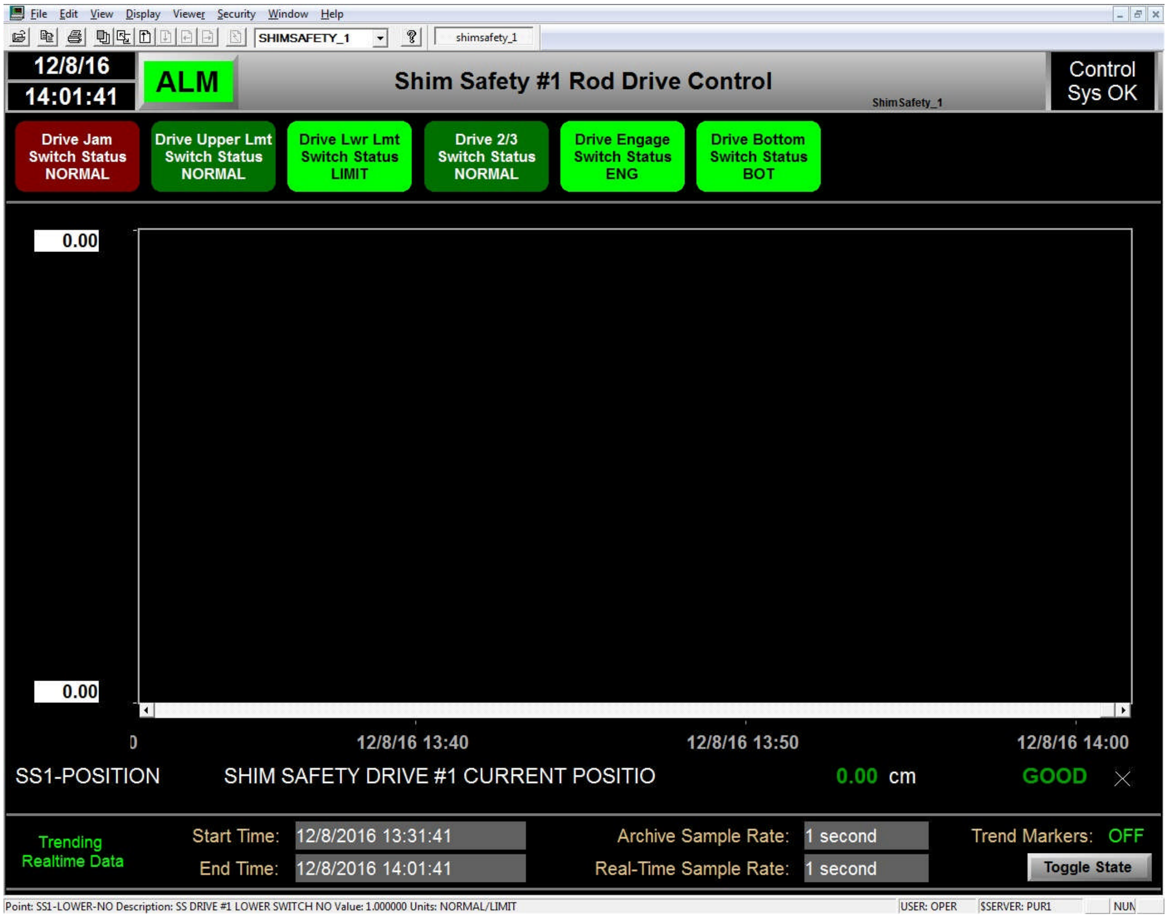


Figure 4-24 – Shim Safety #1 Rod Drive Control Display

4.2.24.1 Display Functions

The display has six (6) indicators below the top frame. There is a single point trend for "SS1-POSITION". Below the trend are indications of the point name, description, value and engineering units for the point plot on the display.

4.2.24.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a ‘Start Time’ and ‘End Time’ to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

See Section 3.2.38 for the rod motion control display screen requirements.

4.2.25 Shim Safety #2 Rod Drive Control

Figure 4-25 – Shim Safety #2 Rod Drive Control Display

4.2.25.1 Display Functions

The display has six (6) indicators below the top frame. There is a single point trend for “SS2-POSITION”. Below the trend are indications of the point name, description, value and engineering units for the point plot on the display.

4.2.25.2 Operator Functions

The operator can ‘left-click’ on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can 'drag' the time location line to any point on the timeline, or use the left and right arrows in the 'Trend Info' pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a 'Start Time' and 'End Time' to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

See Section 3.2.38 for the rod motion control display screen requirements.

4.2.26 Regulating Rod Drive Control

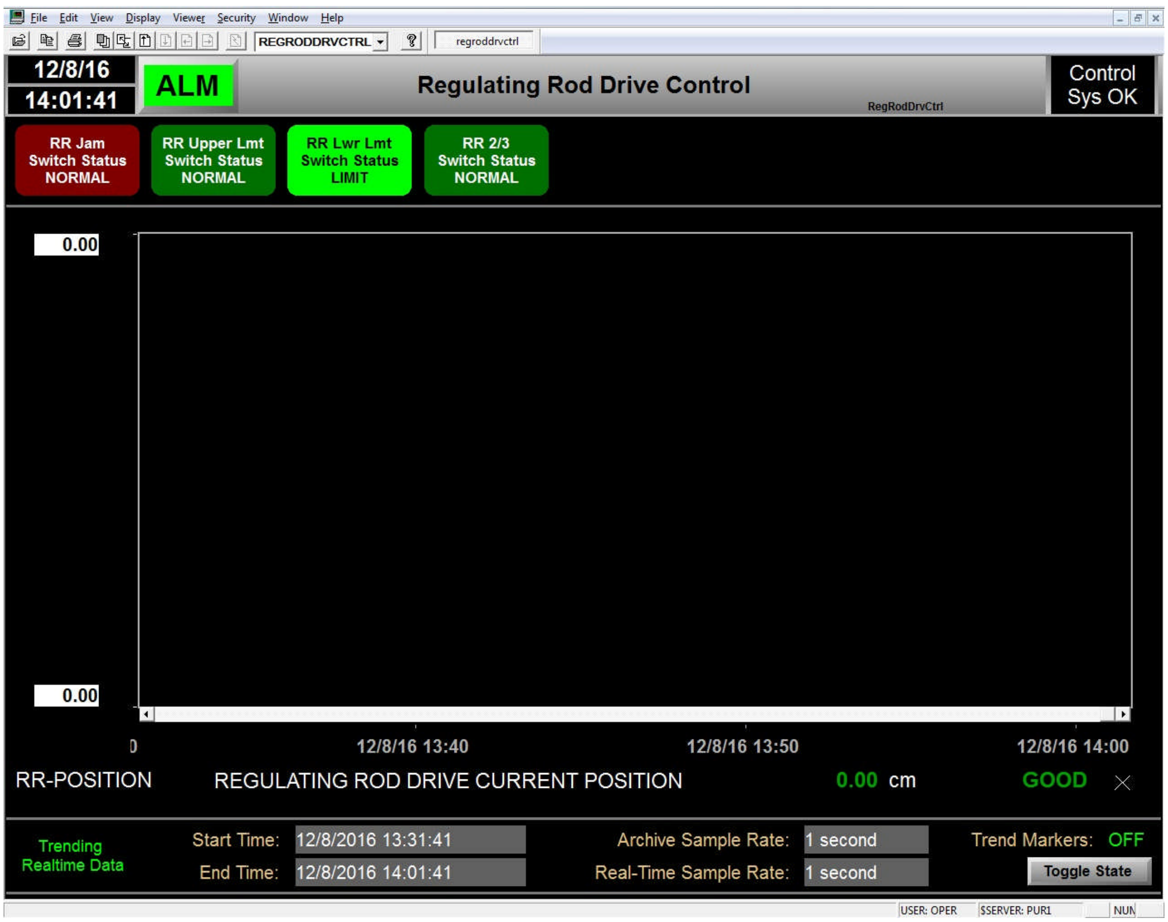


Figure 4-26 – Regulating Rod Drive Control

4.2.26.1 Display Functions

The display has four (4) indicators below the top frame. There is a single point trend for “RR-POSITION”. Below the trend are indications of the point name, description, value and engineering units for the point plot on the display.

4.2.26.2 Operator Functions

The operator can ‘left-click’ on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can ‘drag’ the time location line to any point on the timeline, or use the left and right arrows in the ‘Trend Info’ pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a ‘Start Time’ and ‘End Time’ to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

See Section 3.2.38 for the rod motion control display screen requirements.

4.2.27 Servo Control

Figure 4-27 – Servo Control Display

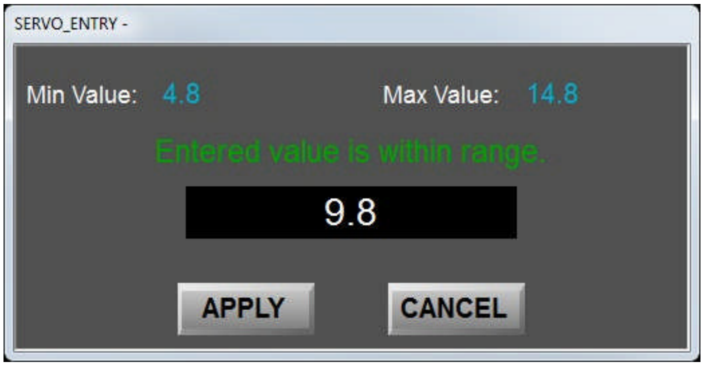


Figure 4-28 – Servo Entry Display

4.2.27.1 Display Functions

The display has four (4) indicators below the top frame. There are three (3) points showing on the trend for “ROD-SERVO-PWR”, “NFD-3-PWR”, and “RR-POSITION”. To the left of the trend are indications of the point name, description, value and engineering units for the point plot on the display.

On the left side of the indicators is one button to DISABLE the servo control. If the Servo is disabled on opening the display, the system will set Target Power to the current value of NFD-3-PWR. If Servo Control is enabled, Target Power will match ROD-SERVO-POWER.

To change the current power level, the operator will left-click the Target Power field. When this field is selected, a pop-up window is launched (Figure 4-28) and will limit the entry to +/-5% of the current linear power level. When Apply is selected, servo mode will enable.

4.2.27.2 Operator Functions

The operator can ‘left-click’ on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can ‘drag’ the time location line to any point on the timeline, or use the left and right arrows in the ‘Trend Info’ pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a ‘Start Time’ and ‘End Time’ to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.2.28 Jam Indication

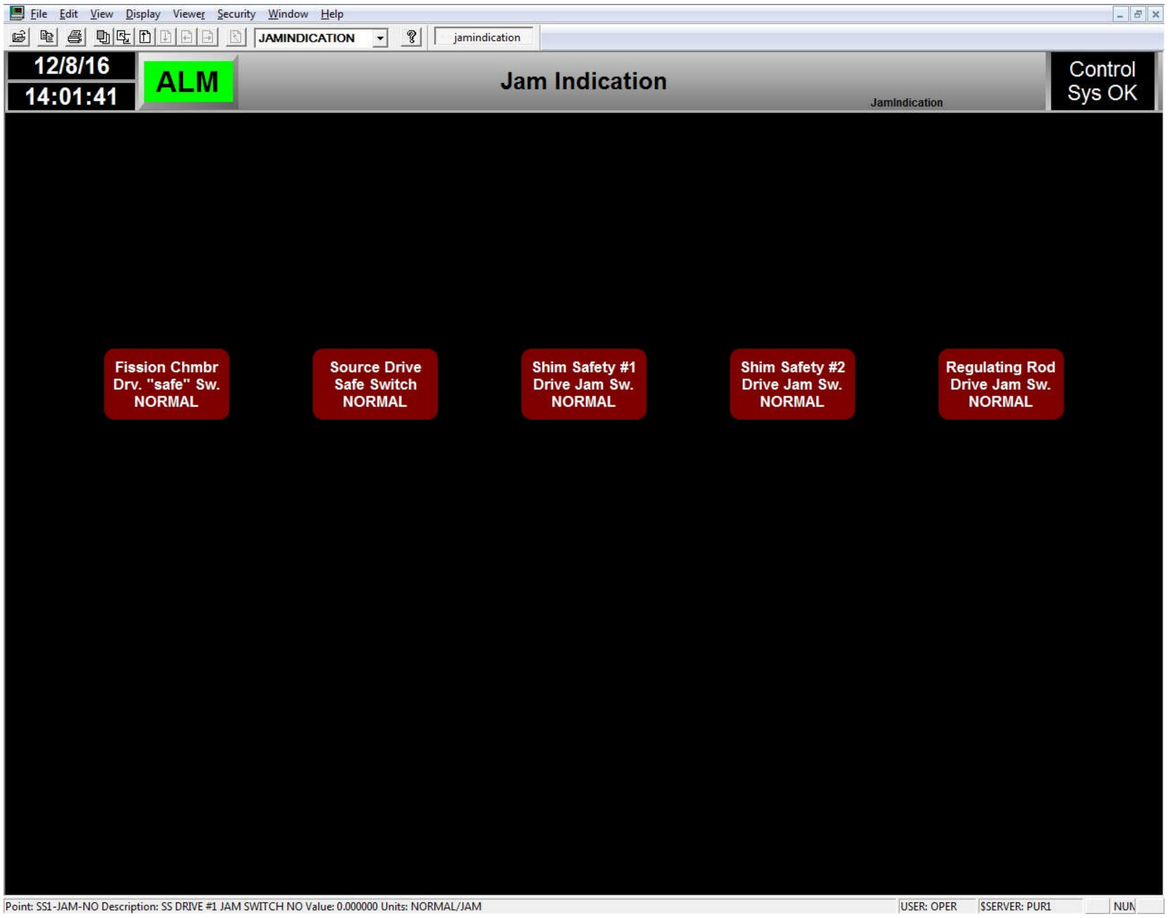


Figure 4-29 – Jam Indication Display

4.2.28.1 Display Functions

The display has five (5) indicators below the top frame. There are no trends on the display.

4.2.28.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

4.2.29 Magnet Power Control

Figure 4-30 – Magnet Power Control Display

4.2.29.1 Display Functions

The display has five (5) indicators below the top frame. There are four (4) points showing to the left of the trend for “MAG-OP-CURR”, “MAG-NOP-CURR”, “MAG-PWR-SP” and “MAG-CURRENT”. The ONLY point plotted on the trend display is “MAG-OP-CURR”.

4.2.29.2 Operator Functions

The operator can ‘left-click’ on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can ‘drag’ the time location line to any point on the timeline, or use the left and right arrows in the ‘Trend Info’ pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

4.2.30 Annunciator

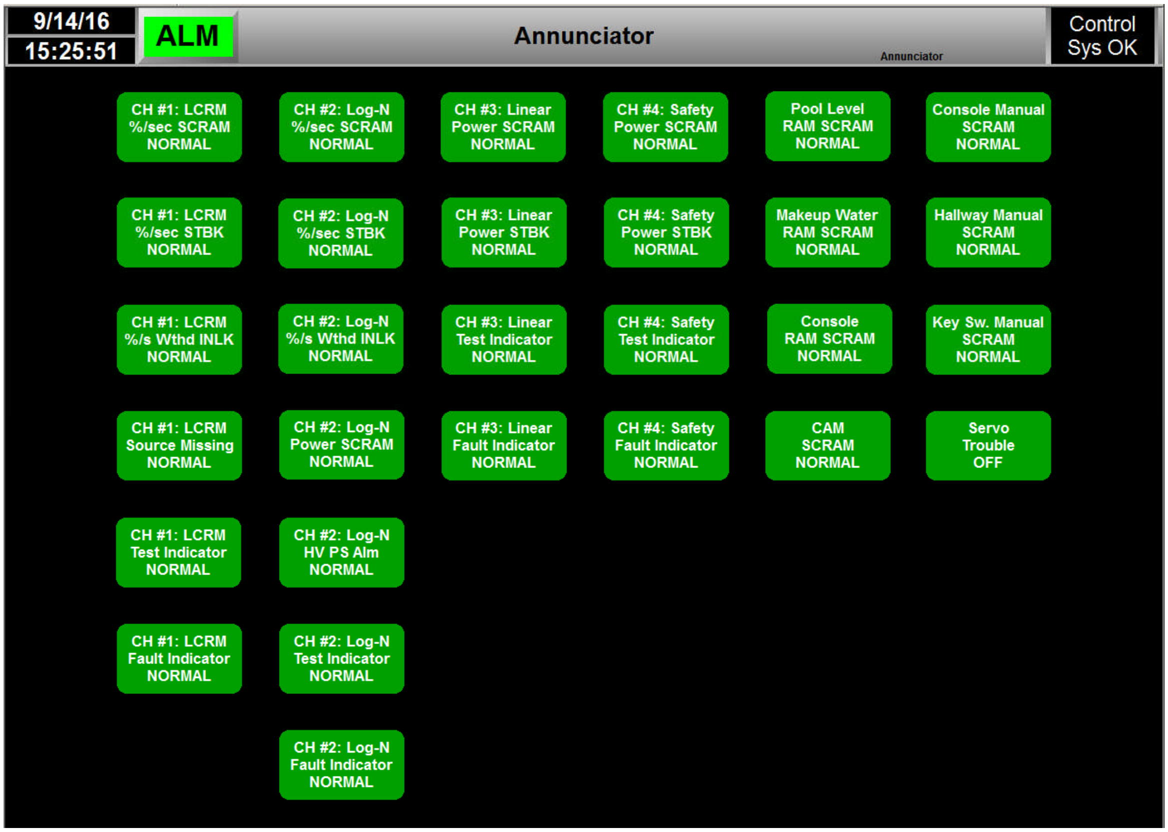


Figure 4-31 – Annunciator Display

4.2.30.1 Display Functions

The display has twenty-nine (29) indicators below the top frame. There are no trends on the display.

4.2.30.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

4.2.31 Joystick

This function does not have an HMI implementation.

4.2.32 SCRAM

This function does not have an HMI implementation.

4.2.33 Setback

This function does not have an HMI implementation.

4.2.34 Isolate Confinement

This function does not have an HMI implementation.

4.2.35 Environmental Health

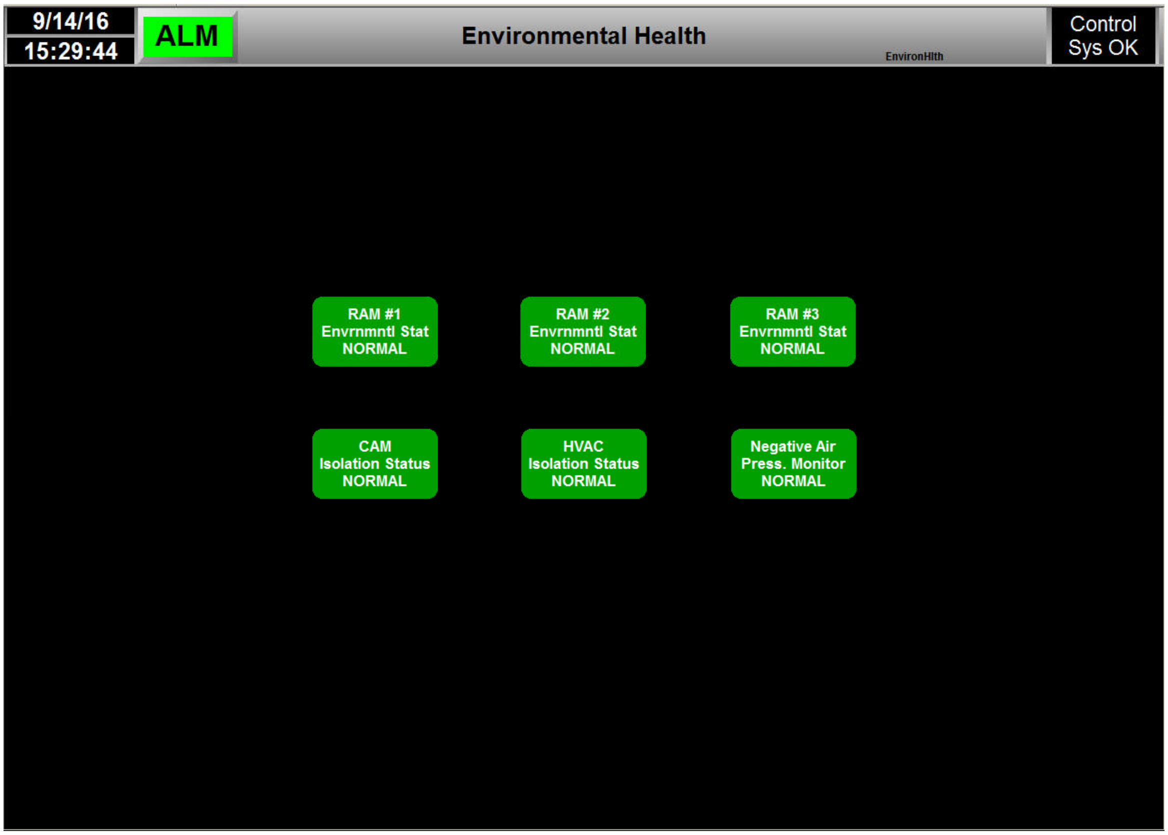


Figure 4-32 – Environmental Health Display

4.2.35.1 Display Functions

The display has six (6) indicators below the top frame. There are no trends on the display.

4.2.35.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

4.2.36 Rod Drop Timing

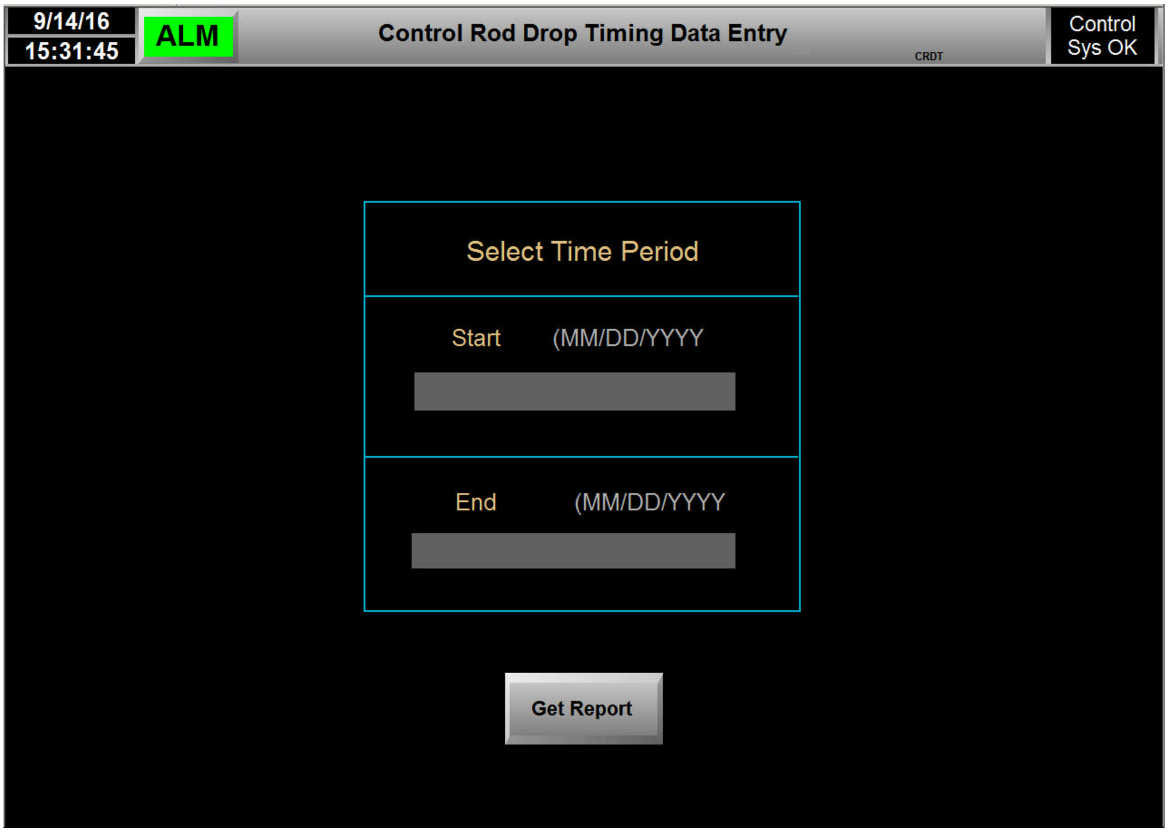


Figure 4-33 – Rod Drop Timing Display

4.2.36.1 Display Functions

There are two (2) input boxes, white text with gray background, to input a Start time and End time value.

There is a button to generate a report for the time period entered above.

4.2.36.2 Operator Functions

See PUR1-SRS-SDD-003 for the functionality descriptions of this function.

4.2.37 Workstation Trouble Watchdog

This function does not have an HMI implementation.

4.2.38 Drive Position Indication

Figure 4-34 – Drive Position Indication

4.2.38.1 Display Functions

The display has selection boxes on the left side for ‘Source’, ‘Fission Chamber’, ‘Shim Safety 1’, ‘Shim Safety 2’ and ‘Regulating Rod’. Only one box may be selected at a time. Selecting another box with a box already selected will de-select the previously selected box. Below the selection boxes is a “CLEAR” button, which serves to unselect all of the selection boxes at one time.

There is an input box, white text with gray background, to input a TARGET position value.

To the right of the target value is a “STOP” button, which cancels any movement command. Below the target position is a “INSERT” button which issues a INSERT request. To the right of the insert button is a “WITHDRAW” button, which issues a WITHDRAW request signal.

Above the STOP button is the “Gang Lower” button, which selects only SS1, SS2 and RR, Set 0 to the target position, and issues a GANG INSERT command.

Above the “Gang Lower” button is the “COARSE WITHDRAW”, “FINE WITHDRAW”, “FINE INSERT” AND “COARSE INSERT” buttons, which issue the appropriate requests to the active selected drives.

To the right of the buttons are switch indicators (Upper/Lower/’2/3 up’/Jam/Engage/ and Bottom), bar graphs, position values, raise/lower command indicators and labels for the chambers.

4.2.38.2 Operator Functions

When any of the check boxes are selected, the Fine and Coarse Withdraw and Insert buttons, and the INSERT and WITHDRAW buttons at the bottom of the display are enabled, allowing them to be pressed/selected. If the CLEAR button is pressed, all selection boxes are cleared, and the buttons become disabled.

The ‘Gang Lower’, ‘STOP’ and ‘CLEAR’ buttons are not disabled and can be pressed at any time.

The bar graphs indicate the position of each chamber, however there will not be a position shown for the SRC (Source), since there is no position system on the Source drive.

4.2.39 Class 1 Horn

This function does not have an HMI implementation.

4.2.40 Indicator Test / Reset

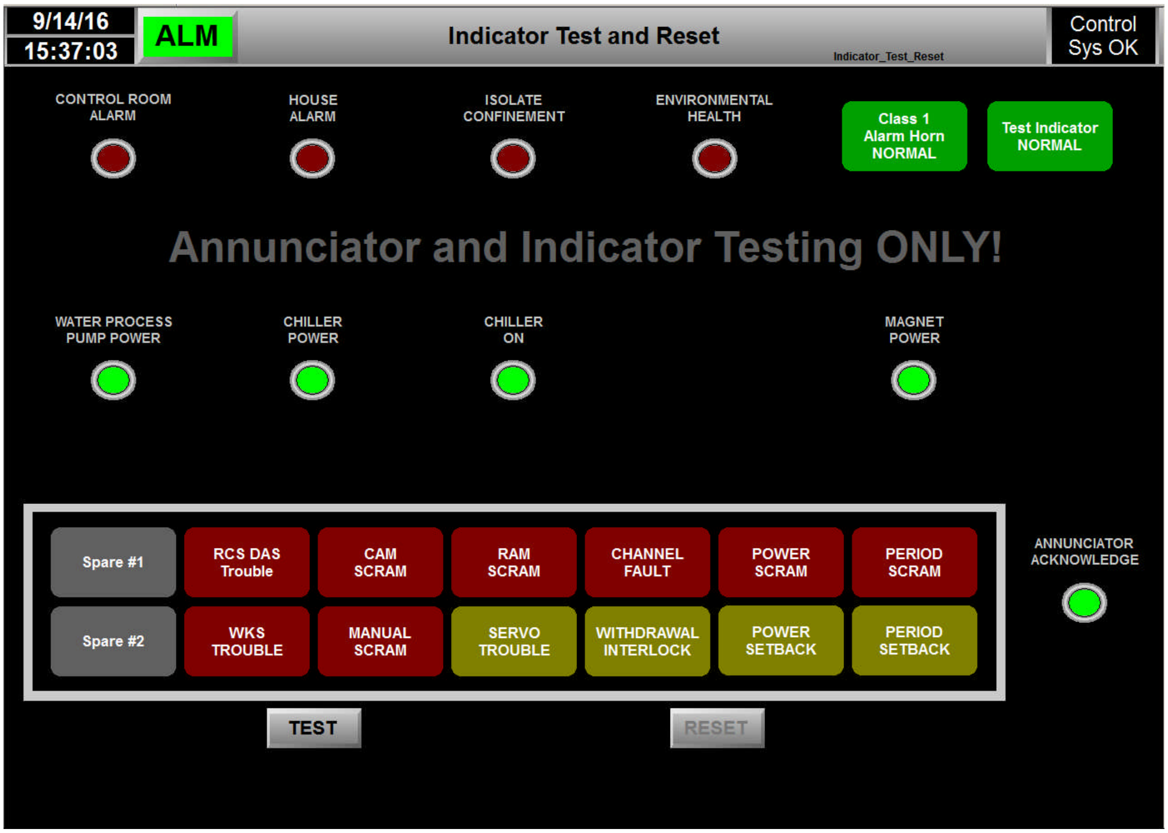


Figure 4-35 – Indicator Test / Reset Display

4.2.40.1 Display Functions

The display has twenty-five (25) indicators below the top frame. There are no trends on the display.

The display allows the operator to test signal indicators by turning them on, or resetting them.

There is a TEST and a RESET button that issue the respective signals for state changes.

4.2.40.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

To test the function, press the TEST button. To Reset the function, press the RESET button.

4.2.41 Resettable Timer

This function does not have an HMI implementation.

4.2.42 Temporary Setback Limits

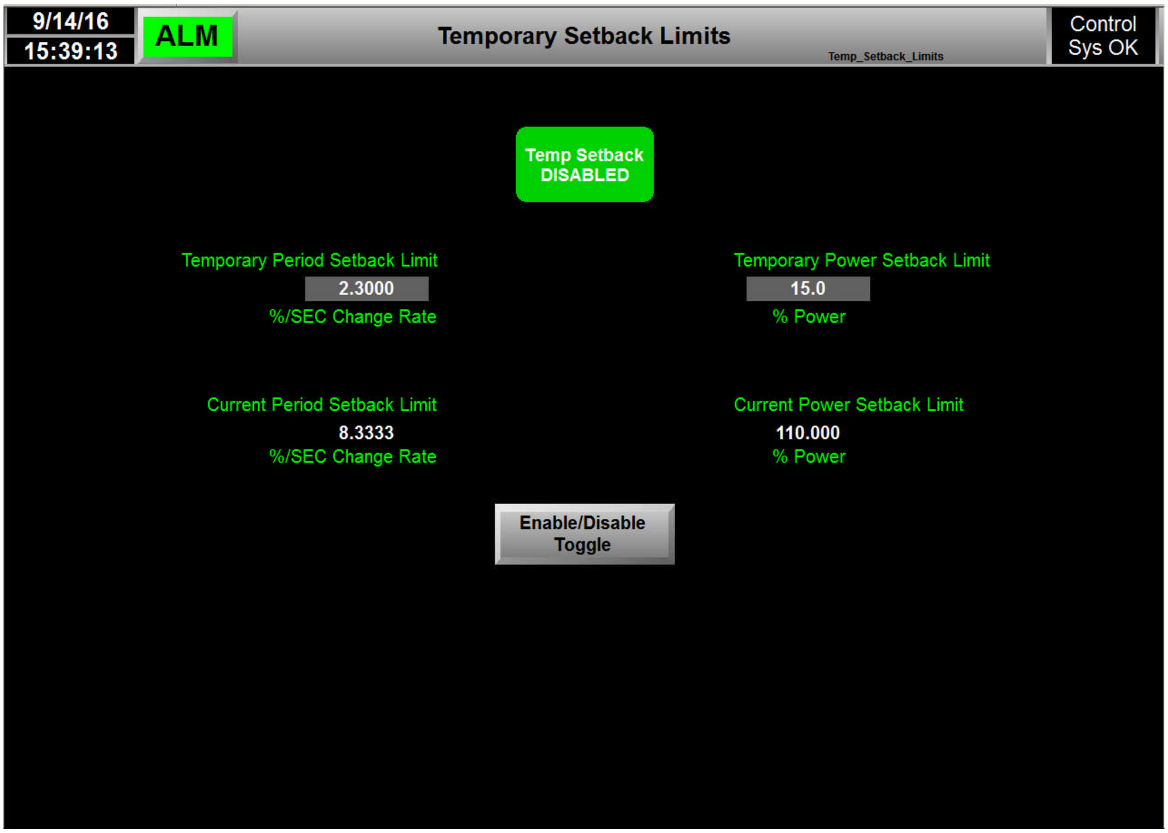


Figure 4-36 – Temporary Setback Limits Display

4.2.42.1 Display Functions

The display has one (1) indicator below the top frame. There are no trends on the display. There are locations (gray background) for the operator to set temporary Setback limits, and points indicating the current system Setback limits.

4.2.42.2 Operator Functions

The operator can 'left-click' on the indicators to see a single point display of the underlying point.

The display allows the operator to Enable or Disable the temporary Setback limits using a button at the lower center of the display. Status is indicated by the status point at the upper center of the display. The operator will be notified if range limits are exceeded on the entry points.

4.2.43 Automatic Startup

Figure 4-37 – Automatic Startup Display

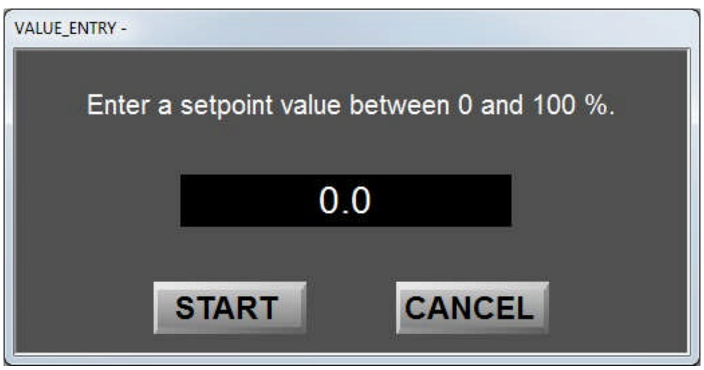


Figure 4-38 – Automatic Startup Entry Display

4.2.43.1 Display Functions

The display has one (1) indicator below the top frame. There are three (3) points showing on the trend for “NFD-3-PWR”, “NFD-1-CR”, and “NFD-2-CR”. To the left of the trend are indications of the point name, description, value and engineering units for the point plot on the display.

On the right side of the Target Power Entry field is one buttons, to DISABLE the automatic startup.

To change the current power level, the operator will left-click the Target Power field. When this field is selected, a pop-up window is launched (Figure 4-38) and will limit the entry to a value between 0 and 100%. When START is selected, the automatic startup algorithm will begin.

4.2.43.2 Operator Functions

The operator can ‘left-click’ on the indicators to see a single point display of the underlying point.

Left-clicking in the trend display will show a pop-up dialog box with the point names, time and values of any trended point (click in the white background to close the trend info pop-up window). The operator can ‘drag’ the time location line to any point on the timeline, or use the left and right arrows in the ‘Trend Info’ pop-up dialog to move the time line in one (1) second increments. The pop-up dialog box will update showing the values of plotted points at the time position indicated by the line.

At the bottom of the screen are locations to enter a ‘Start Time’ and ‘End Time’ to allow working with archive data and or real-time data. The time can be a scrolling window, with current time on one edge and historical time trending to the other edge, or a fixed time range, allowing the operator to look at historical values.

4.3 R*TIME System Administrator Displays

R*TIME system administrator displays are available on the ROC workstation. The R*TIME administrator displays provide additional capability to view RPCS system data and events. The following sections briefly describe the R*TIME administrator displays that are provided.

Many of the displays described in this section require higher login levels than Operator.

4.3.1 Archive Subsystem Displays

The archive subsystem has a set of displays that allow the user to perform many various functions to manipulate archive files.

For a detailed discussion about working with Archives, see Chapter 5 "Working with Archive Files" of the *R*TIME User's Manual*. Read Chapter 5 to become familiar with the Archive process before attempting to perform these functions. This applies to both new and previous users of the Archive system.

The archive backup software backs up specific archive files to a defined backup media. The Archive Backup creates archive file backup requests and monitors the processing of pending requests. For a detailed description of the display, see Chapter 3, Section 3.5.5 “Archive Backup Display” of the *R*TIME User's Manual*.

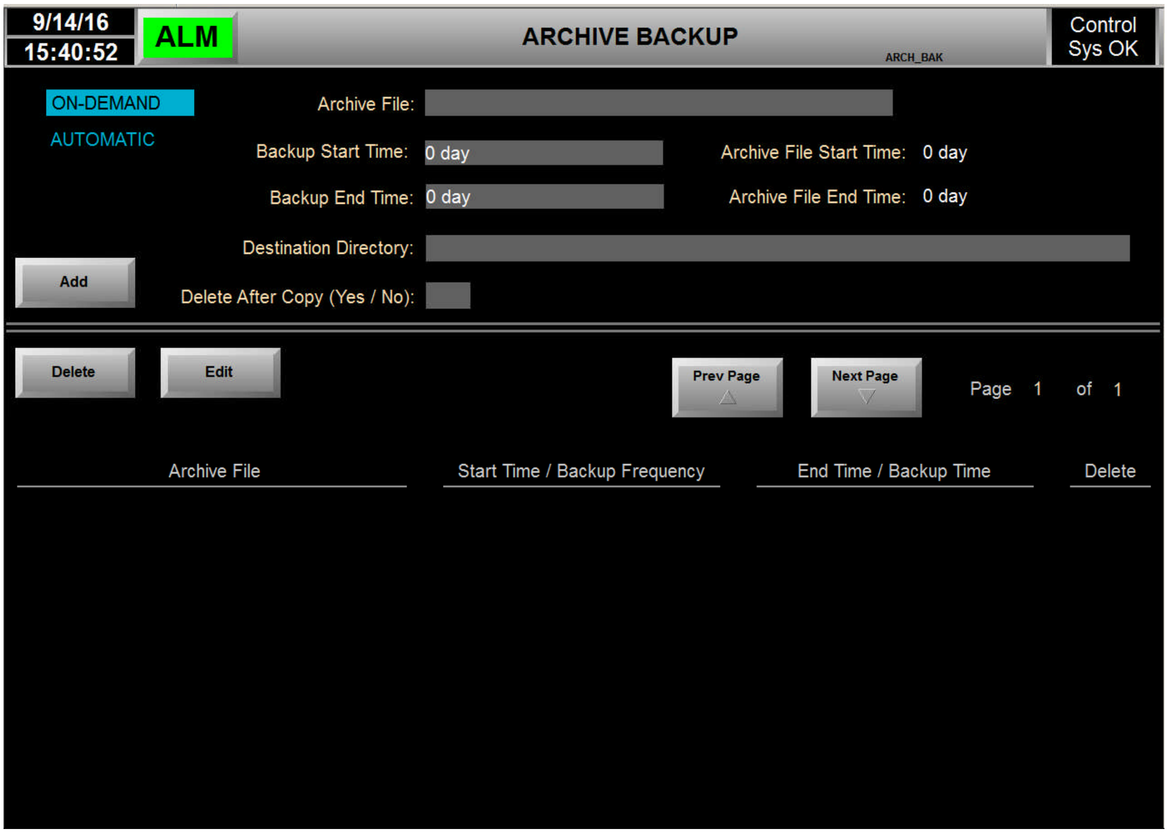


Figure 4-39 - Archive Backup Display

The Monitor Archive System display shows each loaded archive file, its status and corresponding information. For a detailed description of the display, see Chapter 3, Section 3.5.3 "Monitor Archive System Display" of the *R*TIME User's Manual*.

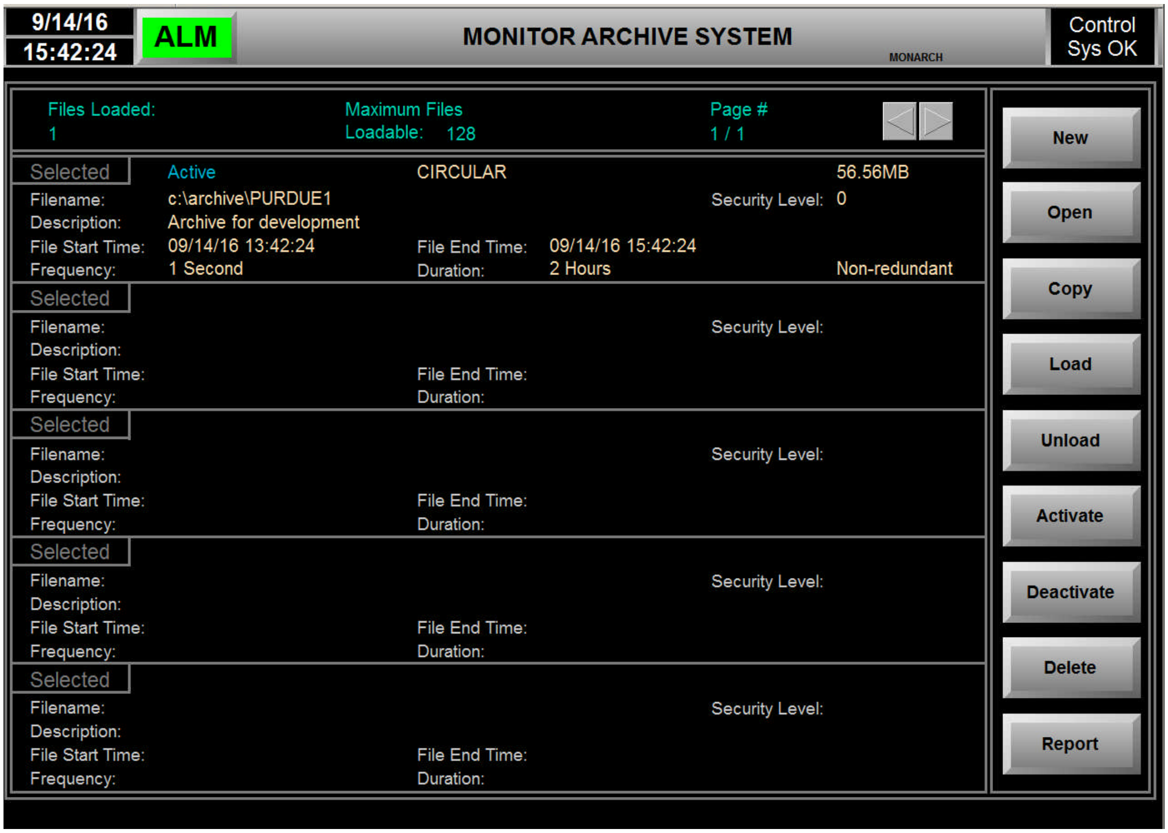


Figure 4-40 - Monitor Archive Display

The Create / Edit Archive display (EDARCDEF.dis) allows the user to create new archive file definitions or edit existing archive file definitions. For a detailed description of the display, see Chapter 3, Section 3.5.2 “Edit Archive File Definition Display” of the *R*TIME User’s Manual*.

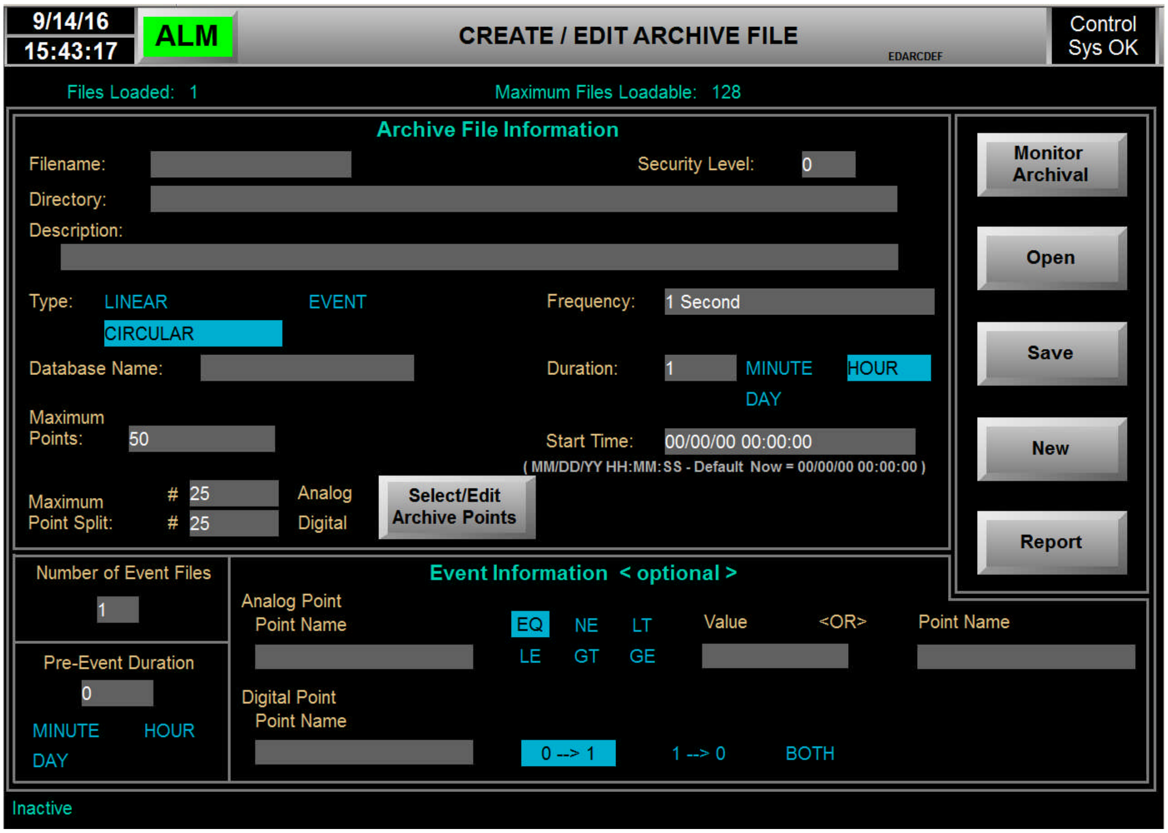


Figure 4-41 – Edit / Create Archive Definition Display

4.3.2 Database Displays

4.3.2.1 Analog Point Displays

There are several unique displays in the Analog Point display group: Analog Point Attributes, Analog Point Alarm Definition, Analog Point Alarm Limits, Analog Point EU Conversion, Analog Point Auxiliary Attributes, Coefficient Generator Data Entry, and View Calculation.

For a detailed description of the analog point displays, see Chapter 3, Section 3.3.1 “Administration Level Analog Point Displays” of the *R*TIME User’s Manual*.

4.3.2.2 Analog Point Attributes Definition Display

The Analog Point Attributes Definition Display (APAD) presents data for a user specified database point. With the proper authorization, the user can change many of the attributes of the point.

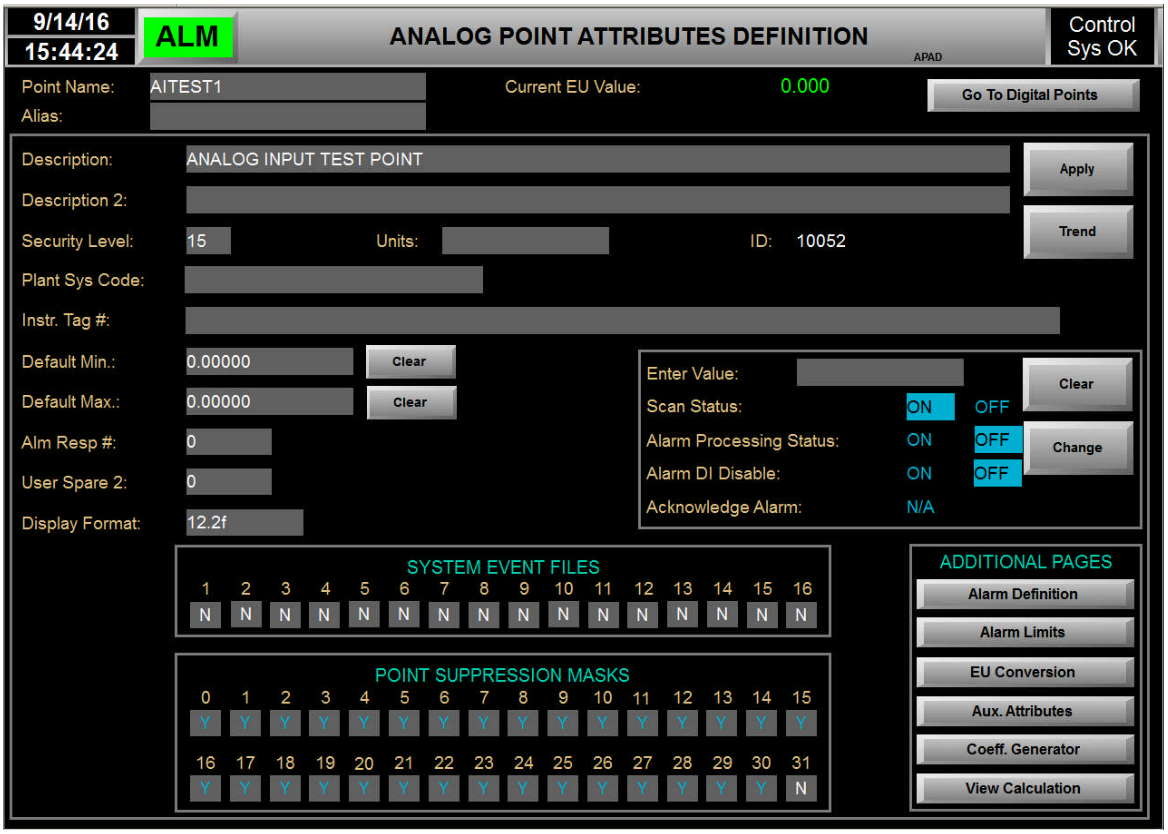


Figure 4-42 - Analog Point Attributes Definition Display

4.3.2.3 Analog Point Alarm Definition Display

The Analog Point Alarm Definition Display (APALMD) presents alarm definition data for a user specified database point. With the proper authorization, the user can change many of the alarm attributes of the point.

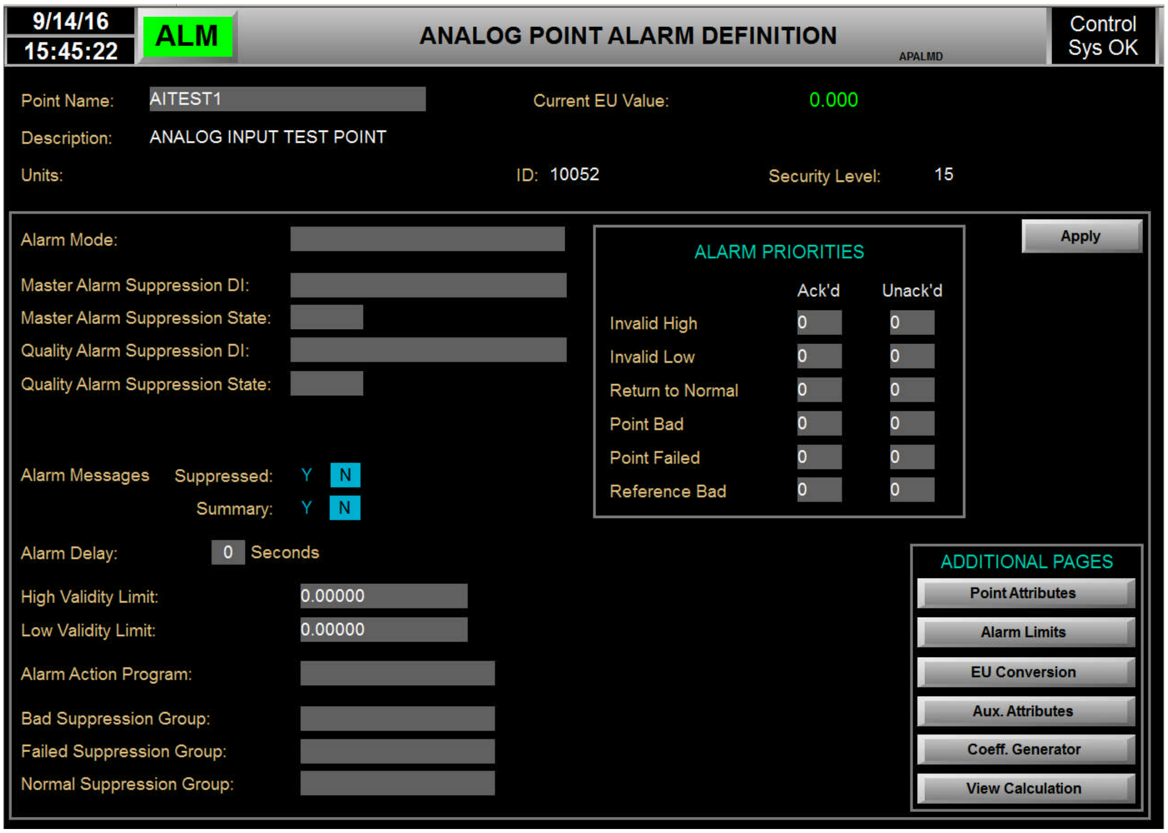


Figure 4-43 - Analog Point Alarm Definition Display

4.3.2.4 Analog Point Alarm Limits Display

The Analog Point Alarm Limits Display (APALML) presents alarm limit data for a user specified database point. With the proper authorization, the user can change the alarm limit attributes of the point.

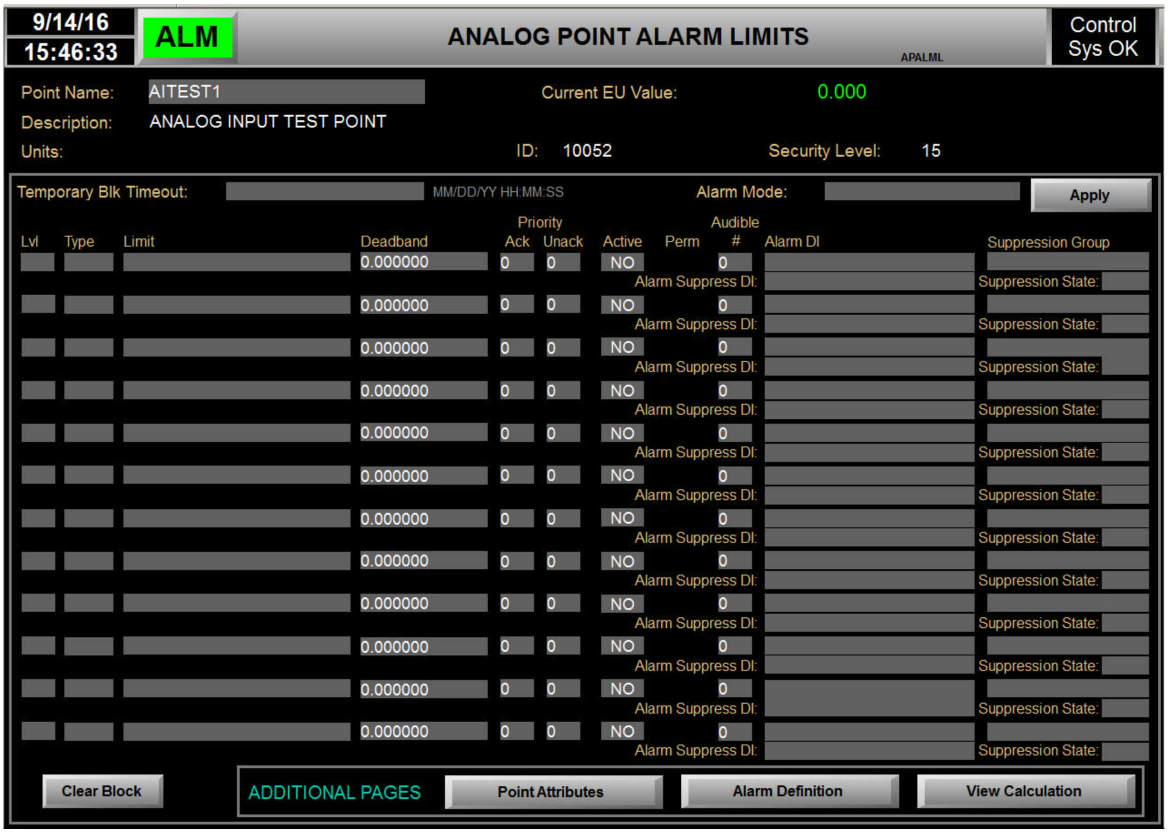


Figure 4-44 - Analog Point Alarm Limits Display

4.3.2.5 Analog Point EU Conversion Display

The Analog Point Alarm EU Conversion Display (APEUD) presents EU Conversion data for a user specified database point. With the proper authorization, the user can change or edit the conversion type and coefficients of the point.

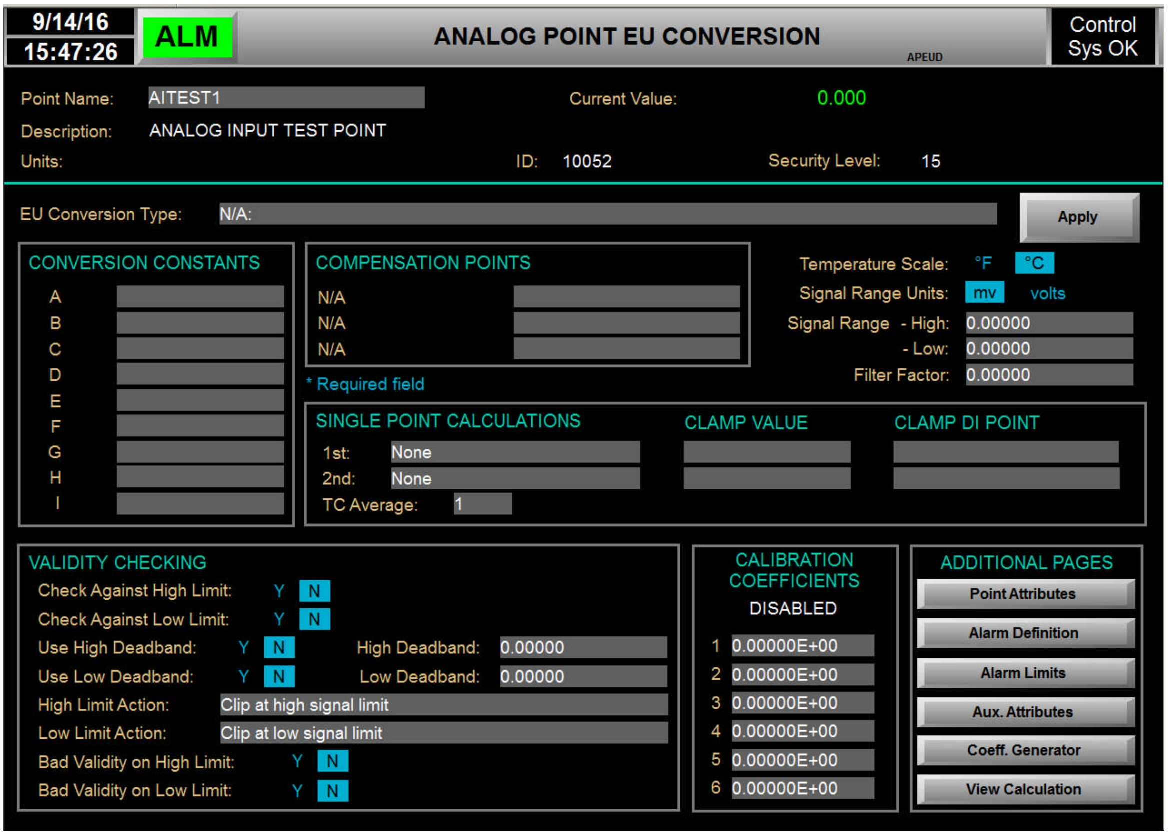


Figure 4-45 - Analog Point EU Conversion Display

4.3.2.6 Analog Point Auxiliary Attributes Display

The Analog Point Auxiliary Attributes Display (APAUX) presents auxiliary data for a user specified database point. With the proper authorization, the user can change the auxiliary attributes of the point.

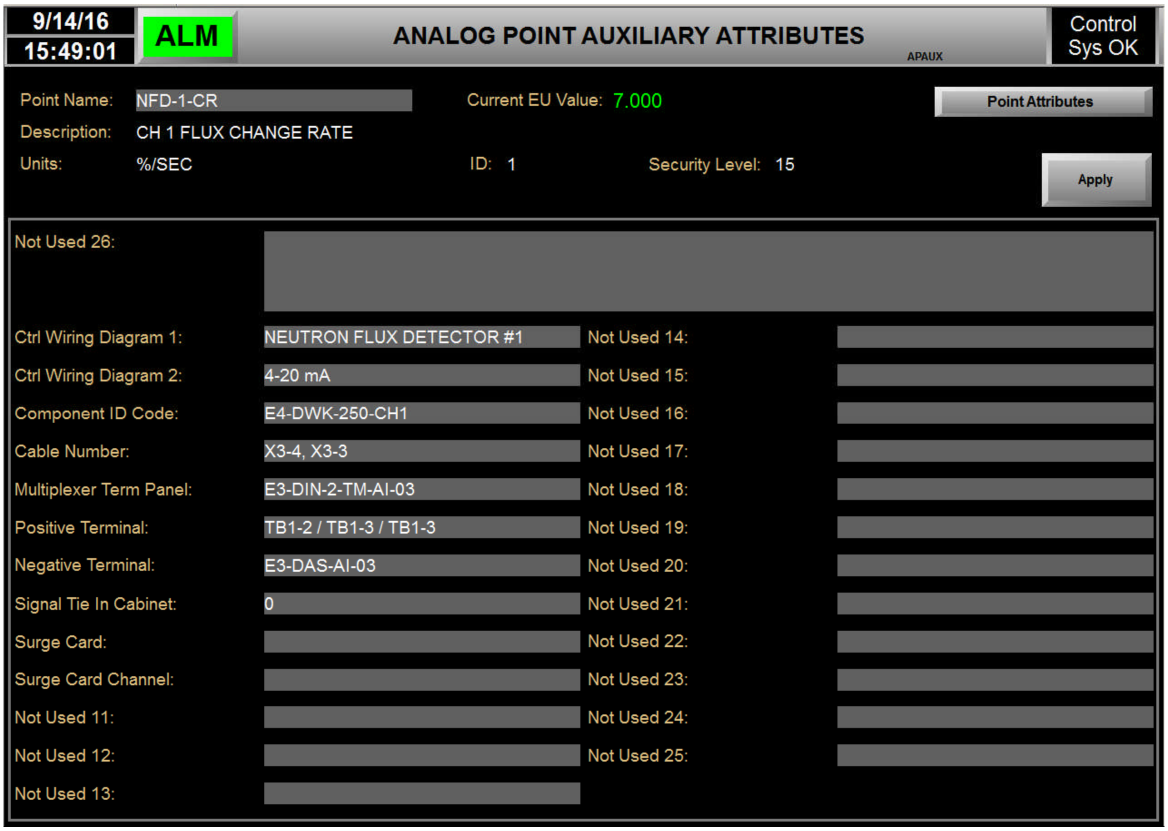


Figure 4-46 - Analog Point Auxiliary Attributes Display

4.3.2.7 Coefficient Generator Data Entry Display

The Coefficient Generator Data Entry Display (COGENDB) presents calibration coefficients for a user specified database point. With the proper authorization, the user can change the calibration attributes of the point.

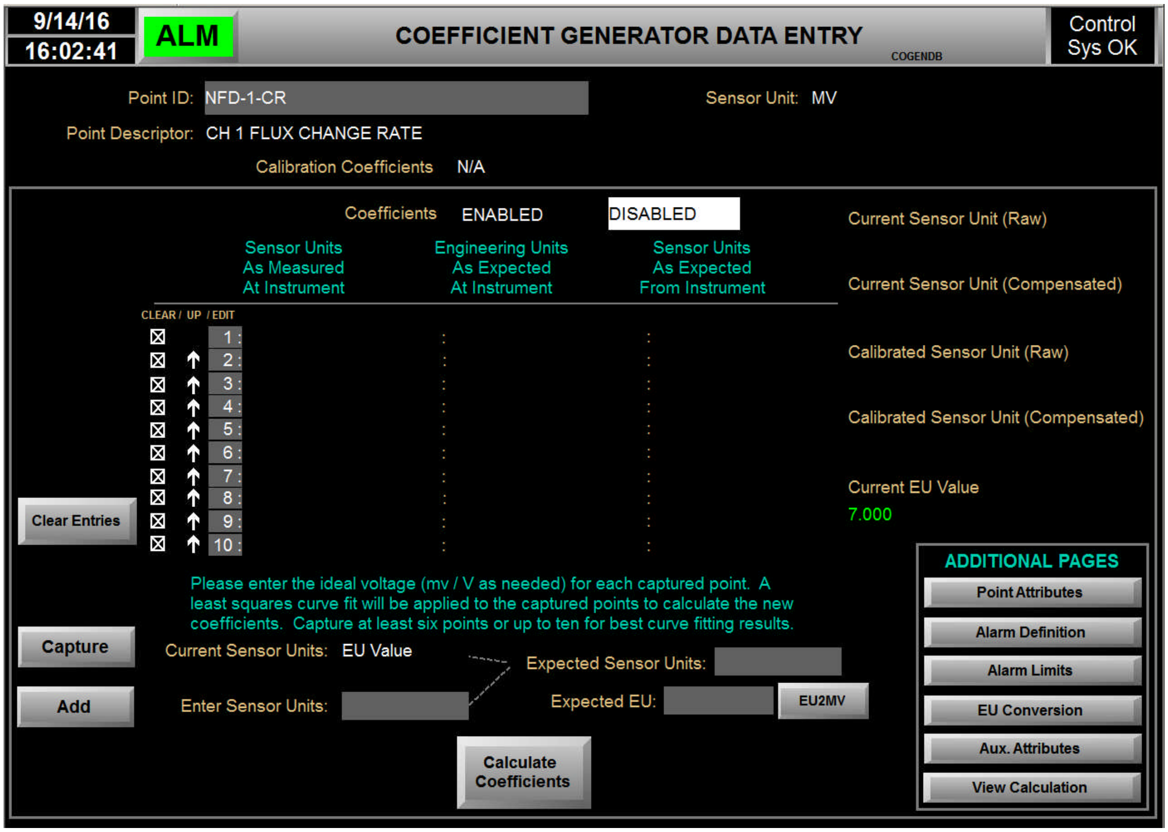


Figure 4-47 - Analog Point Coefficient Verification Display

4.3.2.8 Coefficient Generator Verification Display

The Coefficient Generator Verification Display (COGENVER) verifies the coefficient data for a user specified database point.

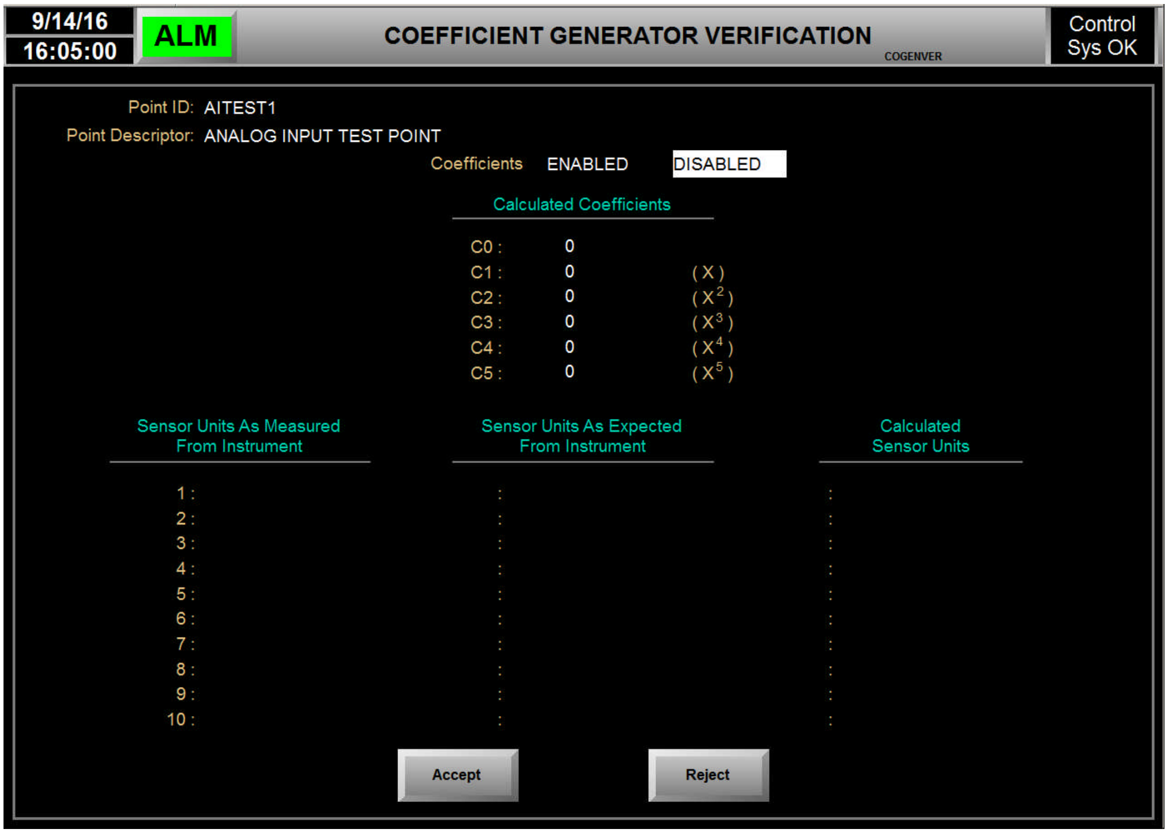


Figure 4-48 - Analog Point Coefficient Verification Display

4.3.2.9 View Calculation Display

The View Calculation Display (int_calc_pts) presents the calculation used for a user specified database point. This display is a "View Only" display. No changes to the calculation can be implemented from this display.

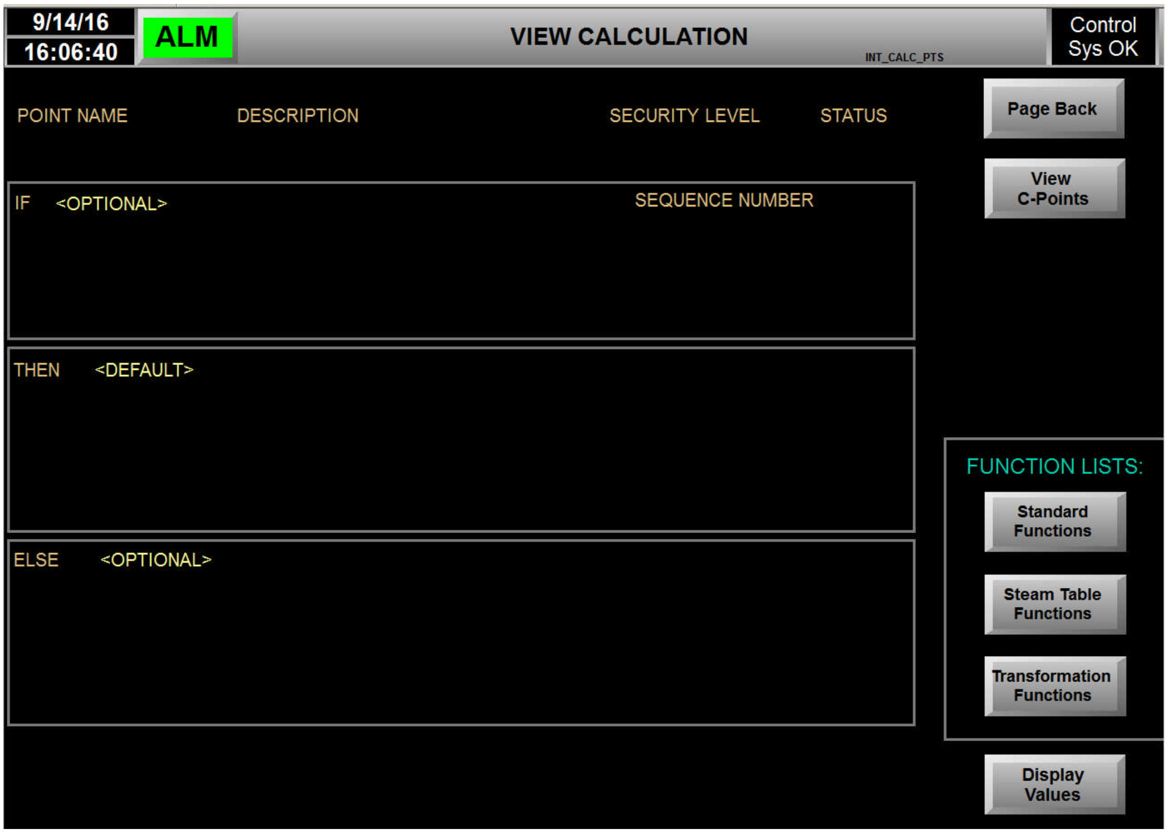


Figure 4-49 - View Calculation Display

4.3.2.10 Digital Point Displays

Like the Analog Point displays, there are several unique displays in the Digital Point display group: Digital Point Attributes, Digital Point Alarm Definition, and Digital Point Auxiliary Attributes. The View Calculation display (Figure 4-49) is common to both analog and digital points.

For a detailed description of the digital point displays, see Chapter 3, Section 3.7.1 "Administration Level Digital Point Displays" of the *R*TIME User's Manual*.

4.3.2.11 Digital Point Attributes Definition Display

The Digital Point Attributes Definition Display (DPAD) presents data for a user specified database point. With the proper authorization, the user can change many of the attributes of the point.

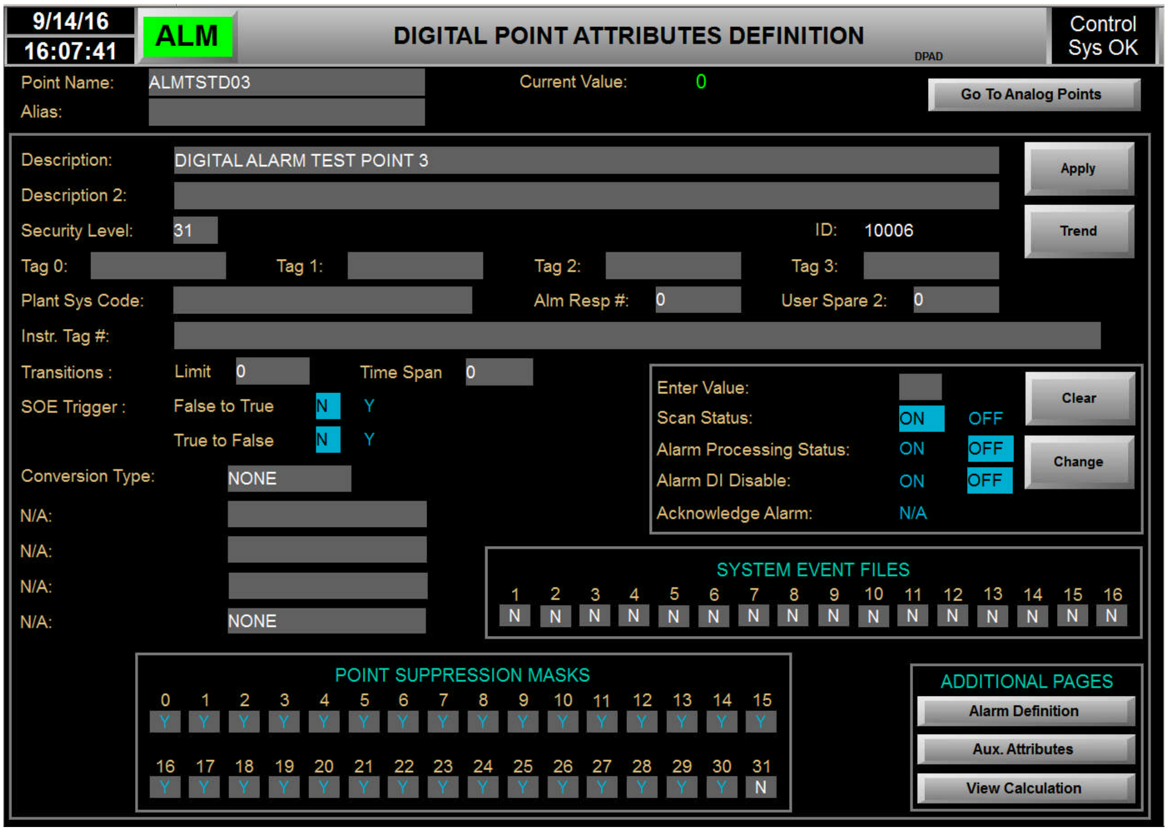


Figure 4-50 – Digital Point Attributes Definition Display

4.3.2.12 Digital Point Alarm Definition Display

The Digital Point Alarm Definition Display (DPALMD) presents alarm definition data for a user specified database point. With the proper authorization, the user can change many of the alarm definition attributes of the point.

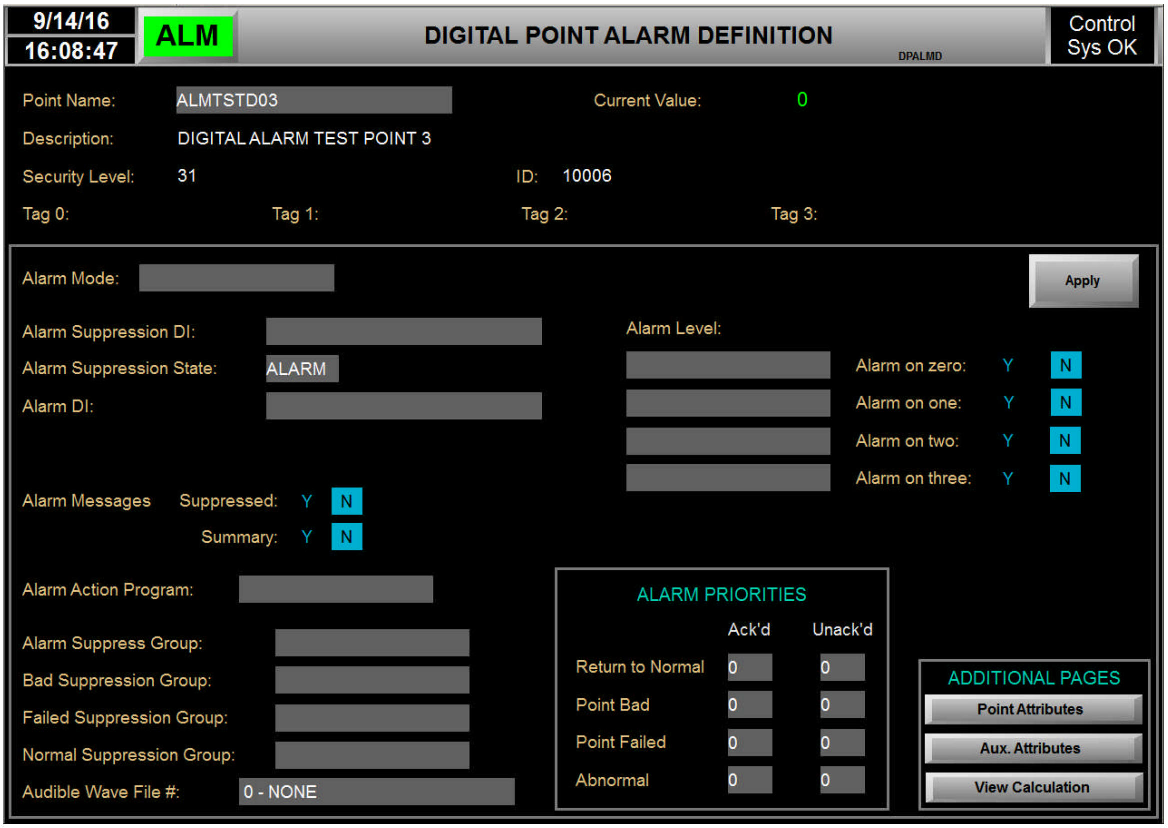


Figure 4-51 –Digital Point Alarm Definition Display

4.3.2.13 Digital Point Auxiliary Attributes Display

The Digital Point Auxiliary Attribute Display (DPAUX) presents auxiliary data for a user specified database point. With the proper authorization, the user can change many of the auxiliary attributes of the point.

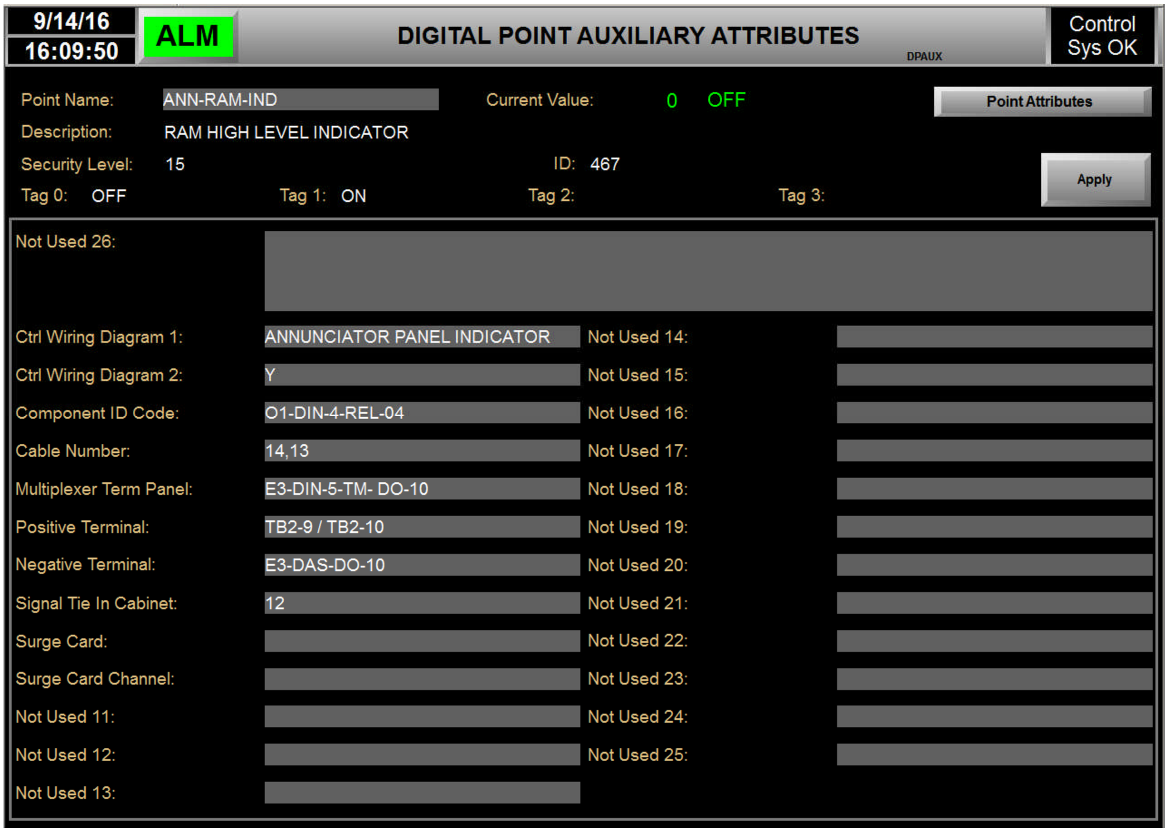


Figure 4-52 – Digital Point Auxiliary Attribute Display

4.3.3 Scheduler

Scheduler allows the authorized person to schedule an application to run at a set time, or series of times.

4.3.3.1 Scheduler Summary Display

Schedule Summary lists all scheduled activities. Users cannot update schedule information on this display. Twenty scheduled activities can be show on each page. For a detailed description

of the display, see Chapter 3, Section 3.18.2 “Scheduler Summary Display” of the *R*TIME User’s Manual*.

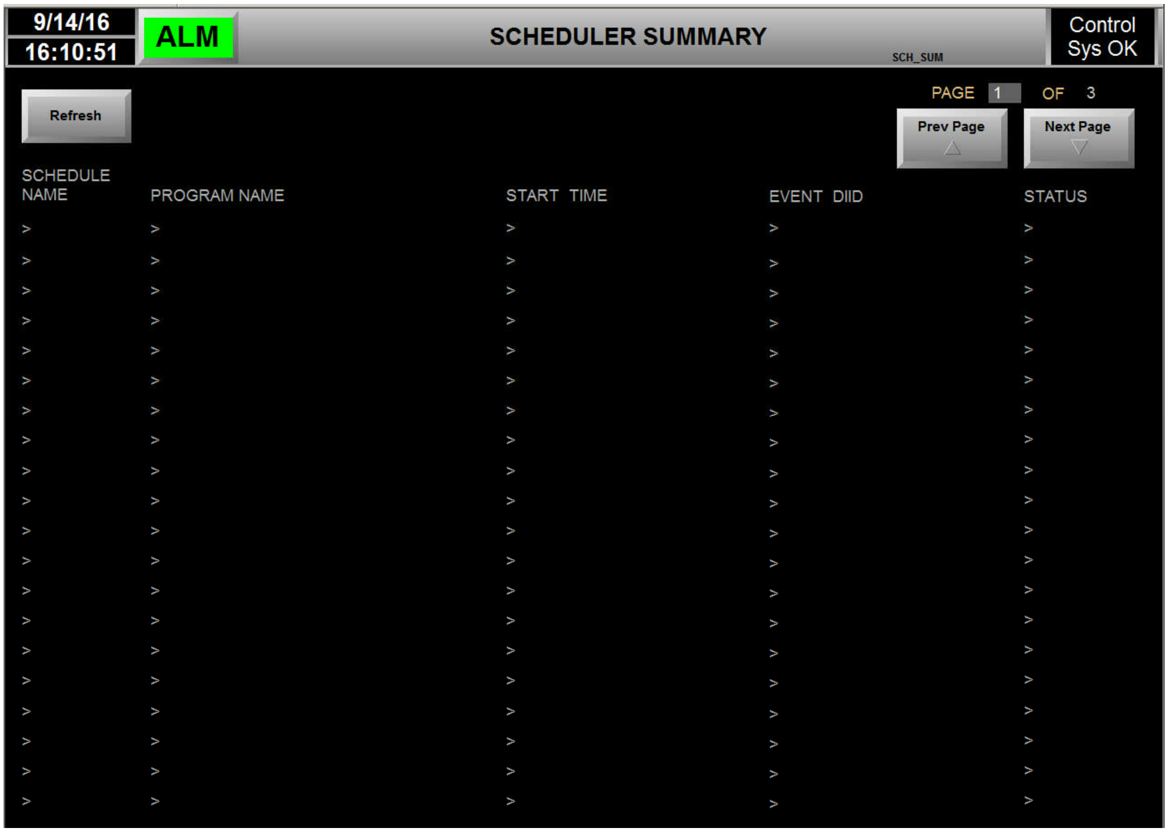


Figure 4-53 - Scheduler Summary Display

4.3.3.2 Scheduler Update Display

The Scheduler Update is used to add, edit, or delete scheduled activities. For a detailed description of the display, see Chapter 3, Section 3.18.3 "Scheduler Update Display" of the *R*TIME User's Manual*.

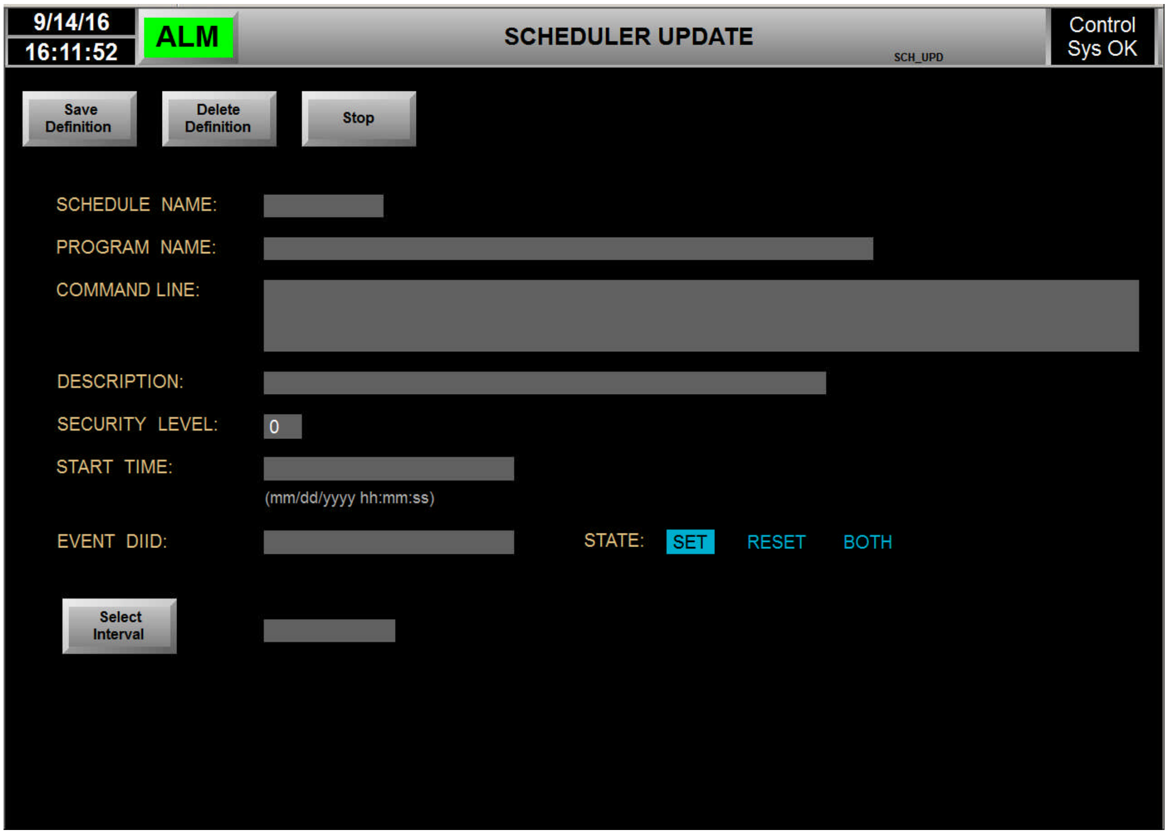


Figure 4-54 - Scheduler Update Display

4.3.4 RTP I/O

The RTP Hardware displays depict the logical addresses and health of the DAS.

4.3.4.1 Hardware Addressing Displays

There are three levels of hardware addressing displays: DAS, chassis, and card. For a detailed discussion of these displays, see Chapter 3, Section 3.12.1 "RTP 2000 Hardware Addressing Displays" of the *R*TIME User's Manual*.

From the top-level DAS Hardware Addressing display, the user can drill down into the chassis, then into the card showing the points tied to each channel.

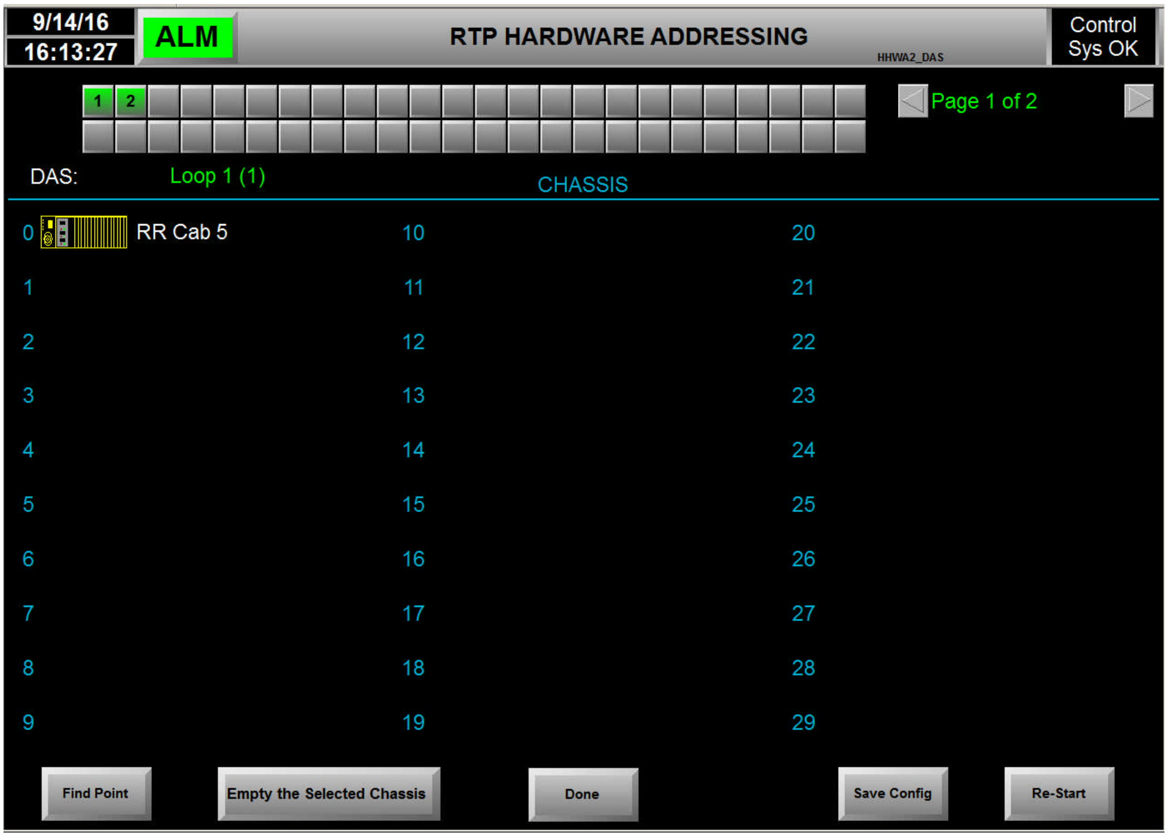


Figure 4-55 - RTP Hardware Addressing Display – DAS Level

From the chassis-level DAS Hardware Addressing displays, the user can see the status of each card in the chassis and drill down into the individual card displays.

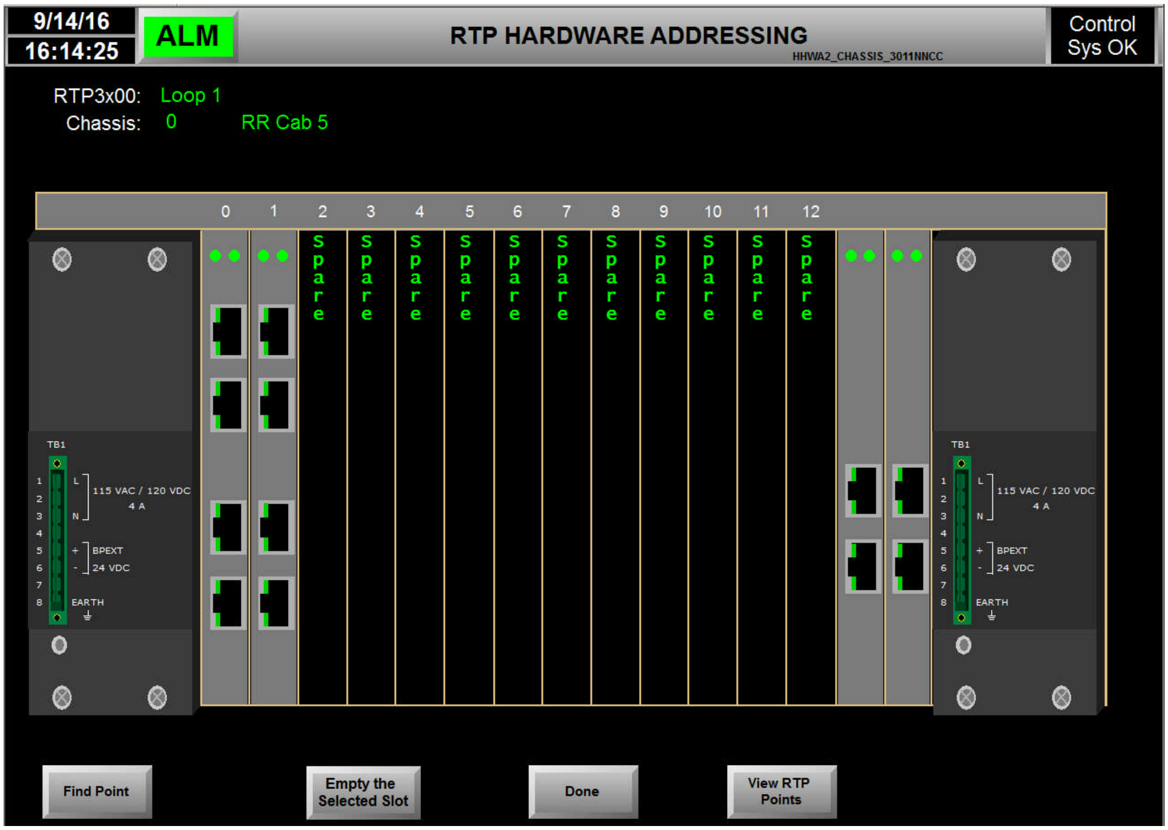


Figure 4-56 - RTP Hardware Addressing Display – Chassis Level

From the card-level DAS Hardware Addressing displays, the user can see each channel on the card and see the status of the channel and the points that are tied to each channel.

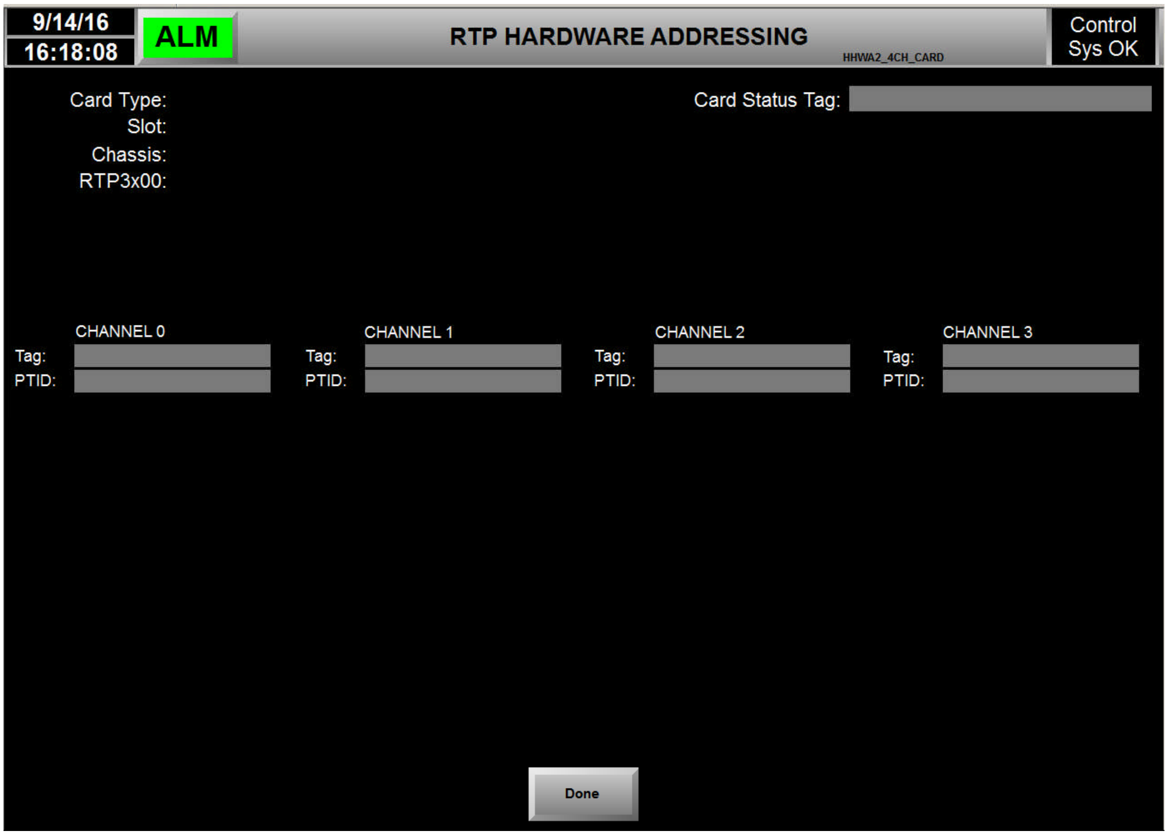


Figure 4-57 - RTP Hardware Addressing Display – Card Level

4.3.4.2 Hardware Health Displays

The same three levels of hardware addressing displays also exist for hardware health displays: DAS, chassis, and card. For a detailed discussion of these displays, see Chapter 3, Section 3.12.2 “RTP Hardware Health Displays” of the *R*TIME User’s Manual*.

From the top-level DAS Health display, the user can drill down into the chassis, then into the card showing the points tied to each channel.

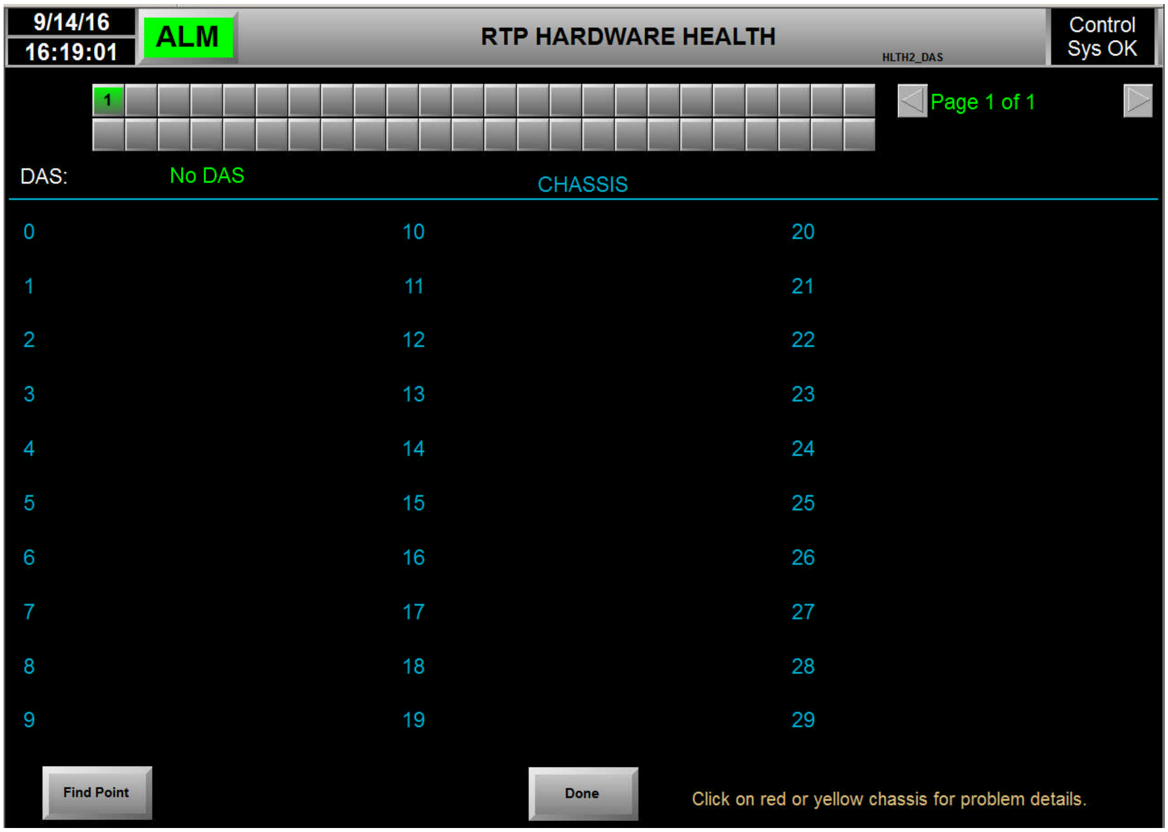


Figure 4-58 - RTP Hardware Health Display – DAS Level

From the chassis-level DAS Health displays, the user can see what type of card is in each slot and drill down into the individual card displays,

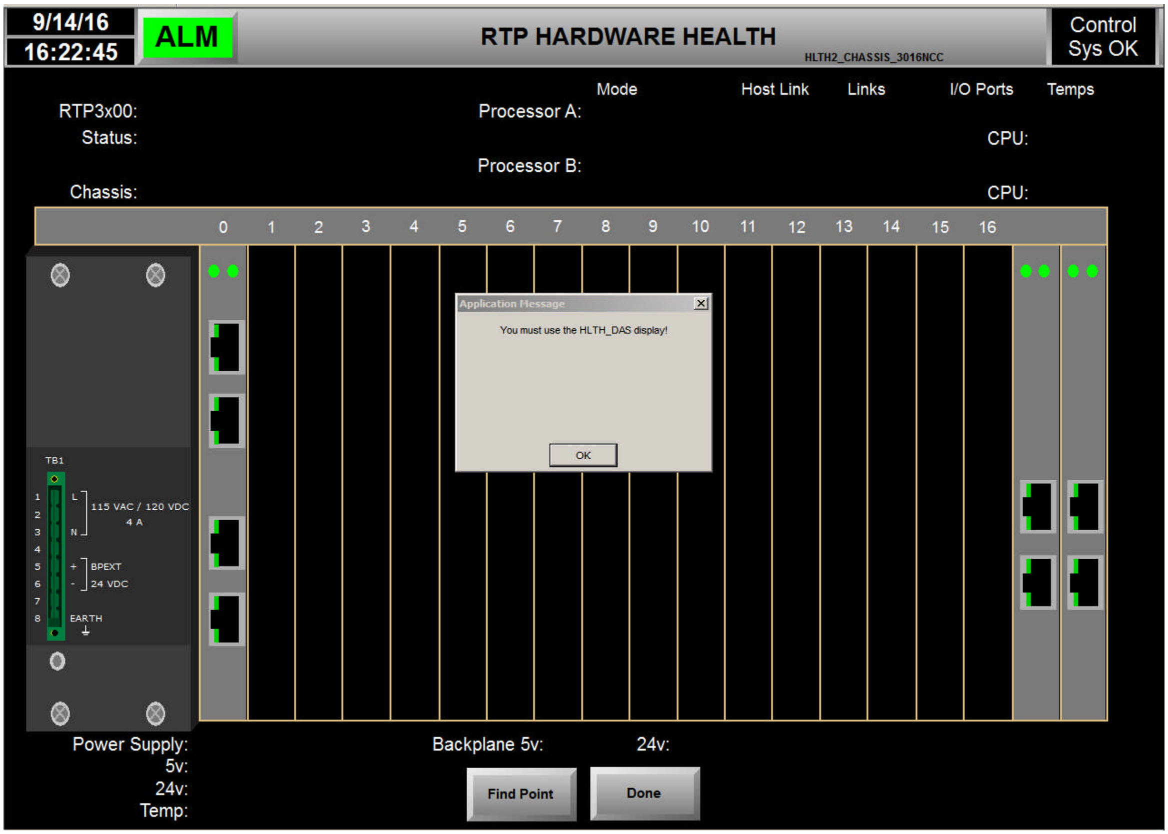


Figure 4-59 - RTP Hardware Health Display – Chassis Level

From the card-level DAS Health displays, the user can see each channel on the card and see what point or points are tied to each channel.

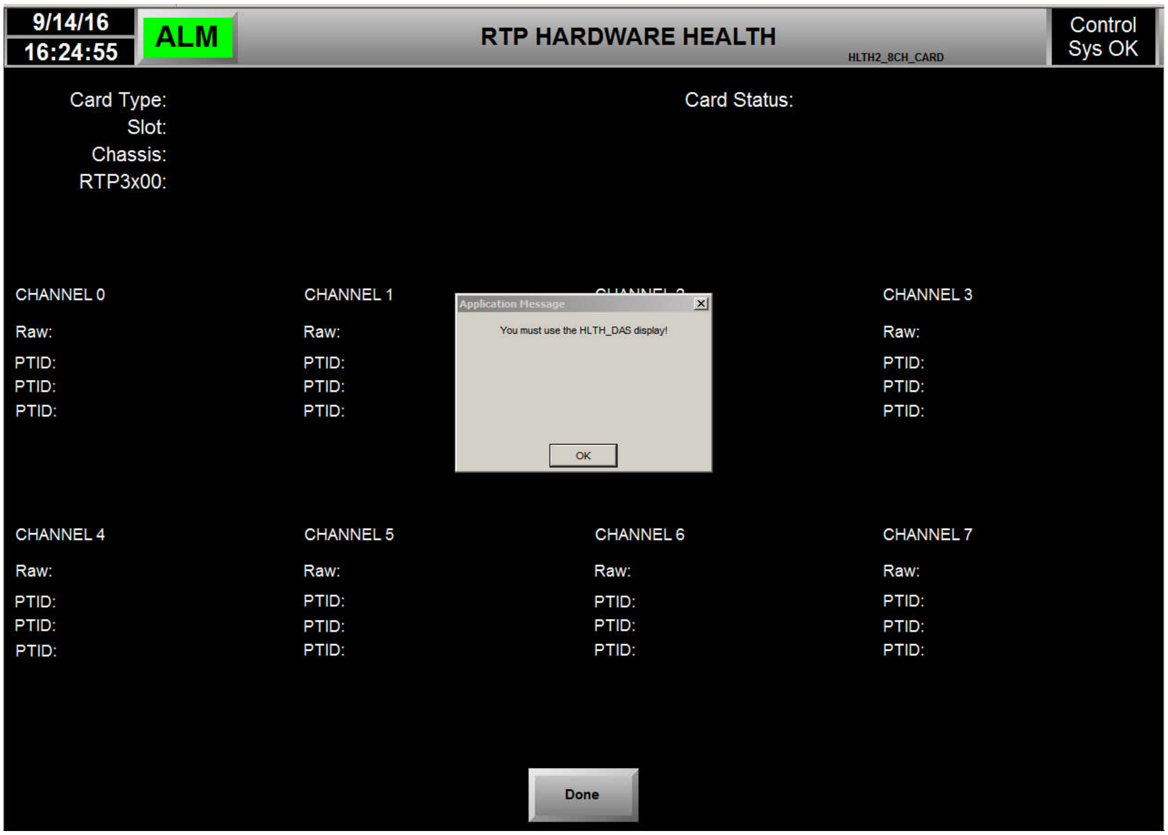


Figure 4-60 - RTP Hardware Health – Card Level

4.3.5 System Calculations

The Calculated Points display defines, modifies, views, saves, deletes, or activates system calculated points (C-points, Interpretive Calculations). All users can view any point calculation, but only users with sufficient security can define or update a point. For a detailed discussion of this display, see Chapter 3, Section 3.6 “Calculation Display” of the *R*TIME User’s Manual*.

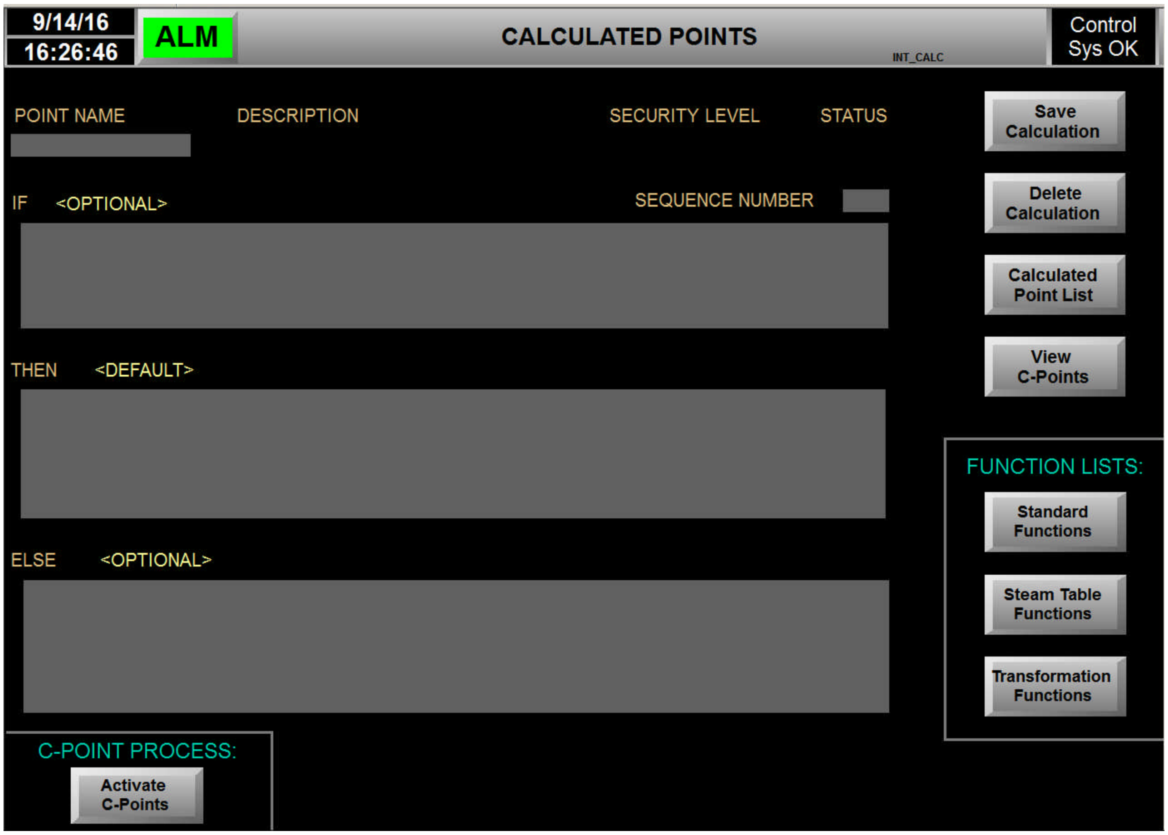


Figure 4-61 - System Calculations Display

4.3.6 Point Group Update

The Group Update and Group Control displays are used to manipulate server group definitions (Figure 4-62), and to "promote" a local group to server group status (Figure 4-63). For a detailed discussion of these displays, see Chapter 3, Section 3.11 "Group Displays" of the *R*TIME User's Manual*.

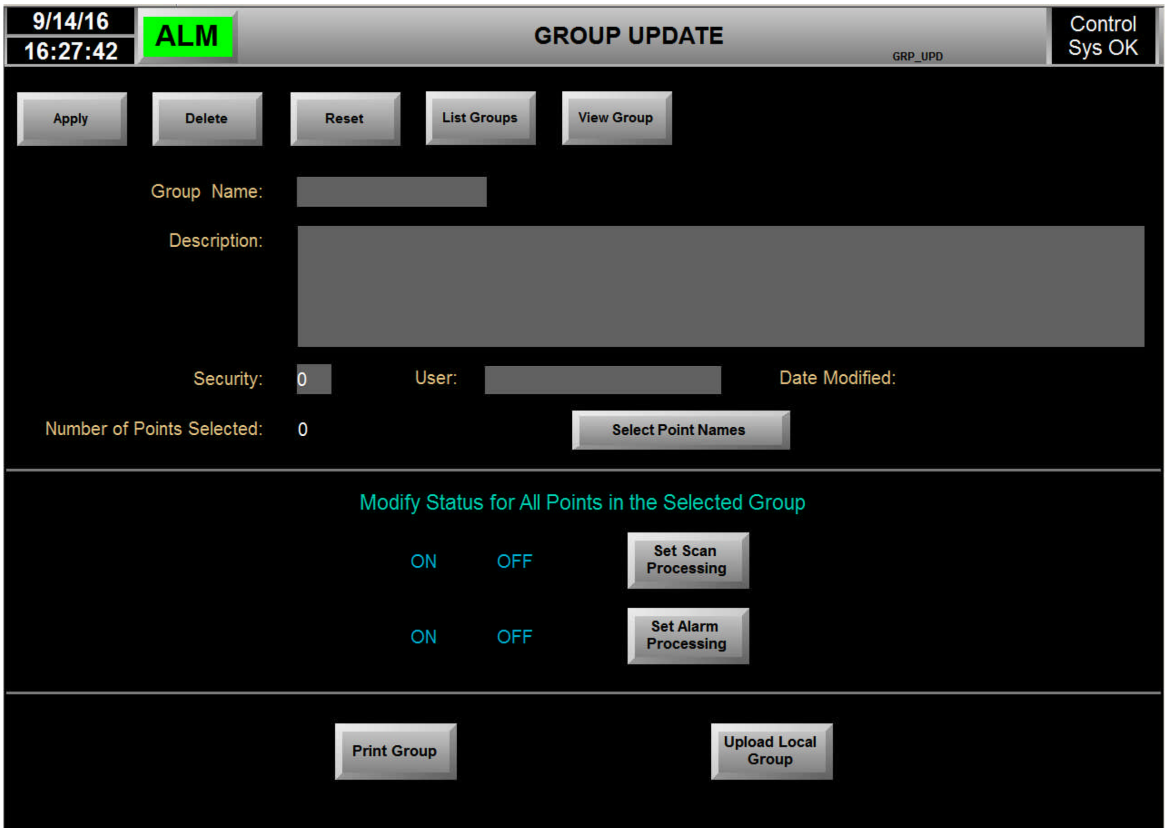


Figure 4-62 - Group Update Display

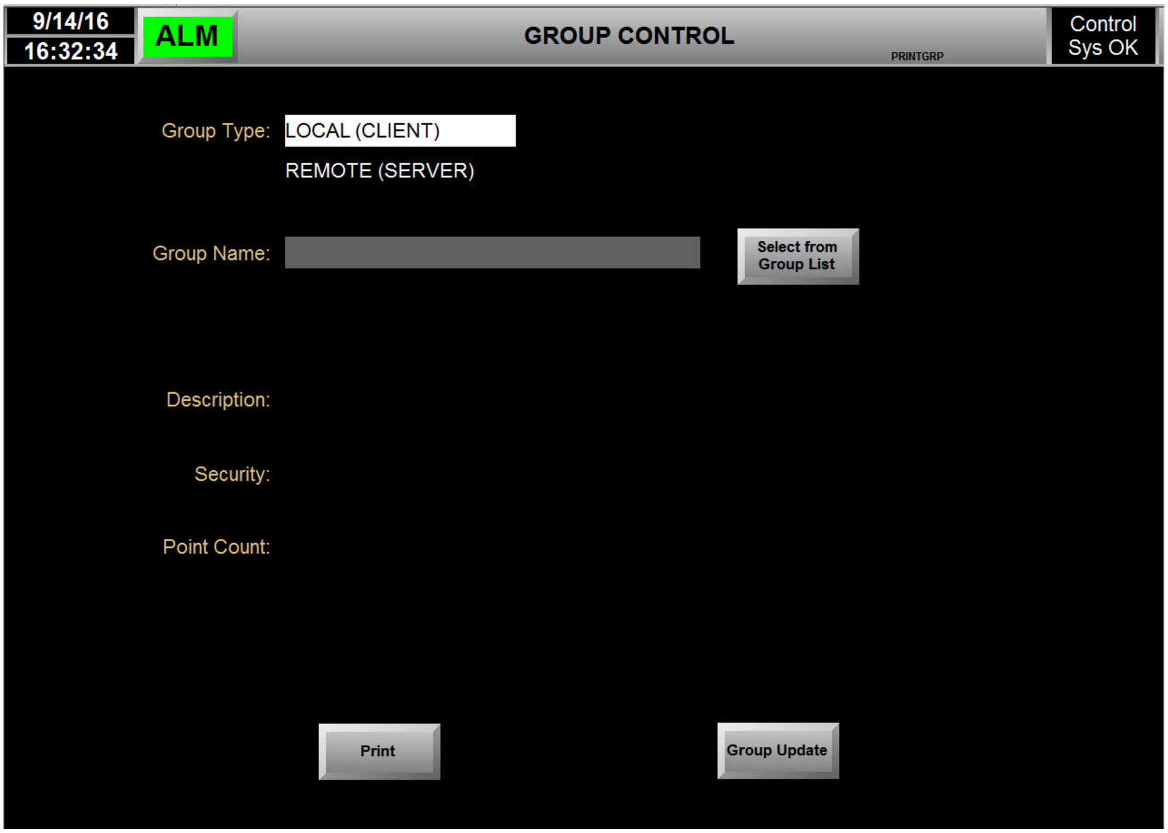


Figure 4-63 - Group Control Display

4.3.7 Password Update

From the Password Update Display, an authorized user can create, delete, modify and list user names, passwords and security levels. Only users with the highest security level may open this display. For a detailed discussion of this display, see Chapter 3, Section 3.16 “Password Update Display” of the *R*TIME User’s Manual*.

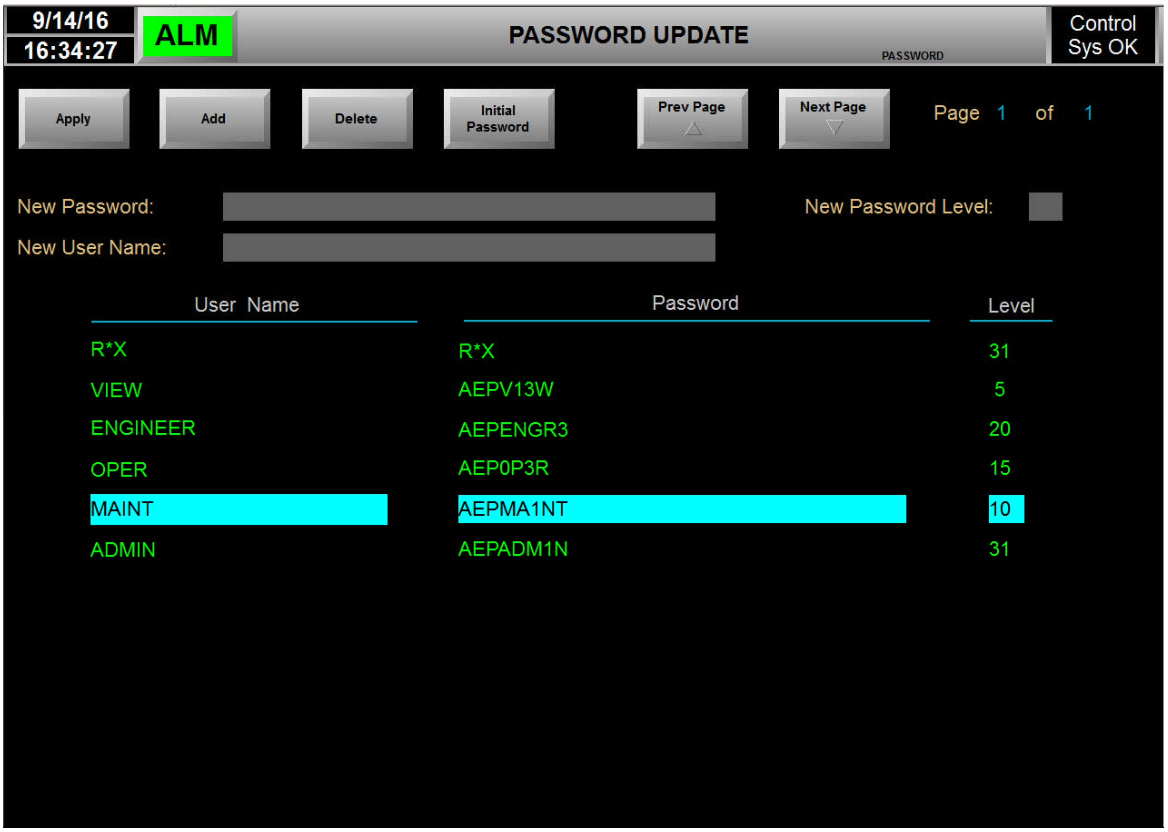


Figure 4-64 - Password Update Display

4.3.8 Test Database Manipulator (TDBM – Development)

This display activates the Test Database Manipulator (TDBM) program. The TDBM program changes the value, quality, and scan status of selected database points. This program is used only in test situations. For a complete discussion of the TDBM program, see Chapter 15, "Test Database Manipulator," of the R*TIME Application Program Interface Manual.

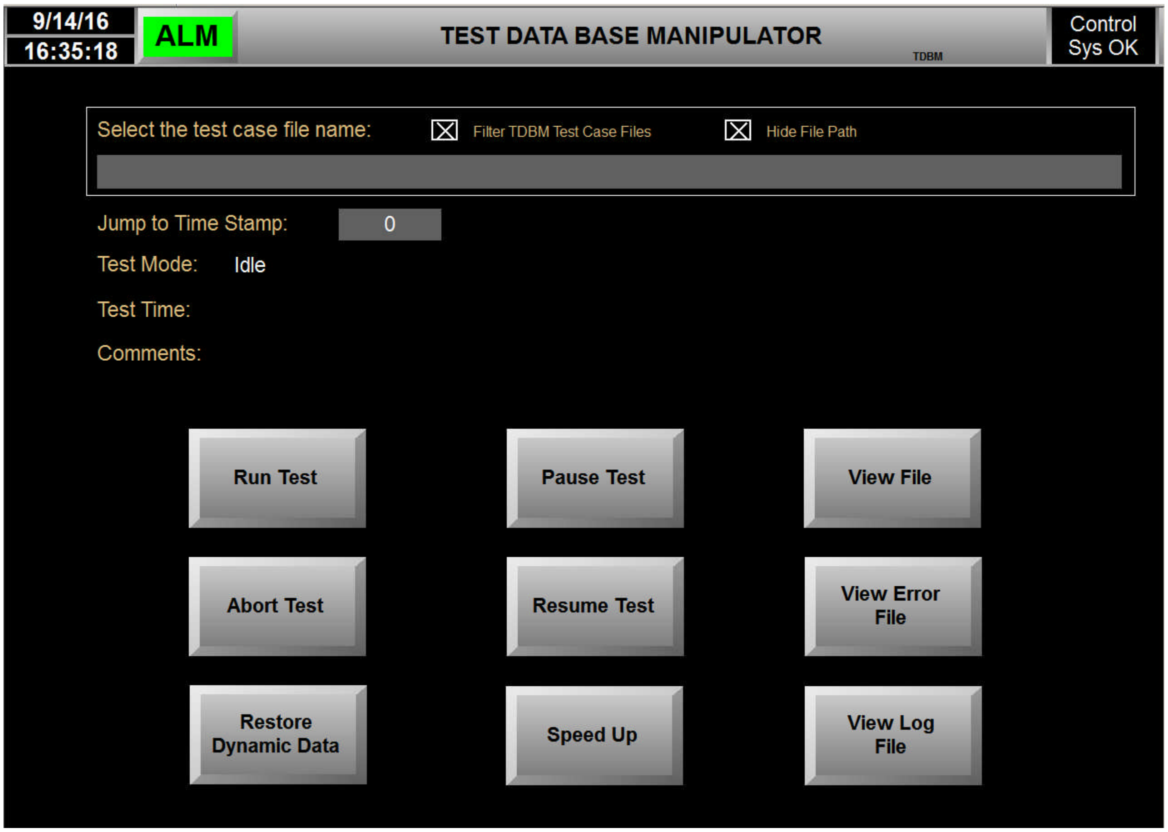


Figure 4-65 - Test Database Manipulator Display

4.3.9 Message Backup

The Message Backup software backs up specific message files to a defined backup media. For a detailed description of the display, see Chapter 3, Section 3.14.2 “Message Backup Display” of the *R*TIME User’s Manual*.

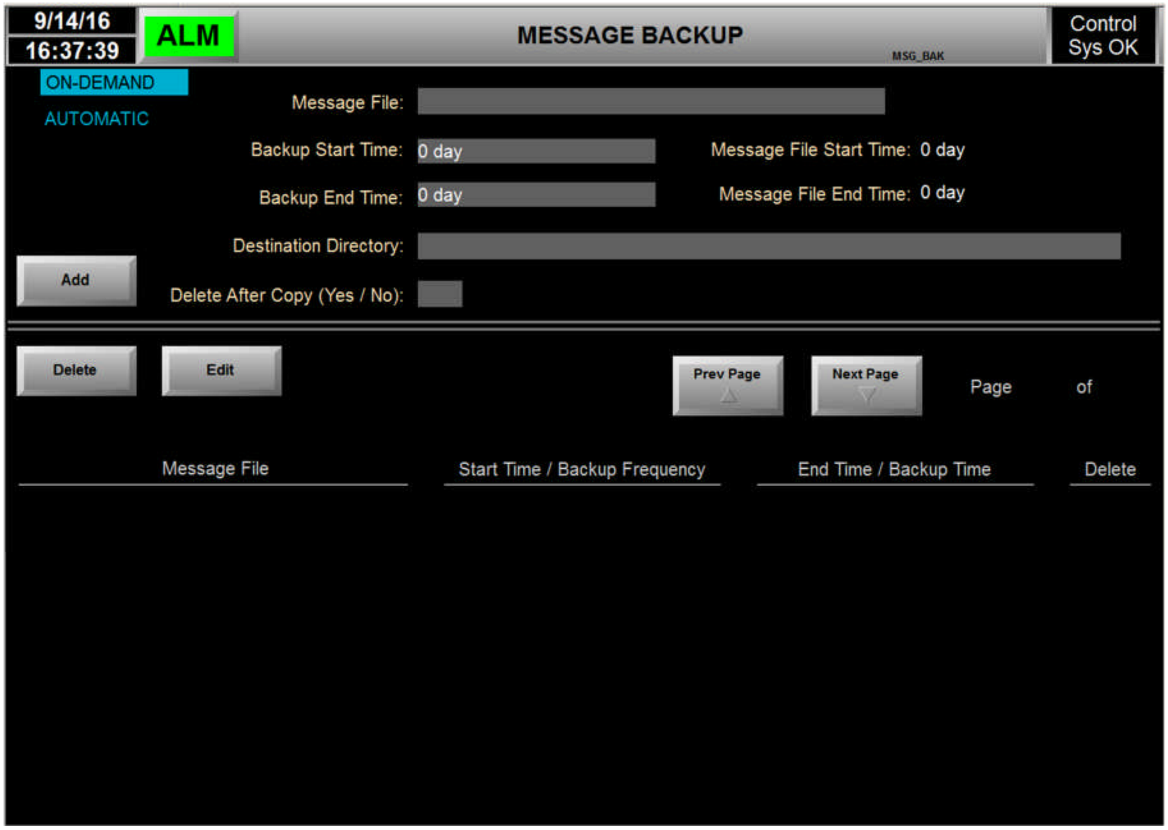


Figure 4-66 - Message Backup Display

4.4 R*TIME User Functions Displays

The displays described in this section are available to all users. Although any user can view the Alarm Summary display the acknowledge functions have both login and geographic security requirements.

4.4.1 Message Subsystem Displays

There are three message displays provided: Message Retrieval, Message Summary, and Message Backup (when applicable). These displays enable viewing of several different message logs and make full or partial backups of selected message files.

4.4.1.1 Message Summary

The Message Summary display contains a dynamic list of messages that is constantly updated as new messages are received. For a detailed description of the display, see Chapter 3, Section 3.14.3 "Message Summary Display" of the *R*TIME User's Manual*.

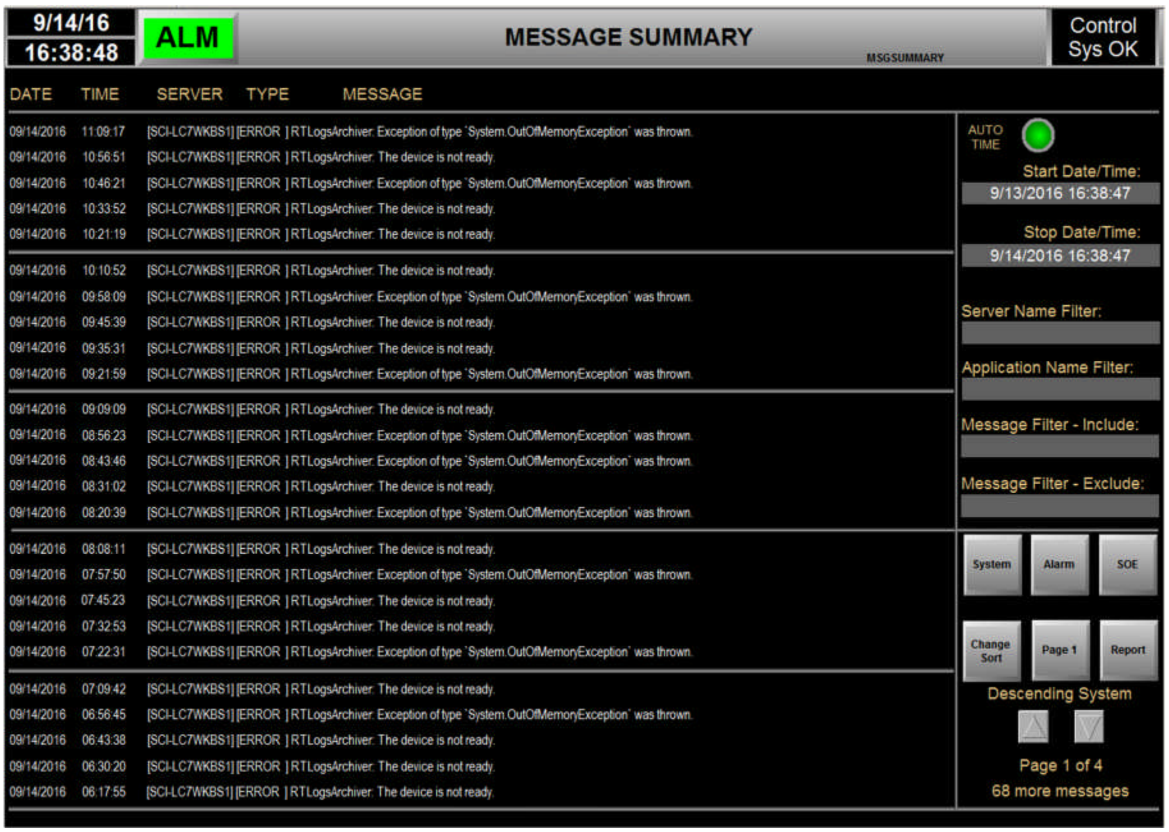


Figure 4-67 - Message Summary Display

4.4.1.2 Message Retrieval

The Message Retrieval display (Figure 4-68) generates a list of messages from the selected message file and displays the results in a text file (Figure 4-69). For a detailed description of the display, see Chapter 3, Section 3.14.1 “Message Retrieval Display” of the *R*TIME User’s Manual*.

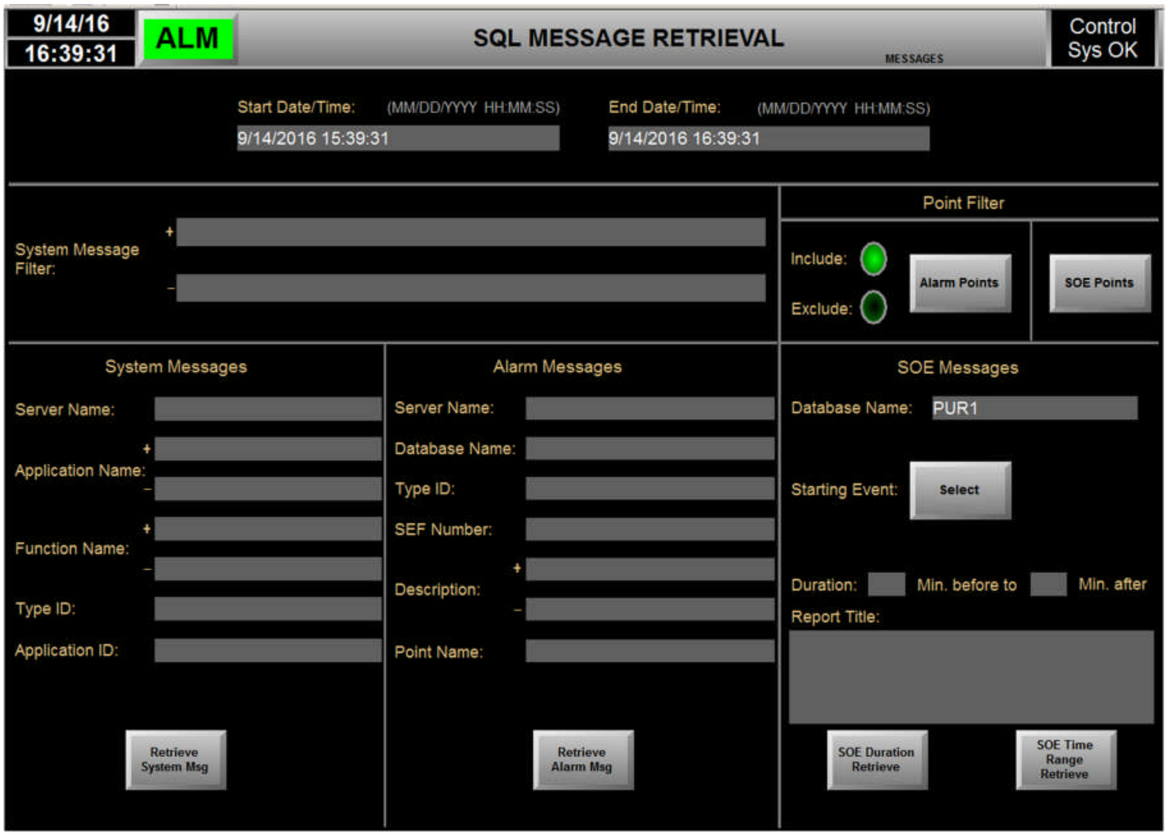
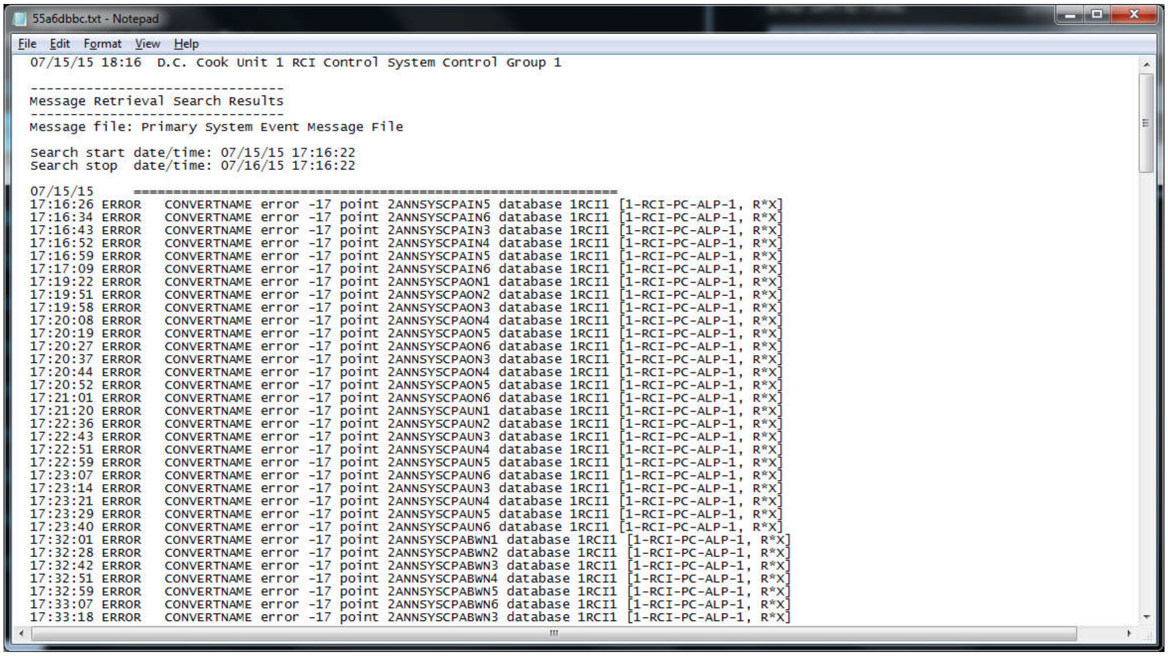


Figure 4-68 - Message Retrieval Display




```
07/15/15 18:16  D.C. Cook Unit 1 RCI Control System Control Group 1

--------------------------------
Message Retrieval Search Results
--------------------------------
Message file: Primary System Event Message File

Search start date/time: 07/15/15 17:16:22
Search stop  date/time: 07/16/15 17:16:22

07/15/15     ============================================================
17:16:26 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAIN5 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:16:34 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAIN6 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:16:43 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAIN3 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:16:52 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAIN4 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:16:59 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAIN5 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:17:09 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAIN6 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:19:22 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAON1 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:19:51 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAON2 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:19:58 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAON3 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:20:08 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAON4 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:20:19 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAON5 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:20:27 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAON6 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:20:37 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAON3 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:20:44 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAON4 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:20:52 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAON5 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:21:01 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAON6 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:21:20 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAUN1 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:22:36 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAUN2 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:22:43 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAUN3 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:22:51 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAUN4 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:22:59 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAUN5 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:23:07 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAUN6 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:23:14 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAUN3 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:23:21 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAUN4 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:23:29 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAUN5 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:23:40 ERROR   CONVERTNAME error -17 point 2ANNSYSCPAUN6 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:32:01 ERROR   CONVERTNAME error -17 point 2ANNSYSCPABWN1 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:32:28 ERROR   CONVERTNAME error -17 point 2ANNSYSCPABWN2 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:32:42 ERROR   CONVERTNAME error -17 point 2ANNSYSCPABWN3 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:32:51 ERROR   CONVERTNAME error -17 point 2ANNSYSCPABWN4 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:32:59 ERROR   CONVERTNAME error -17 point 2ANNSYSCPABWN5 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:33:07 ERROR   CONVERTNAME error -17 point 2ANNSYSCPABWN6 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
17:33:18 ERROR   CONVERTNAME error -17 point 2ANNSYSCPABWN3 database 1RCI1 [1-RCI-PC-ALP-1, R*X]
```

Figure 4-69 - Sample Message Retrieval Results

4.4.2 Point Summaries

The Point Summaries Display (Figure 4-70) enables the user to create a variety of custom reports summarizing the current states of selectable point groupings (Figure 4-71). For a detailed description of the display, see Chapter 3, Section 3.17.1 “Point Summaries Display” of the *R*TIME User’s Manual*.

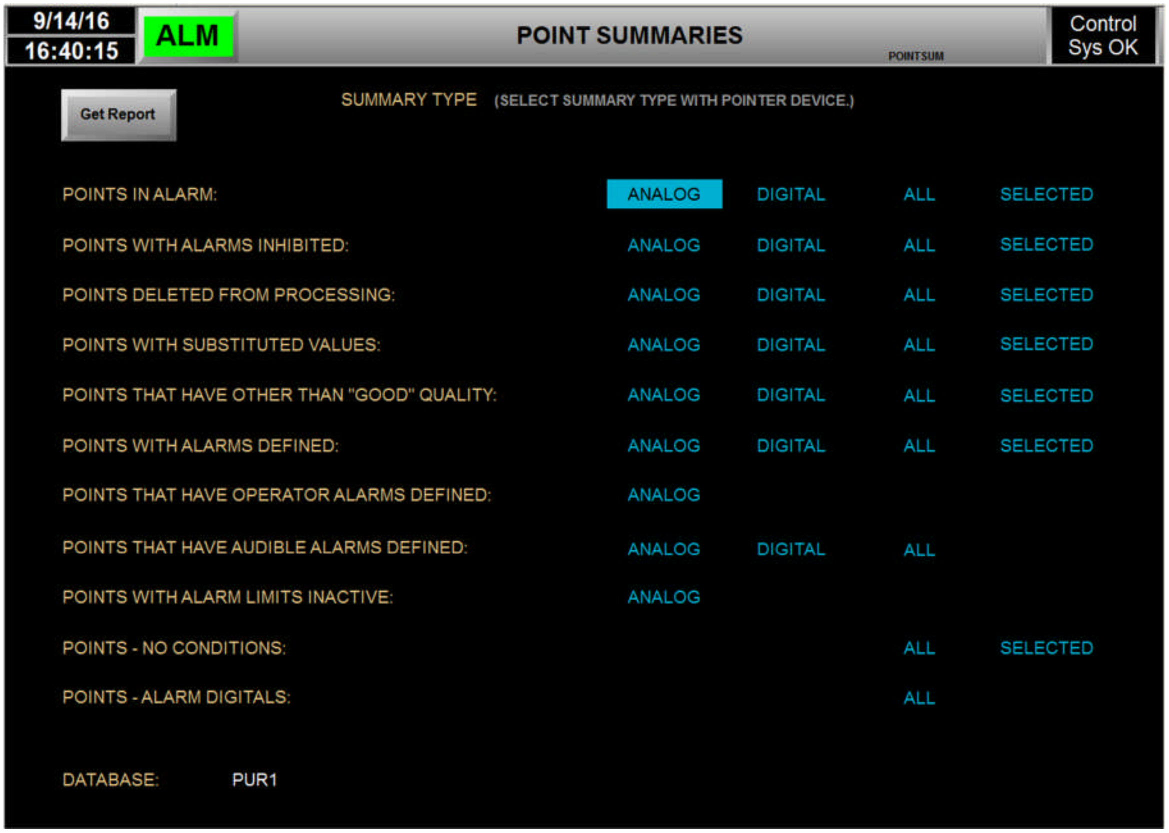
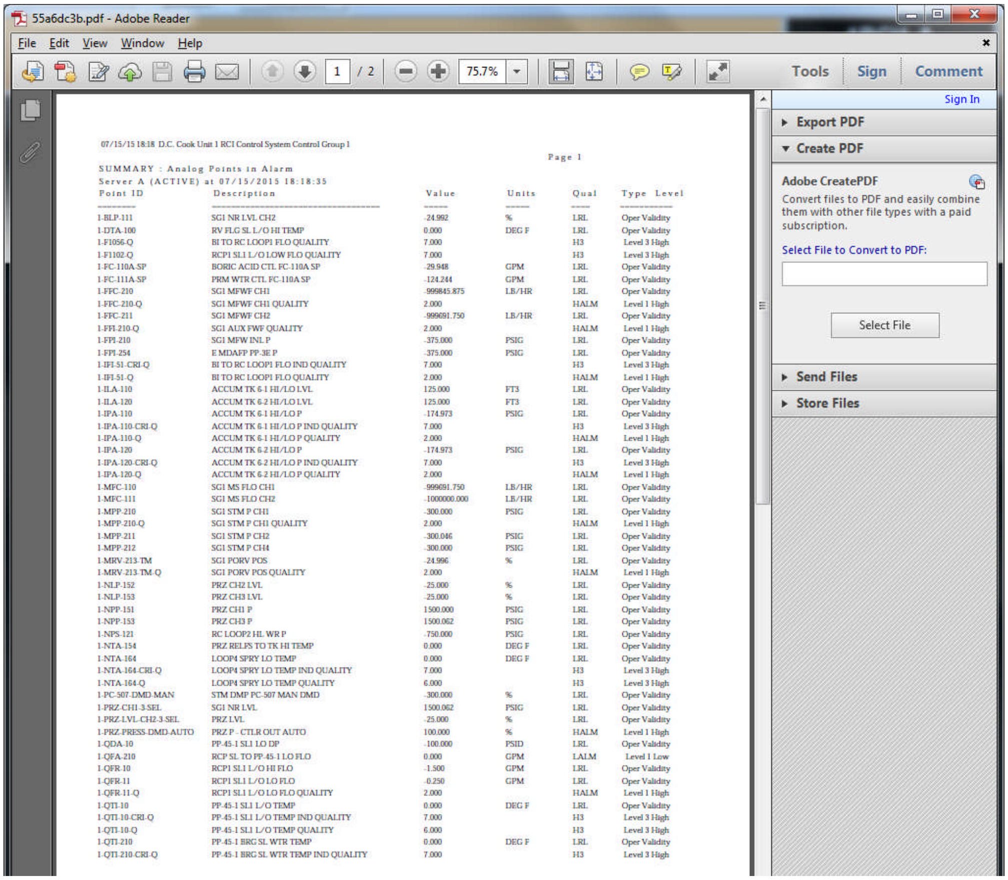


Figure 4-70 - Point Summaries Display



07/15/15 18:18 D.C. Cook Unit 1 RCI Control System Control Group 1

Page 1

SUMMARY : Analog Points in Alarm
Server A (ACTIVE) at 07/15/2015 18:18:35

Point ID	Description	Value	Units	Qual	Type Level
1-BLP-111	SG1 NR LVL CH2	-24.992	%	LRL	Oper Validity
1-DTA-100	RV FLG SL L/O HI TEMP	0.000	DEG F	LRL	Oper Validity
1-F1056-Q	BI TO RC LOOP1 FLO QUALITY	7.000		H3	Level 3 High
1-F1102-Q	RCP1 SL1 L/O LOW FLO QUALITY	7.000		H3	Level 3 High
1-FC-110A-SP	BORIC ACID CTL FC-110A SP	-29.948	GPM	LRL	Oper Validity
1-FC-111A-SP	PRM WTR CTL FC-110A SP	-124.244	GPM	LRL	Oper Validity
1-FFC-210	SG1 MFWF CH1	-999845.875	LB/HR	LRL	Oper Validity
1-FFC-210-Q	SG1 MFWF CH1 QUALITY	2.000		HALM	Level 1 High
1-FFC-211	SG1 MFWF CH2	-999691.750	LB/HR	LRL	Oper Validity
1-FFI-210-Q	SG1 AUX FWF QUALITY	2.000		HALM	Level 1 High
1-FPI-210	SG1 MFW INL P	-375.000	PSIG	LRL	Oper Validity
1-FPI-254	E MDAFP PP-3E P	-375.000	PSIG	LRL	Oper Validity
1-IFI-51-CRI-Q	BI TO RC LOOP1 FLO IND QUALITY	7.000		H3	Level 3 High
1-IFI-51-Q	BI TO RC LOOP1 FLO QUALITY	2.000		HALM	Level 1 High
1-ILA-110	ACCUM TK 6-1 HI/LO LVL	125.000	FT3	LRL	Oper Validity
1-ILA-120	ACCUM TK 6-2 HI/LO LVL	125.000	FT3	LRL	Oper Validity
1-IPA-110	ACCUM TK 6-1 HI/LO P	-174.973	PSIG	LRL	Oper Validity
1-IPA-110-CRI-Q	ACCUM TK 6-1 HI/LO P IND QUALITY	7.000		H3	Level 3 High
1-IPA-110-Q	ACCUM TK 6-1 HI/LO P QUALITY	2.000		HALM	Level 1 High
1-IPA-120	ACCUM TK 6-2 HI/LO P	-174.973	PSIG	LRL	Oper Validity
1-IPA-120-CRI-Q	ACCUM TK 6-2 HI/LO P IND QUALITY	7.000		H3	Level 3 High
1-IPA-120-Q	ACCUM TK 6-2 HI/LO P QUALITY	2.000		HALM	Level 1 High
1-MFC-110	SG1 MS FLO CH1	-999691.750	LB/HR	LRL	Oper Validity
1-MFC-111	SG1 MS FLO CH2	-1000000.000	LB/HR	LRL	Oper Validity
1-MPP-210	SG1 STM P CH1	-300.000	PSIG	LRL	Oper Validity
1-MPP-210-Q	SG1 STM P CH1 QUALITY	2.000		HALM	Level 1 High
1-MPP-211	SG1 STM P CH2	-300.046	PSIG	LRL	Oper Validity
1-MPP-212	SG1 STM P CH4	-300.000	PSIG	LRL	Oper Validity
1-MRV-213-TM	SG1 PORV POS	-24.996	%	LRL	Oper Validity
1-MRV-213-TM-Q	SG1 PORV POS QUALITY	2.000		HALM	Level 1 High
1-NLP-152	PRZ CH2 LVL	-25.000	%	LRL	Oper Validity
1-NLP-153	PRZ CH3 LVL	-25.000	%	LRL	Oper Validity
1-NPP-151	PRZ CH1 P	1500.000	PSIG	LRL	Oper Validity
1-NPP-153	PRZ CH3 P	1500.062	PSIG	LRL	Oper Validity
1-NPS-121	RC LOOP2 HL WR P	-750.000	PSIG	LRL	Oper Validity
1-NTA-154	PRZ RELFS TO TK HI TEMP	0.000	DEG F	LRL	Oper Validity
1-NTA-164	LOOP4 SPRY LO TEMP	0.000	DEG F	LRL	Oper Validity
1-NTA-164-CRI-Q	LOOP4 SPRY LO TEMP IND QUALITY	7.000		H3	Level 3 High
1-NTA-164-Q	LOOP4 SPRY LO TEMP QUALITY	6.000		H3	Level 3 High
1-PC-507-DMD-MAN	STM DMP PC-507 MAN DMD	-300.000	%	LRL	Oper Validity
1-PRZ-CH1-3-SEL	SG1 NR LVL	1500.062	PSIG	LRL	Oper Validity
1-PRZ-LVL-CH2-3-SEL	PRZ LVL	-25.000	%	LRL	Oper Validity
1-PRZ-PRESS-DMD-AUTO	PRZ P - CTLR OUT AUTO	100.000	%	HALM	Level 1 High
1-QDA-10	PP-45-1 SL1 LO DP	-100.000	PSID	LRL	Oper Validity
1-QFA-210	RCP SL TO PP-45-1 LO FLO	0.000	GPM	LALM	Level 1 Low
1-QFR-10	RCP1 SL1 L/O HI FLO	-1.500	GPM	LRL	Oper Validity
1-QFR-11	RCP1 SL1 L/O LO FLO	-0.250	GPM	LRL	Oper Validity
1-QFR-11-Q	RCP1 SL1 L/O LO FLO QUALITY	2.000		HALM	Level 1 High
1-QTI-10	PP-45-1 SL1 L/O TEMP	0.000	DEG F	LRL	Oper Validity
1-QTI-10-CRI-Q	PP-45-1 SL1 L/O TEMP IND QUALITY	7.000		H3	Level 3 High
1-QTI-10-Q	PP-45-1 SL1 L/O TEMP QUALITY	6.000		H3	Level 3 High
1-QTI-210	PP-45-1 BRG SL WTR TEMP	0.000	DEG F	LRL	Oper Validity
1-QTI-210-CRI-Q	PP-45-1 BRG SL WTR TEMP IND QUALITY	7.000		H3	Level 3 High

Figure 4-71 - Sample Point Summary Report

4.4.3 Generic Trends

The Trends Menu opens a variety of trend, bar chart, and X-Y plot displays. For a complete discussion of the trends, trend types, bar charts, and plots, see Chapter 6, "Trends, Bar Charts and X-Y Plots," of the *R*TIME User's Manual*.

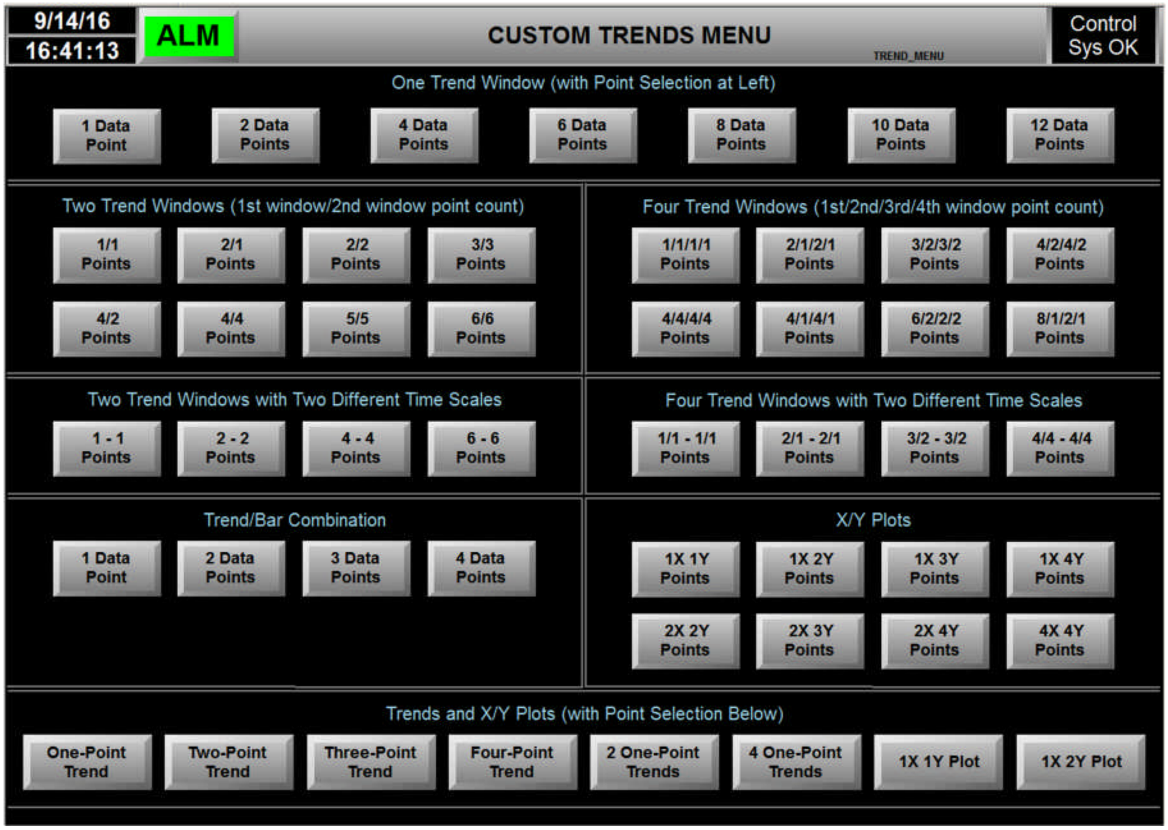


Figure 4-72 - Trend Menu

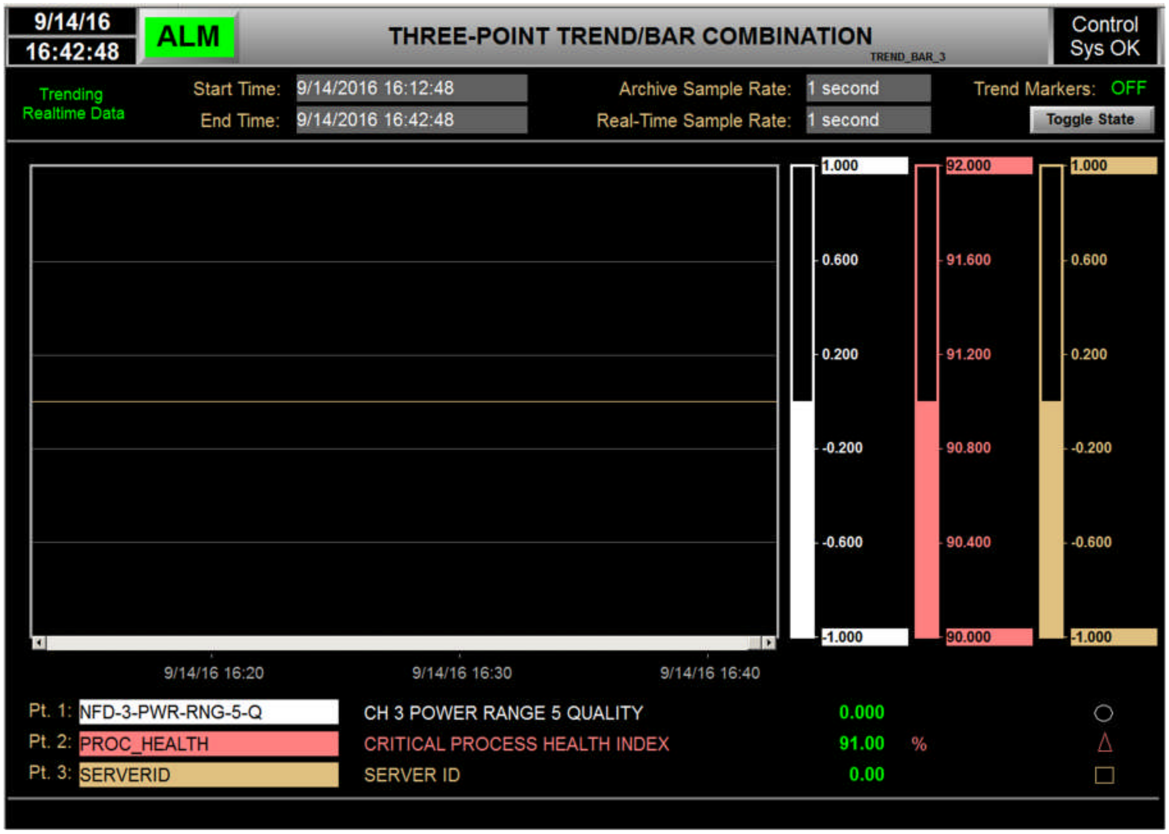


Figure 4-73 - Trend/Bar Combination, 3 Data Points

4.4.4 Tabular (Current Value)

The five Tabular Displays show 25 points per page for up to 125 points. For a detailed description of the display, see Chapter 3, Section 3.21 "Tabular Display" of the *R*TIME User's Manual*.

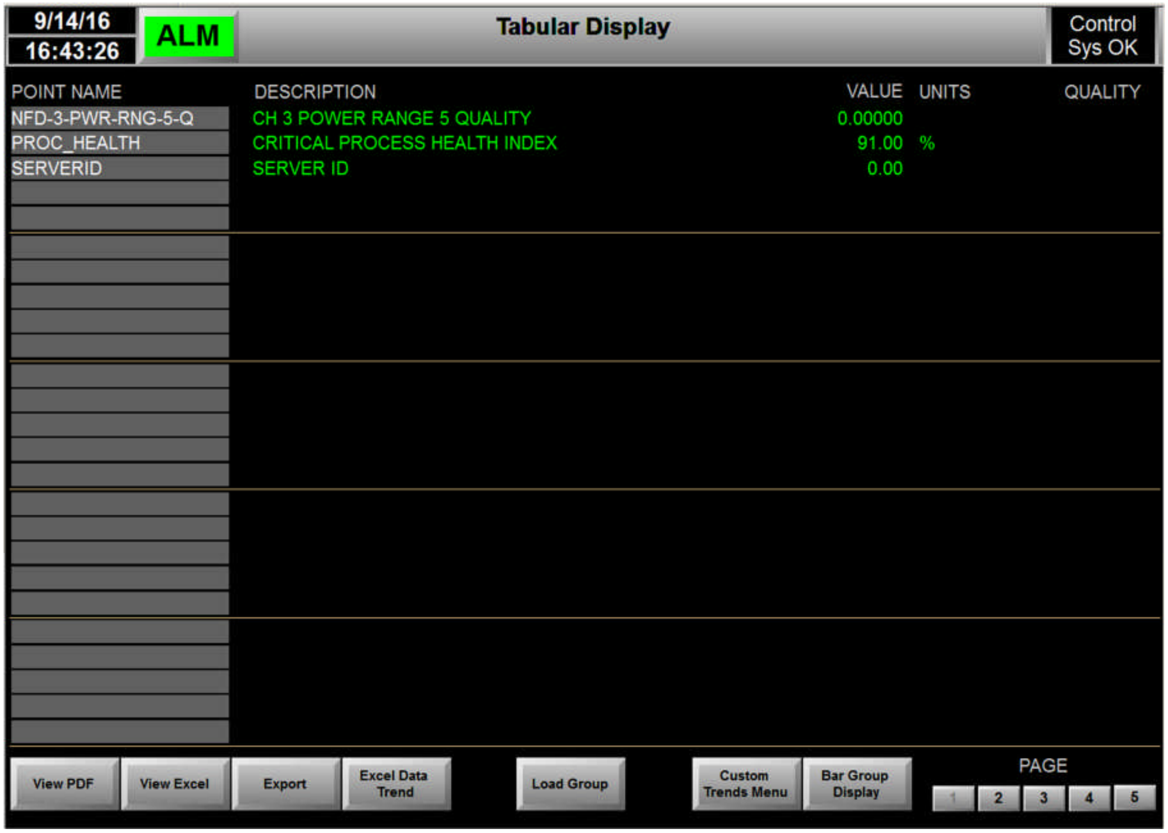


Figure 4-74 - Tabular Display

4.4.5 Alarm Summary

Alarm Summary shows the database points that are in alarm. Eighteen alarms can be shown on each page. New pages of alarms are added to the display set by the application, providing as many pages as are needed to show all the alarms. The pages can be filtered to show only unacknowledged alarms. With the proper authorization, alarms can be acknowledged from this display.

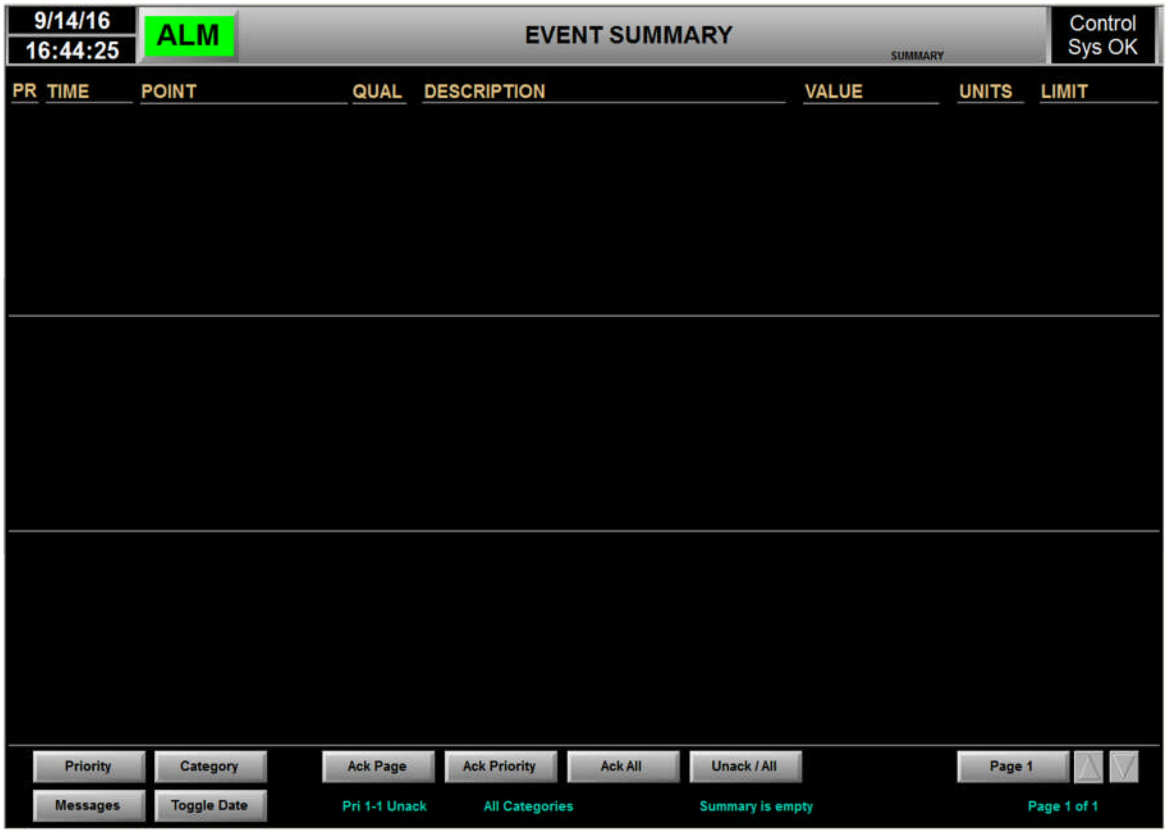


Figure 4-75 - Alarm Summary Display

There are numerous buttons and clickable areas on the Alarm Summary display. Only the alarm acknowledgement functions have geographic security requirements. The user interactions on this display include:

- “Priority” button – allows the user to view “All Alarms by Time” (default) or to filter by priority. The filters are not by a single priority but include all priorities up to the selected priority (e.g. “Priority 1-1 Alarms” shows only priority 1 alarms, “Priority 1-2 Alarms” shows priorities 1 and 2, …, “Priority 1-16 Alarms” shows all 16 alarm priorities.)
- “Messages” button – allows the user to generate a report of the alarm messages from the last 2 hours.
- “Category” button – allows the user to view alarms by category. The default is “All Categories”. Up to 12 categories are available.

- "Toggle Date" button – allows the user to view the time data as either the timestamp when the alarm occurred or as how long ago the alarm occurred.
- "Ack Page" button – allows authorized users to acknowledge the current page of alarms.
- "Ack Priority" button – allows authorized users to acknowledge a selected priority of alarms.
- "Ack All" button – allows authorized users to acknowledge all alarms.
- "Unack / All" button – allows the user to toggle between showing all alarms or only unacknowledged alarms. The default is to view unacknowledged alarms.
- "Page 1" button – loads the first page of alarms
- "▲" button – loads the previous page of alarms
- "▼" button – loads the next page of alarms
- Description fields – selects the point associated with the description and opens the T1 trend display. The trend display provides basic point information as well as a trend of the point's recent history.
- Value fields – selects the point associated with the value and opens either the Analog Point Details (Section 4.4.5.1) or Digital Point Details (Section 4.4.5.2) display based on the point type. The Details displays provide additional information about the selected point as well as a trend of its recent history.

4.4.5.1 Analog Point Details

The Analog Point Details display contains some information about the selected point as well as a trend of its recent history. The point data includes name, description, alias, current value, units, instrument id, category and security level. The trend portion of the display includes eleven buttons to quickly select different trend durations as well as entry fields to manually set the trend times.

The “Point Attributes” button navigates to Single Point Display – Analogs (Section 4.4.5.3).

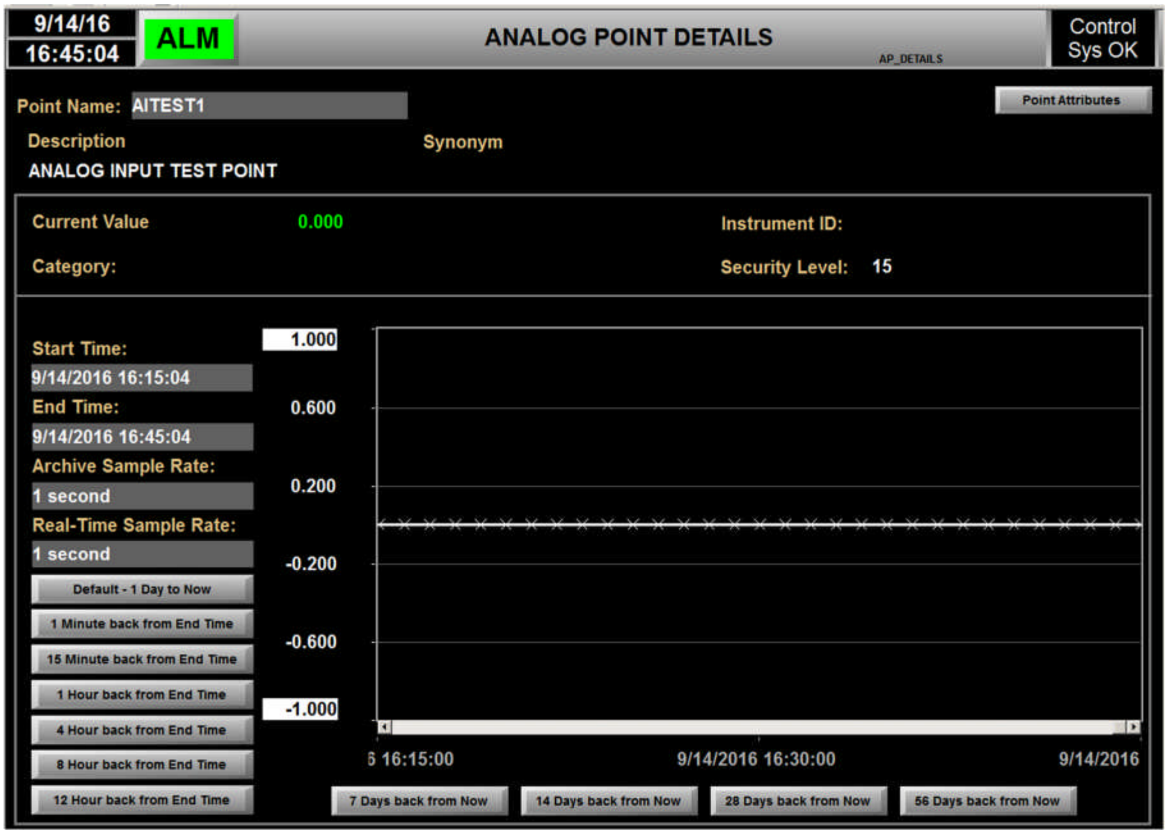


Figure 4-76 – Analog Point Details Display

4.4.5.2 Digital Point Details

The Digital Point Details display contains some information about the selected point as well as a trend of its recent history. The point data includes name, description, alias, current state, instrument id, category and security level. The trend portion of the display includes eleven buttons to quickly select different trend durations as well as entry fields to manually set the trend times.

The "Point Attributes" button navigates to Single Point Display – Digitals (Section 4.4.5.5).

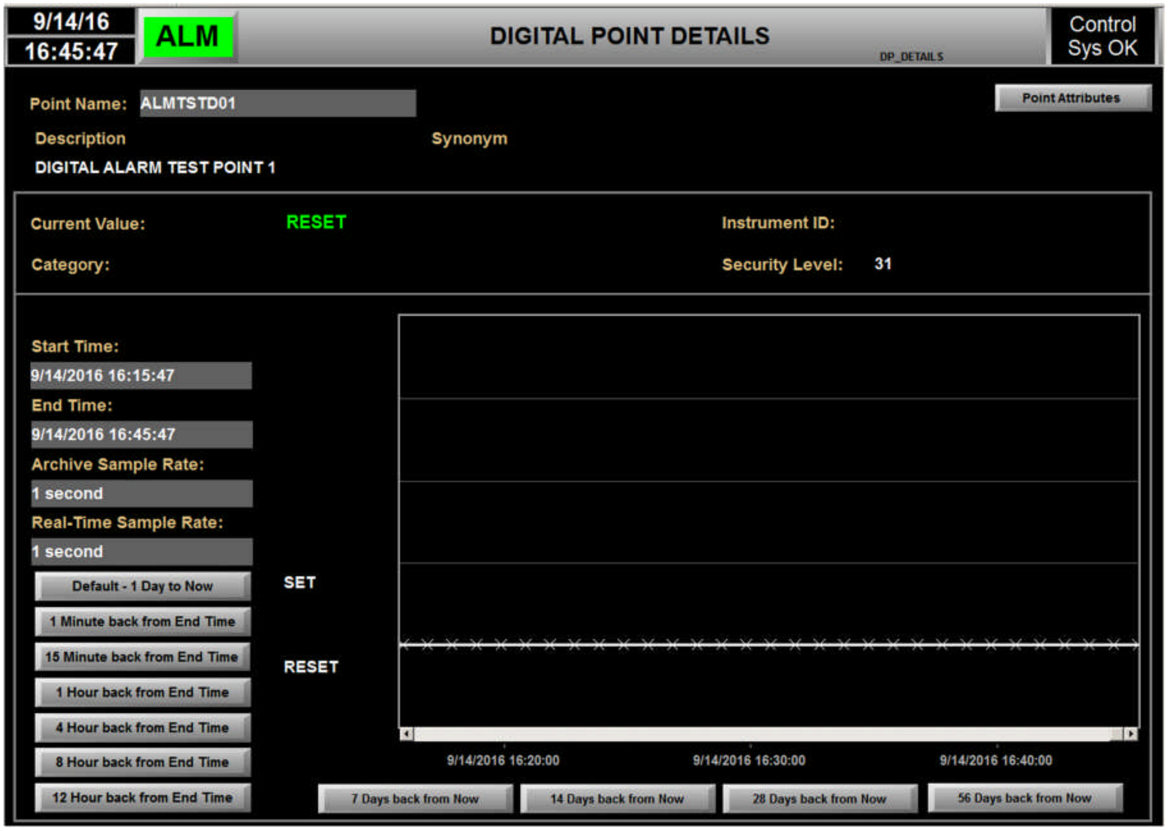


Figure 4-77 – Digital Point Details Display

4.4.5.3 Single Point Display – Analogs

The Single Point Display – Analogs provides basic information about the selected point as well as details about the point's alarm definitions. An authorized user may use this display to modify scan and alarm processing settings. For a detailed description of the display, see Chapter 3, Section 3.3.2.1 "Single Point Display – Analogs" of the *R*TIME User's Manual*.

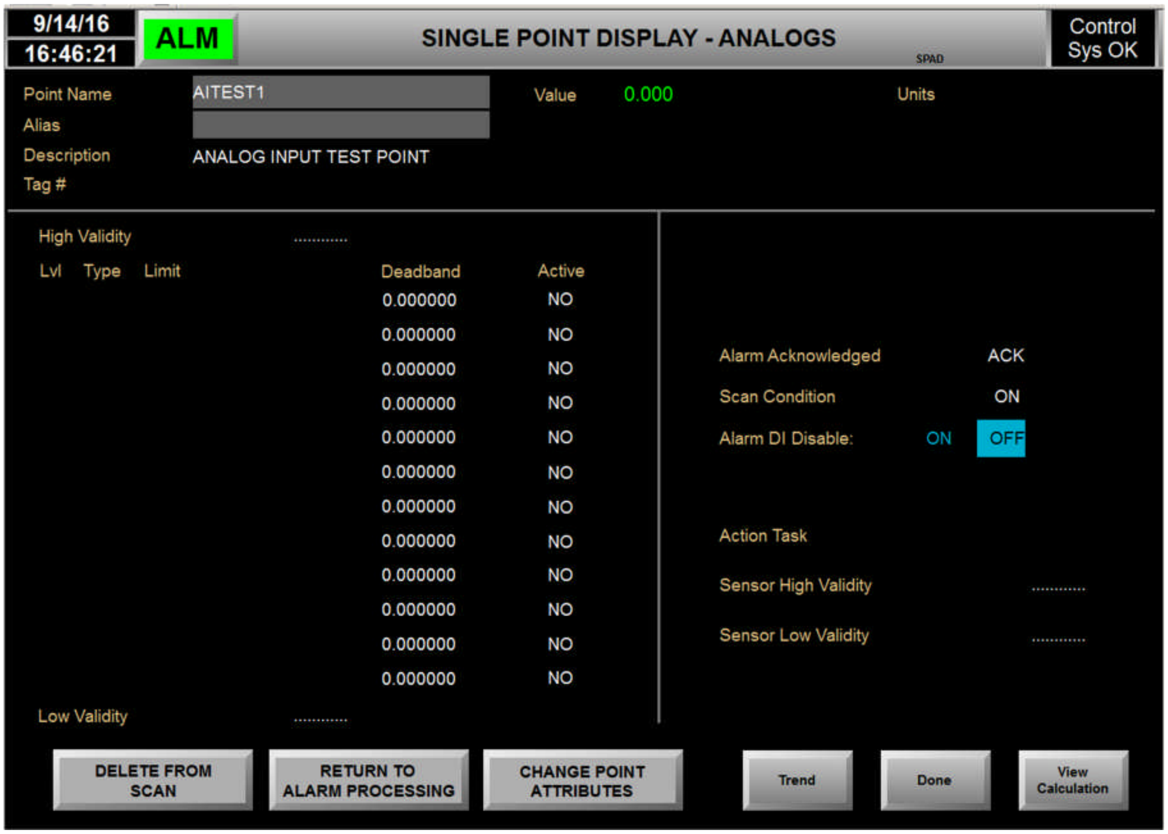


Figure 4-78 – Single Point Display – Analogs

4.4.5.4 Single Point Analog Change Attributes Display

The Single Point Analog Change Attributes Display provides the same information about the selected point as the Single Point Display – Analogs display. An authorized user may use this display to modify the point's scan and alarm processing state, change the point's value, and define or remove operator alarms. For a detailed description of the display, see Chapter 3, Section 3.3.2.2 "Single Point Analog Change Attributes" of the *R*TIME User's Manual*.

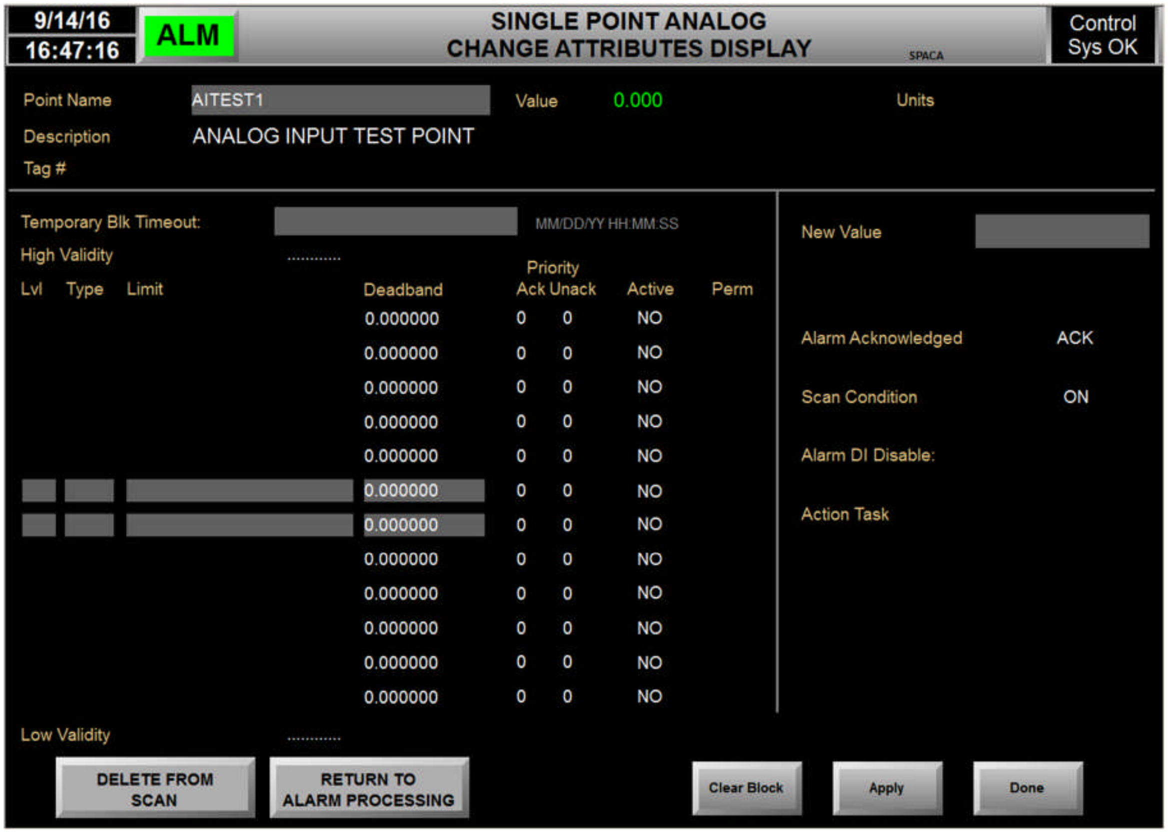


Figure 4-79 – Single Point Analog Change Attributes Display

4.4.5.5 Single Point Display – Digitals

The Single Point Display – Digitals provides basic information about the selected point as well as details about the point's alarm definitions. An authorized user may use this display to modify scan and alarm processing settings. For a detailed description of the display, see Chapter 3, Section 3.7.2.1 "Single Point Display – Digitals" of the *R*TIME User's Manual*.

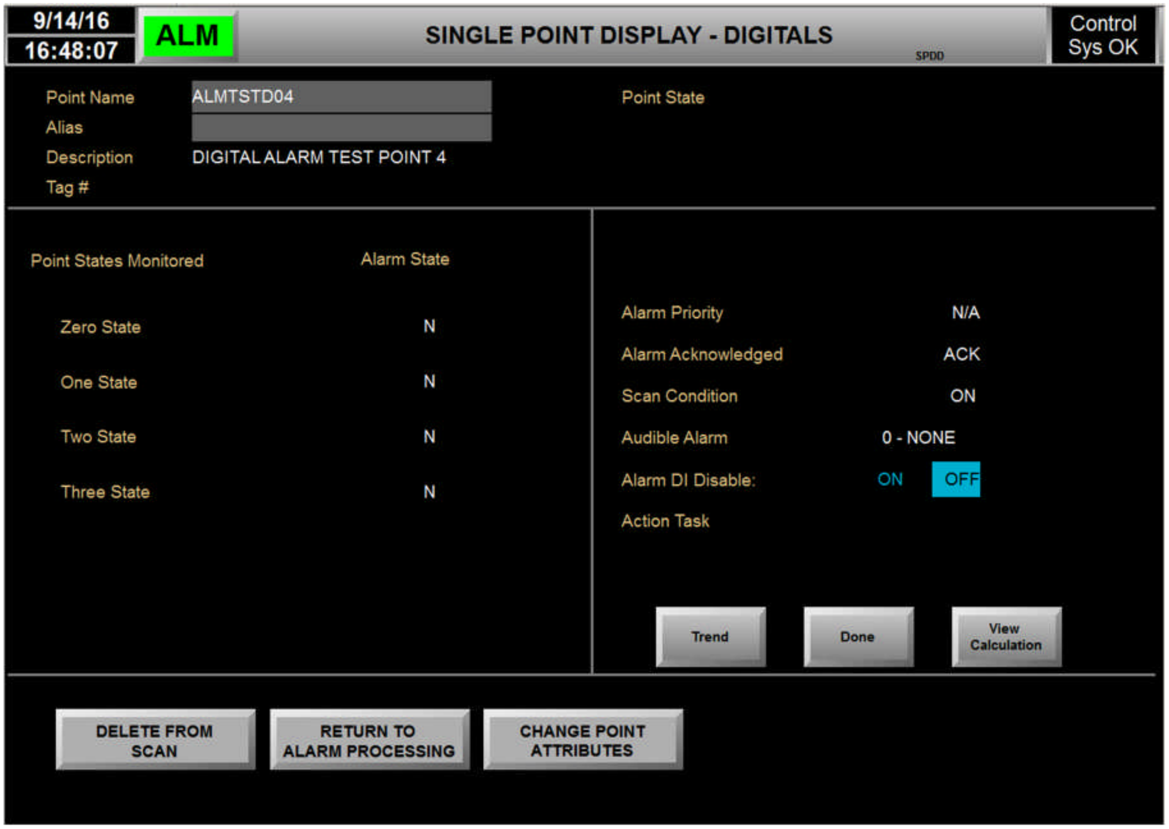


Figure 4-80 – Single Point Display – Digitals

4.4.5.6 Single Point Digital Change Attributes Display

The Single Point Digital Change Attributes Display provides the same information about the selected point as the Single Point Display – Digitals display. An authorized user may use this display to modify the point's scan and alarm processing state, or change the point's value. For a detailed description of the display, see Chapter 3, Section 3.7.2.2 "Single Point Analog Change Attributes" of the *R*TIME User's Manual*.

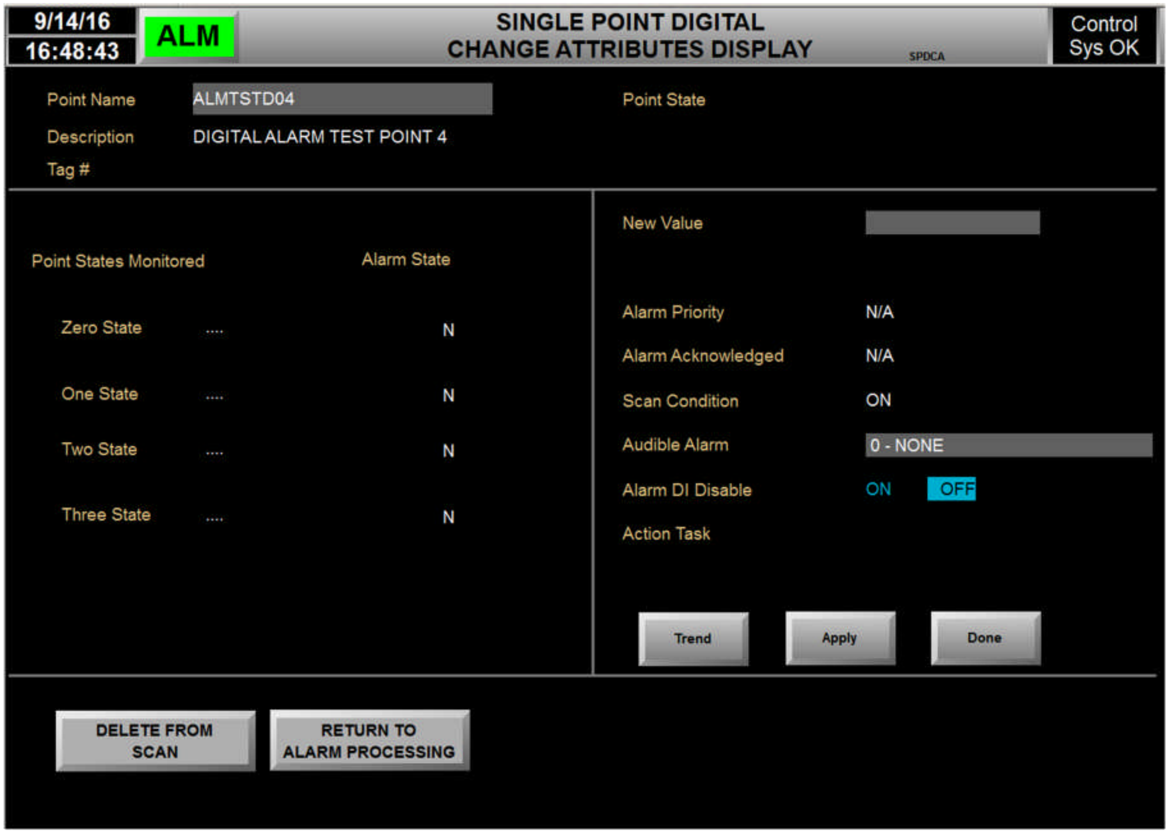


Figure 4-81 – Single Point Digital Change Attributes Display

4.5 User Display Interactions

The user is able to interact with the displays and through them the system programs using the mouse, keyboard and touchscreens. Entities on the displays and toolbar icons in the R*TIME Data Viewer are included to provide navigation and data entry functions.

"Poke" entities (navigation buttons, radio buttons, and data entry fields) may be activated by clicking on them using the left mouse button, touching them on the screen or tabbing to the entity using the keyboard and pressing "Enter" when the correct item is selected. When tabbing to an item using the keyboard the items on the frames are traversed before any items on the main display. The tab order on displays is generally in a top left to bottom right sequence; however, it may vary if a display has been divided into separate areas or has a logical functional progression that differs from the normal geographic sequence.

Besides the "Tab" key, the keyboard has additional display interactions and shortcuts defined which, at a minimum, include the following:

MMI.INI Configurable Definitions:

- "F2" key – navigates to the Alarm Menu display on the EWS, ALP1 and ALP2 workstations or Alarm Summary display on the servers
- "Home" key – navigates to the Top Level display defined for the workstation
- "►" key – navigates to the display defined as Page Right for the current display
- "◄" key – navigates to the display defined as Page Left for the current display
- "▲" key – navigates to the display defined as Page Up for the current display

R*TIME Data Viewer Definitions:

- "Ctrl" + "O" – opens the File Open dialog to open a new display
- "Ctrl" + "P" – opens the Print Dialog to print the display
- "Ctrl" + "C" – copies the active display to the clipboard
- "Ctrl" + "++" – zoom in
- "Ctrl" + "+-" – zoom out
- "Ctrl" + "F10" – zoom to window size
- "Ctrl" + "0" – zoom to 100%
- "Ctrl" + "T" – navigates to the top level display
- "Ctrl" + "Backspace" – navigates back to the previous display
- "Ctrl" + "Shift" + "R" – reset the display
- "Ctrl" + "Alt" + "U" – opens the File Open dialog to open a user state display in the current window
- "Ctrl" + "Alt" + "W" – opens the File Open dialog to open a user state display in a new window
- "Ctrl" + "A" – opens the Save As dialog to save the current display as a user state file.
- "Ctrl" + "Shift" + "N" – opens the Send Display dialog to send a display to another workstation.
- "Ctrl" + "Y" – opens the Archive Replay dialog to modify the replay settings.
- "Ctrl" + "Shift" + "L" – opens the File Open dialog to load an R*TIME environment.

- “Ctrl” + “Shift” + “S” – opens the Save As dialog to save the current displays and settings to an R*TIME environment file.
- “Ctrl” + “R” – toggles the Windows menu on and off.
- “Ctrl” + “L” – opens the R*TIME PASSWORD ENTRY login dialog
- “Ctrl” + “Shift” + “F” – logs off to security level 0
- “Ctrl” + “Shift” + “D” – logs off to the default security level defined in the MMI.INI file.

The keyboard is also required for data entry in many of the RPCS and R*TIME displays.

Wherever possible buttons that are either not applicable or disabled will appear “grayed out” with their button text dark gray instead of black. Items that are not applicable on a display will not be included in the tab order. Items that are applicable, but are currently disabled will be included in the tab order. Clicking, touching or tab selecting a disabled item will not be acknowledged by the display or application.

4.6 Color Use

4.6.1 Alarm Colors

The Alarm Colors, Status String and Replacement Characters configuration will be as described herein.

Table 4-2 – Alarm Colors

Alarm Type	Values		Status Tags		Graphic Color	Status String	Replace Value
	Background Color	Foreground Color	Background Color	Foreground Color			
Acknowledged Return to Normal - Good	000 (Black)	018 (Green)	000 (Black)	018 (Green)	018 (Green)	GOOD	
Unacknowledged Return to Normal - Good	000 (Black)	050 (Blinking Green)	000 (Black)	050 (Blinking Green)	018 (Green)	GOOD	
Good – not alarm point	000 (Black)	018 (Green)	000 (Black)	018 (Green)	018 (Green)	GOOD	
Manually Entered, Off Scan	000 (Black)	012 (Blue)	000 (Black)	012 (Blue)	012 (Blue)	SUB	
Manually Entered, On Scan	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	BAD	?
Off Scan	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	DEL	?
Acknowledged BAD	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	BAD	?
Unacknowledged BAD	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	BAD	?
Acknowledged DAS_BAD	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	INVL	?
Unacknowledged DAS_BAD	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	INVL	?
Acknowledged Failed MV Range High - Validity Range	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	RNGF	?
Unacknowledged Failed MV Range High - Validity Range	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	RNGF	?
Acknowledged Failed MV Range Low - Validity Range	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	RNGF	?

Alarm Type	Values		Status Tags		Graphic Color	Status String	Replace Value
	Background Color	Foreground Color	Background Color	Foreground Color			
Unacknowledged Failed MV Range Low - Validity Range	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	RNGF	?
Acknowledged Failed EU Range Low – Validity Range	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	LRL	?
Unacknowledged Failed EU Range Low – Validity Range	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	LRL	?
Acknowledged Failed EU Range High – Validity Range	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	HRL	?
Unacknowledged Failed EU Range High – Validity Range	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	HRL	?
Acknowledged L1 Alarm Low	000 (Black)	039 (Orange)	000 (Black)	039 (Orange)	039 (Orange)	LALM	
Unacknowledged L1 Alarm Low	000 (Black)	055 (Blinking Orange)	000 (Black)	055 (Blinking Orange)	039 (Orange)	LALM	
Acknowledged L1 Alarm Low SUSPECT Quality	000 (Black)	039 (Orange)	000 (Black)	039 (Orange)	039 (Orange)	SLLM	
Unacknowledged L1 Alarm Low SUSPECT Quality	000 (Black)	055 (Blinking Orange)	000 (Black)	055 (Blinking Orange)	039 (Orange)	SLLM	
Acknowledged L1 Alarm High	000 (Black)	039 (Orange)	000 (Black)	039 (Orange)	039 (Orange)	HALM	
Unacknowledged L1 Alarm High	000 (Black)	055 (Blinking Orange)	000 (Black)	055 (Blinking Orange)	039 (Orange)	HALM	
Acknowledged L1 Alarm High SUSPECT Quality	000 (Black)	039 (Orange)	000 (Black)	039 (Orange)	039 (Orange)	SHLM	
Unacknowledged L1 Alarm High SUSPECT Quality	000 (Black)	055 (Blinking Orange)	000 (Black)	055 (Blinking Orange)	039 (Orange)	SHLM	
Acknowledged L1 Alarm Rate	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR23	

Alarm Type	Values		Status Tags		Graphic Color	Status String	Replace Value
	Background Color	Foreground Color	Background Color	Foreground Color			
Unacknowledged L1 Alarm Rate	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR24	
Acknowledged L2 Alarm Low	000 (Black)	032 (Red)	000 (Black)	032 (Red)	032 (Red)	LOLO	
Unacknowledged L2 Alarm Low	000 (Black)	052 (Blinking Red)	000 (Black)	052 (Blinking Red)	032 (Red)	LOLO	
Acknowledged L2 Alarm High	000 (Black)	032 (Red)	000 (Black)	032 (Red)	032 (Red)	HIHI	
Unacknowledged L2 Alarm High	000 (Black)	052 (Blinking Red)	000 (Black)	052 (Blinking Red)	032 (Red)	HIHI	
Acknowledged L2 Alarm Low SUSPECT Quality	000 (Black)	032 (Red)	000 (Black)	032 (Red)	032 (Red)	SLOL	
Unacknowledged L2 Alarm Low SUSPECT Quality	000 (Black)	052 (Blinking Red)	000 (Black)	052 (Blinking Red)	032 (Red)	SLOL	
Acknowledged L2 Alarm High SUSPECT Quality	000 (Black)	032 (Red)	000 (Black)	032 (Red)	032 (Red)	SHIH	
Unacknowledged L2 Alarm High SUSPECT Quality	000 (Black)	052 (Blinking Red)	000 (Black)	052 (Blinking Red)	032 (Red)	SHIH	
Acknowledged L2 Alarm Rate	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR1	
Unacknowledged L2 Alarm Rate	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR2	
Acknowledged L3 Alarm Low	000 (Black)	032 (Red)	000 (Black)	032 (Red)	032 (Red)	L3	
Unacknowledged L3 Alarm Low	000 (Black)	052 (Blinking Red)	000 (Black)	052 (Blinking Red)	032 (Red)	L3	
Acknowledged L3 Alarm Low SUSPECT Quality	000 (Black)	032 (Red)	000 (Black)	032 (Red)	032 (Red)	SL3	
Unacknowledged L3 Alarm Low SUSPECT Quality	000 (Black)	052 (Blinking Red)	000 (Black)	052 (Blinking Red)	032 (Red)	SL3	
Acknowledged L3 Alarm High	000 (Black)	032 (Red)	000 (Black)	032 (Red)	032 (Red)	H3	

Alarm Type	Values		Status Tags		Graphic Color	Status String	Replace Value
	Background Color	Foreground Color	Background Color	Foreground Color			
Unacknowledged L3 Alarm High	000 (Black)	052 (Blinking Red)	000 (Black)	052 (Blinking Red)	032 (Red)	H3	
Acknowledged L3 Alarm High SUSPECT Quality	000 (Black)	032 (Red)	000 (Black)	032 (Red)	032 (Red)	SH3	
Unacknowledged L3 Alarm High SUSPECT Quality	000 (Black)	052 (Blinking Red)	000 (Black)	052 (Blinking Red)	032 (Red)	SH3	
Acknowledged L3 Alarm Rate	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR3	
Unacknowledged L3 Alarm Rate	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR4	
Acknowledged L4 Alarm Low	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR5	
Unacknowledged L4 Alarm Low	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR6	
Acknowledged L4 Alarm High	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR7	
Unacknowledged L4 Alarm High	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR8	
Acknowledged L4 Alarm Low SUSPECT Quality	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR9	
Unacknowledged L4 Alarm Low SUSPECT Quality	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR10	
Acknowledged L4 Alarm High SUSPECT Quality	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR11	
Unacknowledged L4 Alarm High SUSPECT Quality	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR12	
Acknowledged L4 Alarm Rate	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR13	
Unacknowledged L4 Alarm Rate	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR14	

Alarm Type	Values		Status Tags		Graphic Color	Status String	Replace Value
	Background Color	Foreground Color	Background Color	Foreground Color			
Acknowledged Operator Alarm Low	000 (Black)	039 (Orange)	000 (Black)	039 (Orange)	039 (Orange)	LOP	
Unacknowledged Operator Alarm Low	000 (Black)	055 (Blinking Orange)	000 (Black)	055 (Blinking Orange)	039 (Orange)	LOP	
Acknowledged Operator Alarm Low SUSPECT Quality	000 (Black)	039 (Orange)	000 (Black)	039 (Orange)	039 (Orange)	SLOP	
Unacknowledged Operator Alarm Low SUSPECT Quality	000 (Black)	055 (Blinking Orange)	000 (Black)	055 (Blinking Orange)	039 (Orange)	SLOP	
Acknowledged Operator Alarm High	000 (Black)	039 (Orange)	000 (Black)	039 (Orange)	039 (Orange)	HOP	
Unacknowledged Operator Alarm High	000 (Black)	055 (Blinking Orange)	000 (Black)	055 (Blinking Orange)	039 (Orange)	HOP	
Acknowledged Operator Alarm High SUSPECT Quality	000 (Black)	039 (Orange)	000 (Black)	039 (Orange)	039 (Orange)	SHOP	
Unacknowledged Operator Alarm High SUSPECT Quality	000 (Black)	055 (Blinking Orange)	000 (Black)	055 (Blinking Orange)	039 (Orange)	SHOP	
Acknowledged Operator Alarm Rate	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR21	
Unacknowledged Operator Alarm Rate	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR22	
Suspect	000 (Black)	024 (Yellow)	000 (Black)	024 (Yellow)	024 (Yellow)	SUSP	
Redundancy Failure (POOR)	000 (Black)	039 (Orange)	000 (Black)	039 (Orange)	039 (Orange)	REDU	
Link Lost Color	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	LNK	
Point is deleted from alarm checks	000 (Black)	008 (Cyan)	000 (Black)	008 (Cyan)	008 (Cyan)	DALM	
Point is inhibited from alarm by a cut-out point	000 (Black)	008 (Cyan)	000 (Black)	008 (Cyan)	008 (Cyan)	INHB	
Acknowledged L1 Digital Alarm	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR15	

Alarm Type	Values		Status Tags		Graphic Color	Status String	Replace Value
	Background Color	Foreground Color	Background Color	Foreground Color			
Unacknowledged L1 Digital Alarm	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR16	
Acknowledged L2 Digital Alarm	000 (Black)	032 (Red)	000 (Black)	032 (Red)	032 (Red)	ALM	
Unacknowledged L2 Digital Alarm	000 (Black)	052 (Blinking Red)	000 (Black)	052 (Blinking Red)	032 (Red)	ALM	
Acknowledged L3 Digital Alarm	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR17	
Unacknowledged L3 Digital Alarm	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR18	
Acknowledged L4 Digital Alarm	000 (Black)	040 (Magenta)	000 (Black)	040 (Magenta)	040 (Magenta)	ERR19	
Unacknowledged L4 Digital Alarm	000 (Black)	053 (Blinking Magenta)	000 (Black)	053 (Blinking Magenta)	040 (Magenta)	ERR20	

Table Note: *If none of the conditions are met, the default is Good – Normal*

A visual depiction of the alarm colors is presented in the Figures below.

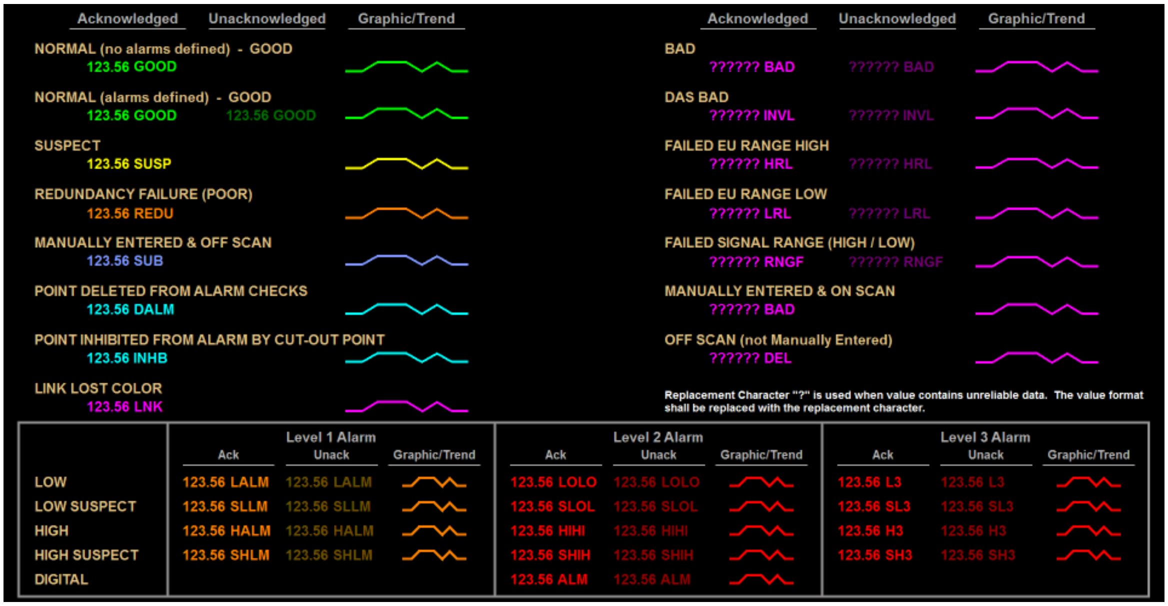


Figure 4-82 – Alarm Color Display Screen

4.6.2 Color Palette

The following table represents the standard R*TIME display color palette. The color index is used as the color designator in INI files. The Display Builder Color Number is the palette reference number when using the R*TIME Display Builder to create or update displays. The Invert Index is the Color Index for the color that will be printed when the "Swap Black and White" option is selected on Page Setup.

Color Index	Red	Green	Blue	Flash Red	Flash Green	Flash Blue	Invert Index	Display Builder Color Number	Color Sample
000	0	0	0				007	1	
001	96	96	96				006	2	
002	122	122	122				005	3	
003	149	149	149				004	4	
004	175	175	175				003	5	
005	202	202	202				002	6	
006	228	228	228				001	7	
007	255	255	255				000	8	
008	0	255	255				015	9	
009	0	175	208				022	10	
010	192	208	255				046	11	
011	160	175	255				014	12	
012	128	149	255				013	13	
013	0	0	255				012	14	
014	0	0	192				011	15	
015	0	0	128				008	16	
016	0	255	0				043	17	

Color Index	Red	Green	Blue	Flash Red	Flash Green	Flash Blue	Invert Index	Display Builder Color Number	Color Sample
017	0	208	0				023	18	
018	0	160	0				020	19	
019	0	112	0				021	20	
020	175	255	175				018	21	
021	122	255	122				019	22	
022	0	208	175				009	23	
023	122	208	0				017	24	
024	255	255	0				047	25	
025	255	255	150				041	26	
026	208	208	0				030	27	
027	250	220	175				038	28	
028	224	192	128				039	29	
029	180	145	78				037	30	
030	192	122	20				026	31	
031	176	88	0				036	32	
032	255	0	0				034	33	
033	208	0	0				035	34	
034	255	128	128				032	35	
035	255	192	192				033	36	
036	255	175	128				031	37	

Color Index	Red	Green	Blue	Flash Red	Flash Green	Flash Blue	Invert Index	Display Builder Color Number	Color Sample
037	255	175	64				029	38	
038	255	150	0				027	39	
039	255	128	0				028	40	
040	255	0	255				044	41	
041	175	0	175				025	42	
042	255	90	128				045	43	
043	255	150	192				016	44	
044	255	150	255				040	45	
045	255	192	255				042	46	
046	175	112	255				010	47	
047	142	0	202				024	48	
048	96	96	96	255	255	255	056	49	
049	0	112	112	0	255	255	057	50	
050	0	112	0	0	255	0	058	51	
051	112	112	0	255	255	0	059	52	
052	112	0	0	255	0	0	060	53	
053	112	0	112	255	0	255	061	54	
054	0	0	112	0	0	255	062	55	
055	112	80	0	255	150	0	063	56	
056	255	255	255	96	96	96	048	57	

Color Index	Red	Green	Blue	Flash Red	Flash Green	Flash Blue	Invert Index	Display Builder Color Number	Color Sample
057	0	255	255	0	112	112	049	58	
058	0	255	0	0	112	0	050	59	
059	255	255	0	112	112	0	051	60	
060	255	0	0	112	0	0	052	61	
061	255	0	255	112	0	112	053	62	
062	0	0	255	0	0	112	054	63	
063	255	150	0	112	80	0	055	64	

Purdue University

Research Reactor

PUR-1

Reactor Protection / Control System
Replacement Project

Hardware Design Document

Revision 3

November 2016

Document - PUR1-HDD-001

Nuclear Division | Scientech

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Revision Page

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Purdue University Approved By:	Date:
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TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

1 Introduction

1.1 Project Description and Background

The requirement for the PUR-1 console replacement is to provide a modern system that meets the NRC requirements for safety and licensing for research reactor applications. Due to the small size of the PUR-1 reactor, the Reactor Protection System (RPS) need not be independent of the Reactor Control System (RCS), and their functions may overlap or be combined. This is typical practice at many non-power reactors due to their low risk to facility staff, the public, and the environment.

There are plans to increase the licensed power rating of the PUR-1 reactor from 1 kW to 12 kW steady state power. The new control system shall be capable of supporting the higher power level with only a recalibration of the instrumentation and changing of applicable setpoints.

Because events during calibration, testing, startup, and operation may be short lived, a complete data acquisition and data storage system will be included in the proposed design. This data system shall be capable of transferring data to other computer systems in real time, or near real time, without risk to the control and protection system from digital intrusion.

1.2 Purpose

The purpose of this document is to define the design of the hardware for the Reactor Protection / Control System Replacement Project. This document describes the overall system design including the type, quantity and location of all hardware and third party software in the Reactor Protection / Control System (RPCS) replacement system. It also describes the networking equipment used to connect the system components. The hardware components identified in this document are based on requirements in the PUR1 Functional Requirements Specification document (Reference 1.4.5).

1.3 Definitions, Acronyms, and Abbreviations

1.3.1 Definitions

The following acronyms and definitions are utilized through this document.

House Alarm	Site evacuation
Class 0 Alarm	Reactor Room Evacuation
Class 1 Alarm	Annunciator alarm from console
Class 2 Alarm	Alarm which does not activate the annunciator and only appears in the RCS Alarm Summary display screen.

Gang Insert / Gang Lower	Simultaneous insertion of Shim Safety Rod #1, Shim Safety Rod #2 and the Regulating Rod using the drive motors.
PUR-1	Purdue University Research Reactor Number One
Reactor SCRAM / Reactor Trip	Insertion of Shim Safety Rod #1 and Shim Safety Rod #2 by removing power to the drive coupler magnets causing the control rods to insert into the reactor core via the force of gravity.
Reactor Setback	Automatic Gang Lower action initiated by the Reactor Control System when any Setback signal is active.
Reactor Operator	Individual licensed to control a nuclear reactor from a control panel within regulatory requirements.
Senior Reactor Operator	Individual licensed to control a nuclear reactor from a control panel within regulatory requirements and perform fuel alterations within the reactor vessel among other duties, responsibilities, and actions. Authorized by law to depart from regulations during emergencies.

1.3.2 Acronyms and Abbreviations

The following abbreviations are utilized through this document.

ASI	Analog Signal Input (also referred to as AI)
ASO	Analog Signal Output (also referred to as AO)
CAM	Continuous Air Monitor
COS	Change of State (synonym for SOE)
CR	Control Rod (includes SS1, SS2 and RR)
DAS	Data Acquisition System
DSI	Digital Signal Input (also referred to as DI)
DSO	Digital Signal Output (also referred to as DO)
DOE	Department of Energy
EMI/RFI	Electromagnetic Interference/Radio Frequency Interference
EU	Engineering Units
FC	Fission Chamber Drive
FMEA	Failure Modes and Effects Analysis
HDD	Hardware Design Document
HEU	Highly Enriched Uranium
HMI	Human-Machine Interface
HVAC	Heating, Ventilation, Air Conditioning
ICD	Instrument Configuration Document
I/O	Input/Output
IEEE	Institute of Electrical and Electronic Engineers
kW	Kilowatt
LEU	Low Enriched Uranium
LNP	Lockheed Nuclear Products
mA	Milliampere
mR/hr	milliRem per hour
MTR	Materials Test Reactor
mV	Millivolt
NFMS	Neutron Flux Monitoring System
NNSA	National Nuclear Security Administration

NRC	U.S. Nuclear Regulatory Commission
NS	Neutron Source Drive
PCS	Power Conditioning System
PDU	Power Distribution Unit
PVC	Polyvinyl Chloride
RAM	Radiation Area Monitor
RCS	Reactor Control System
RDS	Rod Drive System
RMS	Radiation Monitoring System
ROC	Reactor Operator Console
RR	Regulating Rod Drive
RPS	Reactor Protection System
RPCS	Reactor Protection / Control System
RTD	Resistance Temperature Detector
RWMS	Reactor Water & Makeup System
SDD	Software Design Description
SOE	Sequence of Events (synonym for COS)
SRS	Software Requirement Specification
SS1	Shim Safety Rod #1 Drive
SS2	Shim Safety Rod #2 Drive
T/C	Thermocouple
VAC	Volts Alternating Current
VDC	Volts Direct Current

1.4 References

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1.4.9. Thermo Scientific, RMS-3 Area Radiation Monitor Technical Manual, (RMS3 Manual.pdf).

NOTE: In the references above, revision/dates for non-project documents should be treated as specific document references. For project documents, any revision/date indicated as part of the reference should be treated as that revision or later.

1.5 System Overview

The Reactor Protection / Control System Replacement Project for the Purdue University Research Reactor PUR-1 will replace the neutron flux detector equipment, reactor operator console, reactor protection system and reactor control system for the PUR-1 Research Reactor.

The replacement Reactor Protection / Control System (RPCS) will be composed of or interface to the following subsystems:

- Neutron Flux Monitoring System (NFMS) –RPCS subsystem for neutron flux monitoring. Includes the Mirion detectors and associated electronics.
- Reactor Protection System (RPS) – portion of the RPCS that is responsible for the reactor trip function. Includes:
  - physical hardware interfaces to the shim-safety control rod magnets.
  - reactor trip input signals from components external to the Reactor Protection System.
  - a portion of the Reactor Control System control algorithm on the RTP 3000 TAS platform responsible for automatic SCRAM initiated by the RCS.
  - manual SCRAM functions.
  - operator console indicators.
- Reactor Control System (RCS) – portion of RPCS that is responsible for normal reactor startup, shutdown, and control. The RCS includes all operator console HMI equipment and the portion of the control algorithm on the RTP 3000 TAS platform responsible for reactor control. It also includes the R*TIME software and the computer functions (display, historian, reporting, etc.).
- Rod Drive System (RDS) – portion of the RPCS that includes the drive assemblies (Shim Safety Rod #1 (SS1), Shim Safety Rod #2 (SS2), Regulating Rod (RR), Neutron Source (NS) and Fission Chamber (FC)) and the associated cabling, electronics and power supplies.
- Radiation Monitoring System (RMS) – radiation monitoring system equipment. Includes a Continuous Air Monitor (CAM) and multiple Radiation Area Monitors (RAMs).
- HVAC System (HVAC) – HVAC system used to maintain reactor room ventilation and environmental conditions. Includes sensors, dampers and other building controls required to provide confinement by isolating the PUR-1 Reactor Room in the case of an airborne radioactive material release.
- Reactor Water & Make-up System (RWMS) – equipment used to maintain reactor water level, temperature and quality. Also includes sensors used to measure water chemistry parameters.
- Power Conditioning System (PCS) – equipment used to provide regulated, conditioned power to the RPCS components.

2 RPCS Hardware Design

2.1 RPCS Overview

The RPCS is built from of a number of commercial third party hardware and software components. These components are integrated together to form an integrated system. The RPCS system components provide the functionality described in Reference 1.4.5.

The RPCS is composed of two subsystems:

- Reactor Control System (RCS) is responsible for normal startup, shutdown and control.
- Reactor Protection System (RPS) is responsible for reactor trip functionality.

The RCS system is composed of the following types of hardware:

- I/O Equipment
- Data Processing Equipment
- HMI Equipment
- Networking Equipment
- Cabinets

The RPS system is composed of the following types of hardware:

- Relays and Relay Control Equipment
- Magnet Power Supply

In addition to the hardware components, the RPCS system is composed of the following software components:

- RTP NetArrays Control Software
- RPCS Control Application
- R*TIME Server software
- R*TIME Viewer software

2.2 RPCS Hardware

The RPCS will be hosted on commercial computer hardware, networking hardware and I/O equipment described in this document. The hardware configurations meet or exceed all of the Purdue University specification requirements (See References 1.4.4 and 1.4.5) and contain sufficient resources to meet all of the site-specific requirements, except where agreed to between Scientech, Mirion and Purdue University.

The equipment for the RPCS replacement project will be installed in the PUR-1 reactor room of Purdue University. The following describes, in detail, the equipment of the RPCS replacement project.

The Appendices of this document detail the workstation computers, the RTP equipment, the spare parts, the cabinet layout, the I/O layout, the cable connections, the hardware components, the hostnames and IP addresses and the installed third-party software.

Appendix A contains all drawings associated with the project. These include overview layout, detail layout, and cabling connections.

Appendix B defines the master equipment list for the project by Component Name. Component ID's can be considered Scientech equipment numbers. The appendix contains basic information on each component and essential specifications typically needed to produce a design change package.

Appendix C provides a listing by each location/cabinet where equipment is to be located along with critical specifications such as heat load, power and dimensional information.

Appendix D provides a list of recommended spare parts for the system.

Appendix E lists cable connections within the system.

Appendix F identifies which software items are to be loaded on each hardware component that requires software.

Appendix G provides the TCP/IP address and host name assignment list for each item that requires a network address.

Appendix H contains data sheets for the hardware used in the system.

2.3 Equipment Cabinets

The RPCS system provided by Scientech will utilize the existing equipment and operator console cabinets in the Purdue University Research Reactor room. There are four (4) existing equipment cabinets and three (3) existing operator console cabinets. The seven existing cabinets are detailed in Table 2-1.

Table 2-1 – RPCS Cabinet Equipment Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Existing 35U cabinet with side and rear panels	N/A	N/A	4	PUR1-CAB-E1 PUR1-CAB-E2 PUR1-CAB-E3 PUR1-CAB-E4
Existing 24U cabinet with side and rear panels. Angled front upper section.	N/A	N/A	3	PUR1-CAB-O1 PUR1-CAB-O2 PUR1-CAB-O3

Appendix A contains drawings detailing the configuration of the cabinets after installation replacement system.

2.4 RPCS Workstation

The RPCS provided will require a single workstation. The workstation provided will host the R*TIME Server software. This software is utilized to collect data from the RTP control platform and store that data in a data historian. It also provides the data to be displayed on the HMI displays of the Operator Console and monitors overall operation of the Reactor Protection and Control System.

2.4.1 Workstation Computer

The workstation provided will be a Dell Precision Tower 5000 Series. The workstation is equipped with hardware to drive two independent displays as well as networking hardware to interface to the I/O network of the RPCS as well as an additional network port to allow expansion to remote display workstations. A detailed configuration of the workstation is provided in Table 2-2.

Table 2-2 – RPCS Workstation Equipment Detail

Manufacturer	Part Number	Quantity	Device Name(s)
Dell	5810	1	O2-WKS
Consisting of the following configuration:			
Chassis Options: Dell Precision Tower 5810 425W		1	
Processor: Intel® Xeon® Processor E51620 v3 (4C, 3.5GHz, Turbo, HT, 10M, 140W)		1	
Video Card: NVIDIA® Quadro® K620 2GB (DP, DLDVII) (1 DP to SLDVI adapter)		1	
Memory: 8GB (2x4GB) 2133MHz DDR4 RDIMM ECC		1	
HDD/Storage Controller: Integrated Intel AHCI chipset SATA controller (6 x 6.0Gb/s) SW RAID 0/1/5/10		1	
Raid configuration Connectivity: RAID 1		1	
Hard Drive: 1TB 3.5" SerialATA (7,200 RPM) Hard Drive		2	
CD ROM/DVD ROM: 8x Slimline DVDROM Drive		1	
Network Card: 1Gbit NIC addin card (PCIeIntel)		1	
Keyboard: US English (QWERTY) Dell KB212B QuietKey USB Keyboard Black		1	O2-WKS-KB
Mouse: Dell MS111 USB Optical Mouse		1	O2-WKS-MS
Operating System: Microsoft Windows 10		1	
Office Productivity Suite: Microsoft Office Professional 2016		1	

Figure 2-1 shows the physical arrangement of the workstation computer’s front and rear panels.

Figure 2-1 – Workstation Computer Front and Rear Panels

2.4.1.1 Workstation Computer Mounting

The workstation will be installed on a rack mounted shelf. The shelf is detailed in Section 2.18.3. The shelf and workstation computer will be mounted in the operator console cabinet PUR1-CAB-O2.

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

2.4.1.2 Workstation Computer Power Input

The workstation computer is powered by 120VAC. This connection will be supplied using an existing outlet in the operator console. The connection to the outlet will be made with the computer's supplied power cable, which will be terminated with a NEMA 5-15 plug.

Power will be sourced from PUR1-UPS-1 (RCS Battery Back-up). See Section 2.9.2.3 for power consumption specifications.

2.4.2 Workstation Monitors

The RPCS workstation will provide input to two independent monitors. These monitors will be 19" rack-mount displays. The monitors are detailed in Table 2-3.

Table 2-3 – RPCS Workstation Monitors

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
19" LCD Rack Mount Monitor	SiriusView	LCDR8U19-12	2	O2-WKS-MON-1 O3-WKS-MON-1

Figure 2-2 shows the physical arrangement of the workstation computer monitors' rear panels.

Figure 2-2 – Workstation Monitor Rear Panel

2.4.2.1 Workstation Monitors Mounting

The monitors will be mounted using their built-in 19" rack mount brackets. They will be installed in the cabinets listed in Table 2-4.

Table 2-4 – RPCS Workstation Monitor Locations

Monitor Device Name	Monitor Location
O2-WKS-MON-1	PUR1-CAB-O2

Monitor Device Name	Monitor Location
O3-WKS-MON-1	PUR1-CAB-O3

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

2.4.2.2 Workstation Monitors Power Input

The workstation monitors are powered by 120VAC. This connection will be supplied using an existing outlet in the operator console. The connection to the outlet will be made with the computer's supplied power cable, which will be terminated with a NEMA 5-15 plug.

Power will be sourced from PUR1-UPS-1 (RCS Battery Back-up). See Section 2.9.2.3 for power consumption specifications.

2.4.3 Workstation Panel USB Ports

For ease of use, four (4) panel mount USB extension ports will be installed in the system. One will be used for connecting the mouse to the workstation computer, one will be used to connect the keyboard to the workstation computer and the remaining two will be spares. The intent of the spare ports is to have them available for portable storage access (flash drive, external hard drive, etc.). The spare ports will also include removable caps. The USB ports are detailed in Table 2-5

Table 2-5 – RPCS Workstation Panel USB Ports

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
USB Cable, Waterproof Panel Mount Type A Female - Standard Type A Male, 2.0m	L-com	WPUSBAX-2M	4	O2-WKS-USB-1 O2-WKS-USB-2 O3-WKS-USB-1 O3-WKS-USB-2
USB Waterproof Cap	L-com	WPCVR-USB-1394	2	O3-WKS-USB-1-CAP O3-WKS-USB-2-CAP

2.4.3.1 Workstation USB Port Mounting

The USB ports will be mounted in specific new blanking plates of the operator console. The plates will be drilled to the USB port specifications and the USB ports will be mounted using the manufacturer supplied hardware (nut on back of device). Figure 2-3 shows the recommended panel opening for the USB ports. They will be installed in the cabinets listed in Table 2-6.

Table 2-6 – RPCS Workstation Panel USB Port Locations

Panel USB Device Name	Mounting Panel Name	Location
O2-WKS-USB-1 O2-WKS-USB-2	O2-PNL-2U-3	PUR1-CAB-O2
O3-WKS-USB-1 O3-WKS-USB-2	O3-PNL-2U-1	PUR1-CAB-O3

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

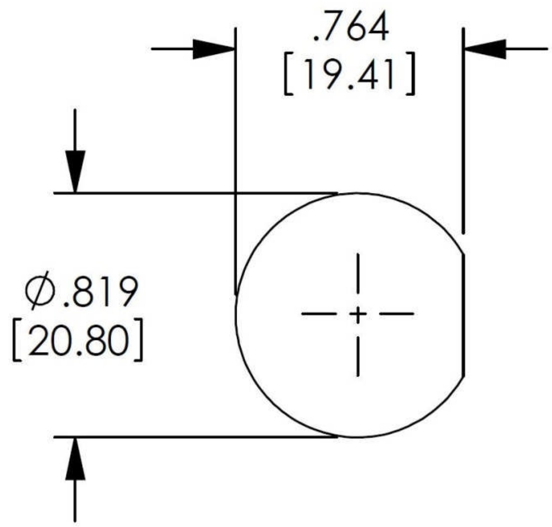


Figure 2-3 – USB Port Mounting Hole

2.5 Networking Hardware

The system will include the networking hardware required to connect all of the networked components together. The RPCS is composed of four I/O networks (see drawing PUR1-HDD-001-13). Three I/O networks are used exclusively by the RTP 3000 TAS hardware. They provide connectivity between the RTP 3000 TAS Node Processors and RTP 3000 TAS Chassis Processors. The other I/O network connects the RTP 3000 TAS Node Processors to the RPCS workstation.

2.5.1 N-Tron 1005TX Ethernet Switch

Four (4) N-Tron Ethernet switches are to be provided by Scientech for the overall network connectivity.

Specifications for the N-Tron switch hardware are shown in Table 2-7.

Table 2-7 – N-Tron Ethernet Switch Equipment Detail

Device Description	Manufacturer	Product Number	Quantity	Device Name(s)
5-port Industrial Gigabit Ethernet Switch	N-Tron	1005TX	4	E3-NSW-1 E3-NSW-2 E3-NSW-3 E3-NSW-4

Figure 2-4 shows the physical arrangement of the Ethernet switch front panel.

Figure 2-4 – Ethernet Switch Front Panel

2.5.1.1 Ethernet Switch Mounting

The N-Tron 1005TX Ethernet switches will be din-rail mounted in their specified cabinet using a Hammond Manufacturing din-rail rack mount kit (P/N: RMAD19003). They will be installed as listed in Table 2-8.

Table 2-8 – Ethernet Switch Installation Locations

Switch Device Name	Din Rail Kit Device Name	Location
E3-NSW-1 E3-NSW-2 E3-NSW-3 E3-NSW-4	E3-DIN-1	PUR1-CAB-E3

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

2.5.1.2 Ethernet Switch Power Input

The Ethernet switches require a 10-30VDC input. This connection will be supplied using a 24VDC power distribution (P/N: SC-PDU-24VDC, Name: E3-24VDC-PDU). The connection to the power distribution will be made with 16AWG cable, which will be terminated with ferrules on each conductor.

Power will be sourced from PUR1-UPS-1 (RCS Battery Back-up). See Section 2.9.2.3 for power consumption specifications.

2.6 RTP I/O Hardware

The system will utilize data acquisition equipment from RTP Corporation. A list of the equipment to be provided is detailed in Appendix B. Refer to Appendix A drawing PUR1-HDD-001-05 for a layout of RTP 3000 TAS components.

The RCI system will utilize the RTP NetSuite software to maintain the RTP I/O configuration as well as monitoring all I/O for the system. The RTP NetSuite software will be installed on the RPCS workstation and will be used to update the I/O configuration of the RTP I/O equipment. This software will be used when exercising the I/O equipment, when RTP cards are added or removed from the I/O configuration, and to diagnose I/O hardware problems.

For additional information on any RTP component, refer to the RTP manuals in Appendix H.

2.6.1 RPCS RTP 3000 TAS System Description

The RPCS RTP 3000 TAS hardware will be configured as a single data acquisition system (DAS) node.

The node is a RTP 3000D controller consisting of a single I/O chassis, containing two (2) RTP 3000 TAS Node Processors and two (2) RTP 3000 TAS Chassis Processors. Additionally, the chassis contains redundant power supplies, chassis fans, and all of the I/O cards required for the system.

At a high level, the HMI will communicate to the RTP hardware through the RTP 3000 TAS Node Processor. The Node Processor card is responsible for running the RTP NetArrays control algorithm project developed for the node. The Node Processor communicates with the Chassis Processor(s). A Chassis Processor card is responsible for sending and receiving communication between the Node Processor and the I/O cards. The I/O cards read the field inputs and set outputs to the field.

2.6.1.1 RTP 3000 TAS Chassis

The RTP chassis will contain all the RTP cards. It will also contain the redundant power supplies and redundantly powered chassis fans. The chassis configuration used for the RPCS is shown in Table 2-9.

Table 2-9 – RPCS I/O Chassis Configuration

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
SIL-3 Dual-Redundant Node, Consists of 1-11 I/O slot chassis, 2-NPs, 2-CPs, 2-120/240 VAC P.S	RTP Corp.	3000D/R2-155	1	E3-DAS

2.6.1.1.1 RTP 3000 TAS Mounting

The RTP 3000 TAS chassis will be mounted in equipment cabinet PUR1-CAB-E3. It is rack-mounted using the built-in rack mounting plates of the RTP chassis.

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

Figure 2-5 – RTP 3000 TAS

2.6.1.1.2 RTP 3000 TAS Input Power

The chassis' power supplies are each powered by 120VAC. The power supply cables will be terminated with NEMA 5-15P plugs and will receive power from the cabinet's 120VAC distribution. The power input source is detailed in Table 2-10.

Power will be sourced from PUR1-UPS-1 (RCS Battery Back-up). See Section 2.9.2.3 for power consumption specifications.

Table 2-10 – RTP 3000 TAS Power Input Power Source Location

PDU Device Name	120VAC Source Device Name	120VAC Source Location
E3-DAS-PS-1	E3-120VAC-PDU	PUR1-CAB-E3
E3-DAS-PS-2	E3-120VAC-PDU	PUR1-CAB-E3

2.6.1.2 3000/06 Node Processor

The Node Processor card is the main processing unit of the RTP 3000 TAS. It solves the logic within the NetArrays projects, communicates with the Chassis Processor and the RPCS

workstation. The RPCS configuration contains two (2) Node Processors which operate as a redundant pair. They are detailed in Table 2-11.

Table 2-11 – RPCS RTP Node Processor Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
RTP 3000 TAS Node Processor	RTP Corp.	3000/06	2	E3-DAS-NP-00 E3-DAS-NP-01

The Node Processors must be installed in the left most available slots in the RTP chassis. See Table 2-12 for installation locations.

Table 2-12 – Node Processor Installation Locations

Node Processor Device Name	E3-DAS Slot Number
E3-DAS-NP-00	0
E3-DAS-NP-01	1

For communication, each Node Processor contains four (4) Ethernet ports. From top to bottom the ports are labeled J1, J2, J3, and J4 (see Figure 2-6). J1 is used for connection to the RPCS workstation (Network A). J2, J3, and J4 connect to the RTP I/O networks B, C, and D. See Table 2-13 to determine which ports connect to each network.

Figure 2-6 – RTP 3000 TAS Node Processor Front Panel

Table 2-13 – RTP Ethernet Cabling Matrix

Description	Redundant ID	Ethernet Port	Host Switch A	I/O Switch B	I/O Switch C	I/O Switch D
Node Processor	Single (Non-redundant)	J1	X			
		J2	X			
		J3			X	
		J4				X
	A	J1	X			
		J2		X		
		J3			X	
		J4				X
	B	J1	X			
		J2		X		
		J3			X	
		J4				X
	C	J1	X			
		J2		X		
		J3			X	
		J4				X
	D	J1	X			
		J2		X		
		J3			X	
		J4				X
Chassis Processor	Main (00-15)	J1			X	
		J2				X
	Redundant (00R - 15R)	J1		X		
		J2				X

2.6.1.3 3000/01 Chassis Processor

The RTP Chassis Processor card is a pass through for communication between the RTP I/O cards and the RTP Node Processor. The RPCS configuration contains two (2) Chassis Processors which operate as a redundant pair. They are detailed in Table 2-14.

Table 2-14 – RPCS RTP Chassis Processor Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
RTP 3000 TAS Chassis Processor	RTP Corp.	3000/01	2	E3-DAS-CP-13 E3-DAS-CP-14

The Chassis Processors must be installed in the right most available slots in the RTP chassis with the Main Chassis Processor in the right most slot and the Redundant Chassis Processor in the second right most slot. See Table 2-15 for installation locations.

Table 2-15 – Chassis Processor Installation Locations

Chassis Processor Device Name	E3-DAS Slot Number
E3-DAS-CP-00	13
E3-DAS-CP-01	14

For communication, each Chassis Processor contains two (2) Ethernet ports. From top to bottom the ports are labeled J1 and J2 (see Figure 2-7). See Table 2-13 to determine which ports connect to each network.

Figure 2-7 - Chassis Processor Front Panel

2.6.1.4 RTP 3000 Voltage Input

The RPCS will have one voltage input card and termination module combination configured for the system. The voltage input card and termination module support 32 channels of input from -10 to +10 VDC. Field cables will land on the termination module using 18 AWG wires terminated with ferrules. The termination module is connected to the analog input card through the RTP supplied cable (type 3056/00). The RTP card and termination modules for voltage inputs are detailed in Table 2-16.

Table 2-16 –RTP Voltage Input Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
SIL-3 32-Channel High Availability Single Ended AI Card, 16-bit A/D, 1KHz scan rate	RTP Corp.	3126-Y	1	E3-DAS-AI-02
SIL-3 Single Termination Module - 32 channel voltage input	RTP Corp.	3099/21-102	1	E3-DIN-2-TM-AI-02

2.6.1.4.1 RTP 3000 Voltage Input Mounting

The RTP 3126 input cards may be installed in any available slot from 2-12. For the delivered RPCS, the card will be mounted as shown in Table 2-17. The termination module is din-rail mounted in its specified cabinet using a Hammond Manufacturing din-rail rack mount kit (P/N: RMAD19003). They will be installed as listed in Table 2-18.

Table 2-17 – Voltage Input Card Installation Location

I/O Card Device Name	E3-DAS Slot Number
E3-DAS-AI-02	2

Table 2-18 – Voltage Input Termination Module Installation Location

Termination Module Device Name	Din Rail Kit Device Name	Location
E3-DIN-2-TB-AI-02	E3-DIN-2	PUR1-CAB-E3

2.6.1.4.2 RTP 3000 Voltage Input Field Wiring

The RTP 3099/21-102 termination module (seen in Figure 2-8) field connection assignments are shown in Table 2-19. A sample wiring diagram is shown in Figure 2-9.

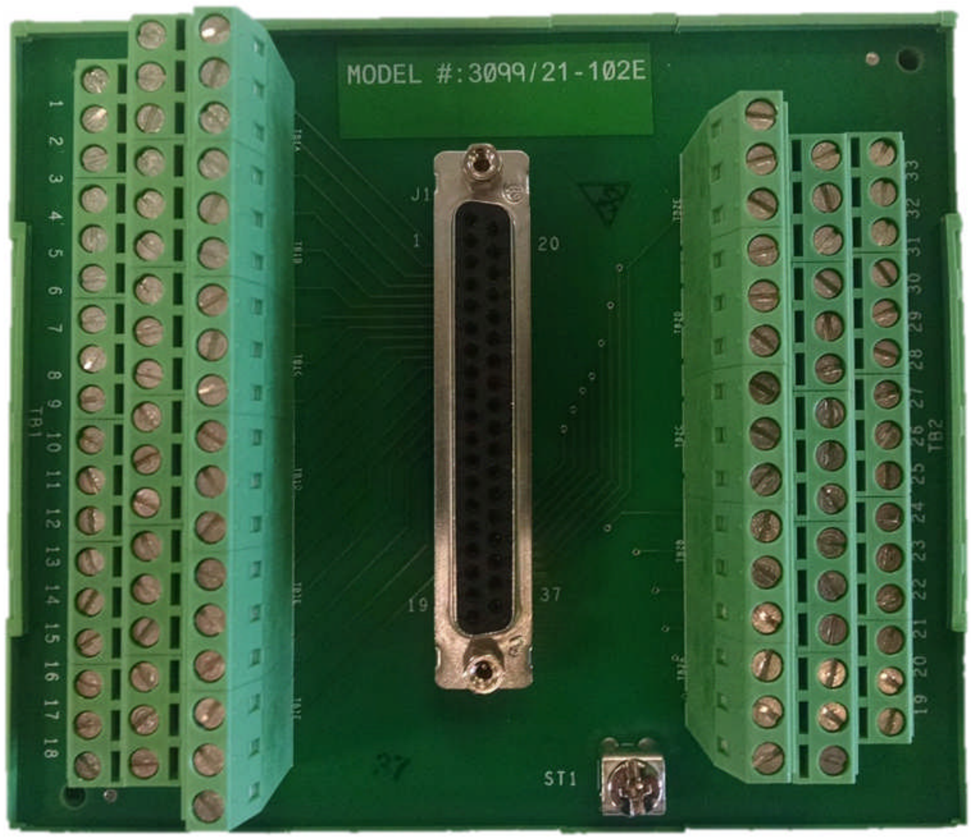
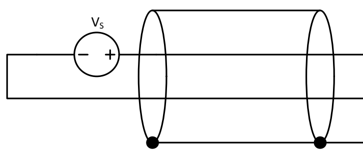


Figure 2-8 – RTP 3099/21-102 Termination Module



PIN	SIGNAL
1 TOP	CH 0 +
1 MIDDLE	CH 0 -
1 BOTTOM	CH 0 SHIELD

Figure 2-9 – 3099/21-102 Sample Wiring

Table 2-19 – RTP 3099/21-102 Termination Module Pinout

Pin	Signal	Pin	Signal	Pin	Signal
1 TOP	Channel 0 +	12 TOP	Channel 11 +	23 TOP	Channel 22 +
1 MIDDLE	Channel 0 -	12 MIDDLE	Channel 11 -	23 MIDDLE	Channel 22 -
1 BOTTOM	Channel 0 Shield	12 BOTTOM	Channel 11 Shield	23 BOTTOM	Channel 22 Shield
2 TOP	Channel 1 +	13 TOP	Channel 12 +	24 TOP	Channel 23 +
2 MIDDLE	Channel 1 -	13 MIDDLE	Channel 12 -	24 MIDDLE	Channel 23 -
2 BOTTOM	Channel 1 Shield	13 BOTTOM	Channel 12 Shield	24 BOTTOM	Channel 23 Shield
3 TOP	Channel 2 +	14 TOP	Channel 13 +	25 TOP	Channel 24 +
3 MIDDLE	Channel 2 -	14 MIDDLE	Channel 13 -	25 MIDDLE	Channel 24 -
3 BOTTOM	Channel 2 Shield	14 BOTTOM	Channel 13 Shield	25 BOTTOM	Channel 24 Shield
4 TOP	Channel 3 +	15 TOP	Channel 14 +	26 TOP	Channel 25 +
4 MIDDLE	Channel 3 -	15 MIDDLE	Channel 14 -	26 MIDDLE	Channel 25 -
4 BOTTOM	Channel 3 Shield	15 BOTTOM	Channel 14 Shield	26 BOTTOM	Channel 25 Shield
5 TOP	Channel 4 +	16 TOP	Channel 15 +	27 TOP	Channel 26 +
5 MIDDLE	Channel 4 -	16 MIDDLE	Channel 15 -	27 MIDDLE	Channel 26 -
5 BOTTOM	Channel 4 Shield	16 BOTTOM	Channel 15 Shield	27 BOTTOM	Channel 26 Shield
6 TOP	Channel 5 +	17 TOP	Channel 16 +	28 TOP	Channel 27 +
6 MIDDLE	Channel 5 -	17 MIDDLE	Channel 16 -	28 MIDDLE	Channel 27 -
6 BOTTOM	Channel 5 Shield	17 BOTTOM	Channel 16 Shield	28 BOTTOM	Channel 27 Shield
7 TOP	Channel 6 +	18 TOP	Channel 17 +	29 TOP	Channel 28 +
7 MIDDLE	Channel 6 -	18 MIDDLE	Channel 17 -	29 MIDDLE	Channel 28 -
7 BOTTOM	Channel 6 Shield	18 BOTTOM	Channel 17 Shield	29 BOTTOM	Channel 28 Shield
8 TOP	Channel 7 +	19 TOP	Channel 18 +	30 TOP	Channel 29 +
8 MIDDLE	Channel 7 -	19 MIDDLE	Channel 18 -	30 MIDDLE	Channel 29 -
8 BOTTOM	Channel 7 Shield	19 BOTTOM	Channel 18 Shield	30 BOTTOM	Channel 29 Shield
9 TOP	Channel 8 +	20 TOP	Channel 19 +	31 TOP	Channel 30 +
9 MIDDLE	Channel 8 -	20 MIDDLE	Channel 19 -	31 MIDDLE	Channel 30 -
9 BOTTOM	Channel 8 Shield	20 BOTTOM	Channel 19 Shield	31 BOTTOM	Channel 30 Shield
10 TOP	Channel 9 +	21 TOP	Channel 20 +	32 TOP	Channel 31 +
10 MIDDLE	Channel 9 -	21 MIDDLE	Channel 20 -	32 MIDDLE	Channel 31 -
10 BOTTOM	Channel 9 Shield	21 BOTTOM	Channel 20 Shield	32 BOTTOM	Channel 31 Shield
11 TOP	Channel 10 +	22 TOP	Channel 21 +	33 TOP	Field Power +
11 MIDDLE	Channel 10 -	22 MIDDLE	Channel 21 -	33 MIDDLE	No Connection
11 BOTTOM	Channel 10 Shield	22 BOTTOM	Channel 21 Shield	33 BOTTOM	Field Power -

2.6.1.5 RTP 3000 Current Input

The RPCS will have one current input card and termination module combination configured for the system. The current input card and termination module support 32 channels of input from 4 to 20 mA. Field cables will land on the termination module using 18 AWG wires terminated with ferrules. The termination module is connected to the analog input card through the RTP supplied cable (type 3056/00). The RTP card and termination modules for current inputs are detailed in Table 2-20.

Table 2-20 –RTP Current Input Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
SIL-3 32-Channel High Availability Single Ended AI Card, 16-bit A/D, 1KHz scan rate	RTP Corp.	3126-Y	1	E3-DAS-AI-03
Single Termination Module - 32 channel current input, supplies power from 300ma resettable fuse	RTP Corp.	3099/21-207	1	E3-DIN-2-TM-AI-03

2.6.1.5.1 RTP 3000 Current Input Mounting

The RTP 3126 input cards may be installed in any available slot from 2-12. For the delivered RPCS, the card will be mounted as shown in Table 2-21. The termination module is din-rail mounted in its specified cabinet using a Hammond Manufacturing din-rail rack mount kit (P/N: RMAD19003). They will be installed as listed in Table 2-22.

Table 2-21 – Current Input Card Installation Location

I/O Card Device Name	E3-DAS Slot Number
E3-DAS-AI-03	3

Table 2-22 – Current Input Termination Module Installation Location

Termination Module Device Name	Din Rail Kit Device Name	Location
E3-DIN-2-TB-AI-03	E3-DIN-2	PUR1-CAB-E3

2.6.1.5.2 RTP 3000 Current Input Field Wiring

The RTP 3099/21-207 termination module (seen in Figure 2-10) field connection assignments are shown in Table 2-23. Note that the wiring shown is only for self-powered current inputs. There are no loop powered devices used in the Purdue RPCS replacement project. For instruction on cabling loop-powered devices, see the RTP datasheets in Appendix H. A sample wiring diagram of the self-powered current loops used in the RPCS is shown in Figure 2-11.

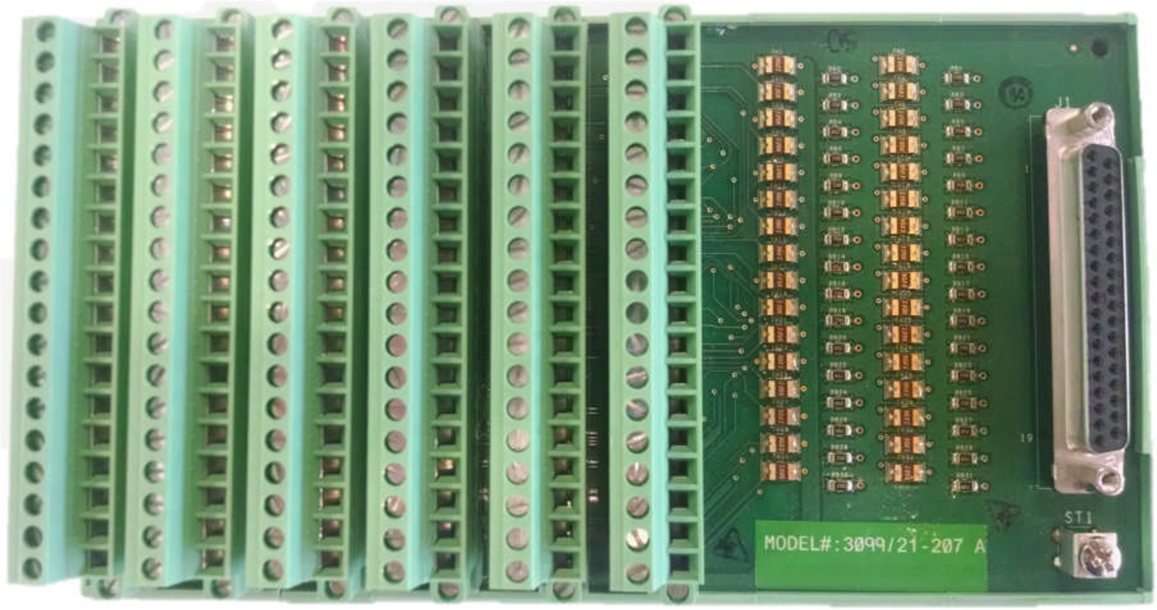
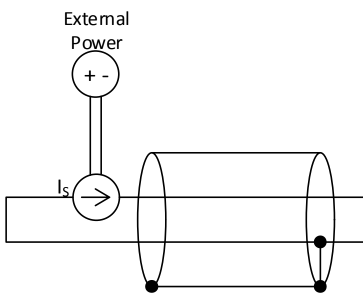


Figure 2-10 – RTP 3099/21-207 Termination Module



PIN	SIGNAL
TB1 PIN 1	
TB1 PIN 2	CH 0 +
TB1 PIN 3	CH 0 -, CH 0 SHIELD

Figure 2-11 – 3099/21-207 Sample Wiring

Table 2-23 – RTP 3099/21-207 Termination Module Pinout (self-powered)

Pin	Signal	Pin	Signal	Pin	Signal
TB 1 PIN 1	No Connection	TB 3 PIN 1	No Connection	TB 5 PIN 1	No Connection
TB 1 PIN 2	Channel 0 +	TB 3 PIN 2	Channel 12 +	TB 5 PIN 2	Channel 24 +
TB 1 PIN 3	Channel 0 -, Channel 0 Shield	TB 3 PIN 3	Channel 12 -, Channel 12 Shield	TB 5 PIN 3	Channel 24 -, Channel 24 Shield
TB 1 PIN 4	No Connection	TB 3 PIN 4	No Connection	TB 5 PIN 4	No Connection
TB 1 PIN 5	Channel 1 +	TB 3 PIN 5	Channel 13 +	TB 5 PIN 5	Channel 25 +
TB 1 PIN 6	Channel 1 -, Channel 1 Shield	TB 3 PIN 6	Channel 13 -, Channel 13 Shield	TB 5 PIN 6	Channel 25 -, Channel 25 Shield
TB 1 PIN 7	No Connection	TB 3 PIN 7	No Connection	TB 5 PIN 7	No Connection
TB 1 PIN 8	Channel 2 +	TB 3 PIN 8	Channel 14 +	TB 5 PIN 8	Channel 26 +
TB 1 PIN 9	Channel 2 -, Channel 2 Shield	TB 3 PIN 9	Channel 14 -, Channel 14 Shield	TB 5 PIN 9	Channel 26 -, Channel 26 Shield
TB 1 PIN 10	No Connection	TB 3 PIN 10	No Connection	TB 5 PIN 10	No Connection
TB 1 PIN 11	Channel 3 +	TB 3 PIN 11	Channel 15 +	TB 5 PIN 11	Channel 27 +
TB 1 PIN 12	Channel 3 -, Channel 3 Shield	TB 3 PIN 12	Channel 15 -, Channel 15 Shield	TB 5 PIN 12	Channel 27 -, Channel 27 Shield
TB 1 PIN 13	No Connection	TB 3 PIN 13	No Connection	TB 5 PIN 13	No Connection
TB 1 PIN 14	Channel 4 +	TB 3 PIN 14	Channel 16 +	TB 5 PIN 14	Channel 28 +
TB 1 PIN 15	Channel 4 -, Channel 4 Shield	TB 3 PIN 15	Channel 16 -, Channel 16 Shield	TB 5 PIN 15	Channel 28 -, Channel 28 Shield
TB 1 PIN 16	No Connection	TB 3 PIN 16	No Connection	TB 5 PIN 16	No Connection
TB 1 PIN 17	Channel 5 +	TB 3 PIN 17	Channel 17 +	TB 5 PIN 17	Channel 29 +
TB 1 PIN 18	Channel 5 -, Channel 5 Shield	TB 3 PIN 18	Channel 17 -, Channel 17 Shield	TB 5 PIN 18	Channel 29 -, Channel 29 Shield
TB 2 PIN 1	No Connection	TB 4 PIN 1	No Connection	TB 6 PIN 1	No Connection
TB 2 PIN 2	Channel 6 +	TB 4 PIN 2	Channel 18 +	TB 6 PIN 2	Channel 30 +
TB 2 PIN 3	Channel 6 -, Channel 6 Shield	TB 4 PIN 3	Channel 18 -, Channel 18 Shield	TB 6 PIN 3	Channel 30 -, Channel 30 Shield
TB 2 PIN 4	No Connection	TB 4 PIN 4	No Connection	TB 6 PIN 4	No Connection
TB 2 PIN 5	Channel 7 +	TB 4 PIN 5	Channel 19 +	TB 6 PIN 5	Channel 31 +
TB 2 PIN 6	Channel 7 -, Channel 7 Shield	TB 4 PIN 6	Channel 19 -, Channel 19 Shield	TB 6 PIN 6	Channel 31 -, Channel 31 Shield
TB 2 PIN 7	No Connection	TB 4 PIN 7	No Connection	TB 6 PIN 7	No Connection
TB 2 PIN 8	Channel 8 +	TB 4 PIN 8	Channel 20 +	TB 6 PIN 8	No Connection
TB 2 PIN 9	Channel 8 -, Channel 8 Shield	TB 4 PIN 9	Channel 20 -, Channel 20 Shield	TB 6 PIN 9	No Connection
TB 2 PIN 10	No Connection	TB 4 PIN 10	No Connection	TB 6 PIN 10	No Connection
TB 2 PIN 11	Channel 9 +	TB 4 PIN 11	Channel 21 +	TB 6 PIN 11	No Connection
TB 2 PIN 12	Channel 9 -, Channel 9 Shield	TB 4 PIN 12	Channel 21 -, Channel 21 Shield	TB 6 PIN 12	No Connection
TB 2 PIN 13	No Connection	TB 4 PIN 13	No Connection	TB 6 PIN 13	No Connection
TB 2 PIN 14	Channel 10 +	TB 4 PIN 14	Channel 22 +	TB 6 PIN 14	No Connection
TB 2 PIN 15	Channel 10 -, Channel 10 Shield	TB 4 PIN 15	Channel 22 -, Channel 22 Shield	TB 6 PIN 15	No Connection
TB 2 PIN 16	No Connection	TB 4 PIN 16	No Connection	TB 6 PIN 16	No Connection
TB 2 PIN 17	Channel 11 +	TB 4 PIN 17	Channel 23 +	TB 6 PIN 17	Field Power + (*)
TB 2 PIN 18	Channel 11 -, Channel 11 Shield	TB 4 PIN 18	Channel 23 -, Channel 23 Shield	TB 6 PIN 18	Field Power - (*)

(*) – Field power connection is only required when using loop-powered devices.

2.6.1.6 RTP 3000 Voltage Output

The RPCS will have one voltage output card and termination module combination configured for the system. The voltage output card and termination module support 16 channels of output from -10 to +10 VDC. Field cables will land on the termination module using 18 AWG wires terminated with ferrules. The termination module is connected to the analog output card through the RTP supplied cable (type 3056/00). The RTP card and termination modules for voltage outputs are detailed in Table 2-24.

Table 2-24 –RTP Voltage Output Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
SIL-3 16-Channel 16 Bit Analog Output Card, -10 to +10 or 0 to 10 volts	RTP Corp.	3122	1	E3-DAS-AO-04
SIL-3 Single Termination Module - 16 channel isolated analog output	RTP Corp.	3099/22-100	1	E3-DIN-2-TM-AO-04

2.6.1.6.1 RTP 3000 Voltage Output Mounting

The RTP 3122 voltage output cards may be installed in any available slot from 2-12. For the delivered RPCS, the card will be mounted as shown in Table 2-25. The termination module is din-rail mounted in its specified cabinet using a Hammond Manufacturing din-rail rack mount kit (P/N: RMAD19003). They will be installed as listed in Table 2-26.

Table 2-25 – Voltage Output Card Installation Location

I/O Card Device Name	E3-DAS Slot Number
E3-DAS-AO-04	4

Table 2-26 – Voltage Output Termination Module Installation Location

Termination Module Device Name	Din Rail Kit Device Name	Location
E3-DIN-2-TM-AO-04	E3-DIN-2	PUR1-CAB-E3

2.6.1.6.2 RTP 3000 Voltage Output Field Wiring

The RTP 3099/22-100 termination module (seen in Figure 2-8) field connection assignments are shown in Table 2-27. A sample wiring diagram is shown in Figure 2-13.

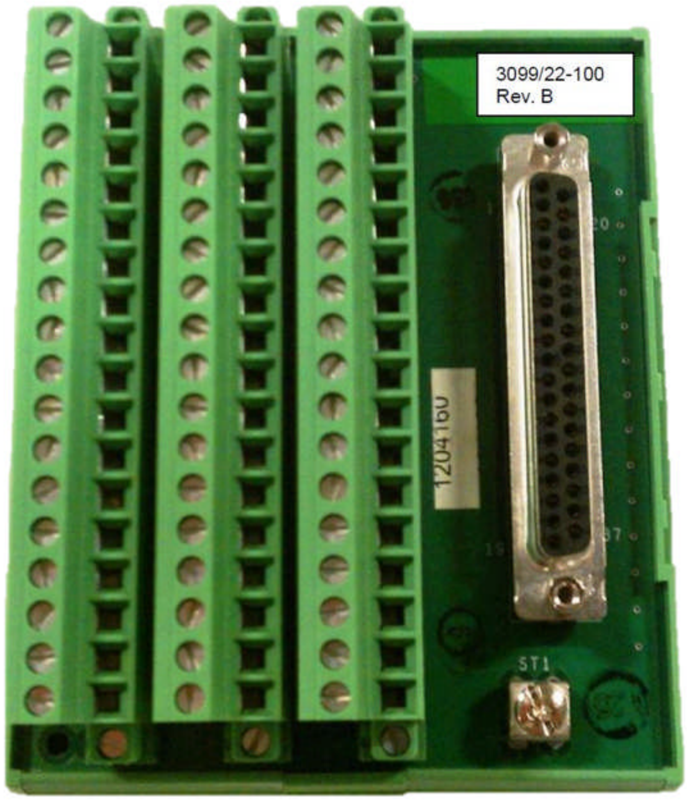


Figure 2-12 – RTP 3099/22-100 Termination Module

	PIN	SIGNAL
LOAD	TB1 PIN 1	CH 0 +
	TB1 PIN 2	CH 0 -
	TB1 PIN 3	CH 0 SHIELD
LOAD	TB1 PIN 4	CH 1 +
	TB1 PIN 5	CH 1 -
	TB1 PIN 6	CH 1 SHIELD

Figure 2-13 – 3099/22-100 Sample Wiring

Table 2-27 – RTP 3099/22-100 Termination Module Pinout

Pin	Signal	Pin	Signal	Pin	Signal
TB 1 PIN 1	Channel 0 +	TB 2 PIN 1	Channel 6 +	TB 3 PIN 1	Channel 12 +
TB 1 PIN 2	Channel 0 -	TB 2 PIN 2	Channel 6 -	TB 3 PIN 2	Channel 12 -
TB 1 PIN 3	Channel 0 Shield	TB 2 PIN 3	Channel 6 Shield	TB 3 PIN 3	Channel 12 Shield
TB 1 PIN 4	Channel 1 +	TB 2 PIN 4	Channel 7 +	TB 3 PIN 4	Channel 13 +
TB 1 PIN 5	Channel 1 -	TB 2 PIN 5	Channel 7 -	TB 3 PIN 5	Channel 13 -
TB 1 PIN 6	Channel 1 Shield	TB 2 PIN 6	Channel 7 Shield	TB 3 PIN 6	Channel 13 Shield
TB 1 PIN 7	Channel 2 +	TB 2 PIN 7	Channel 8 +	TB 3 PIN 7	Channel 14 +
TB 1 PIN 8	Channel 2 -	TB 2 PIN 8	Channel 8 -	TB 3 PIN 8	Channel 14 -
TB 1 PIN 9	Channel 2 Shield	TB 2 PIN 9	Channel 8 Shield	TB 3 PIN 9	Channel 14 Shield
TB 1 PIN 10	Channel 3 +	TB 2 PIN 10	Channel 9 +	TB 3 PIN 10	Channel 15 +
TB 1 PIN 11	Channel 3 -	TB 2 PIN 11	Channel 9 -	TB 3 PIN 11	Channel 15 -
TB 1 PIN 12	Channel 3 Shield	TB 2 PIN 12	Channel 9 Shield	TB 3 PIN 12	Channel 15 Shield
TB 1 PIN 13	Channel 4 +	TB 2 PIN 13	Channel 10 +	TB 3 PIN 13	No Connection
TB 1 PIN 14	Channel 4 -	TB 2 PIN 14	Channel 10 -	TB 3 PIN 14	No Connection
TB 1 PIN 15	Channel 4 Shield	TB 2 PIN 15	Channel 10 Shield	TB 3 PIN 15	No Connection
TB 1 PIN 16	Channel 5 +	TB 2 PIN 16	Channel 11 +	TB 3 PIN 16	No Connection
TB 1 PIN 17	Channel 5 -	TB 2 PIN 17	Channel 11 -	TB 3 PIN 17	No Connection
TB 1 PIN 18	Channel 5 Shield	TB 2 PIN 18	Channel 11 Shield	TB 3 PIN 18	No Connection

2.6.1.7 RTP 3000 Digital Inputs

The RPCS will have four (4) digital input card and termination module combinations configured for the system. The digital input card and termination module support 32 channels. They are contact closure sensing and are also line supervised (able to detect field cable faults or shorts). Field cables will land on the termination module using 18 AWG wires terminated with ferrules. A termination module is connected to a digital input card through the RTP supplied cable (type 3056/00). The RTP card and termination modules for digital inputs are detailed in Table 2-28.

Table 2-28 –RTP Voltage Input Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
SIL-3 32-Channel High Availability Isolated Digital Input Card	RTP Corp.	3126-X	4	E3-DAS-DI-05 E3-DAS-DI-06 E3-DAS-DI-07 E3-DAS-DI-08
SIL-3 Single Termination Module - 32 channel supervised digital input, 24 VDC	RTP Corp.	3099/21-101	4	E3-DIN-3-TM-DI-05 E3-DIN-3-TM-DI-06 E3-DIN-4-TM-DI-07 E3-DIN-4-TM-DI-08

2.6.1.7.1 RTP 3000 Digital Input Mounting

The RTP 3126 digital input cards may be installed in any available slot from 2-12. For the delivered RPCS, the card will be mounted as shown in Table 2-29. The termination modules are din-rail mounted in their specified cabinet using Hammond Manufacturing din-rail rack mount kits (P/N: RMAD19003). They will be installed as listed in Table 2-30.

Table 2-29 – Digital Input Card Installation Location

I/O Card Device Name	E3-DAS Slot Number
E3-DAS-DI-05	5
E3-DAS-DI-06	6
E3-DAS-DI-07	7
E3-DAS-DI-08	8

Table 2-30 – Digital Input Termination Module Installation Location

Termination Module Device Name	Din Rail Kit Device Name	Location
E3-DIN-3-TM-DI-05	E3-DIN-3	PUR1-CAB-E3
E3-DIN-3-TM-DI-06	E3-DIN-3	PUR1-CAB-E3
E3-DIN-4-TM-DI-07	E3-DIN-4	PUR1-CAB-E3
E3-DIN-4-TM-DI-08	E3-DIN-4	PUR1-CAB-E3

2.6.1.7.2 RTP 3000 Digital Input Field Wiring

The RTP 3099/21-101 termination module (seen in Figure 2-14) field connection assignments are shown in Table 2-31. For line supervised digital inputs, a series 1 kΩ resistor must be installed as well as a 10 kΩ resistor in parallel with the contact being monitored. For best results the parallel resistor should be installed as close to the contacts as possible. Additionally, the termination module requires a 24 VDC input to power the circuit. A sample wiring diagram is shown in Figure 2-15.

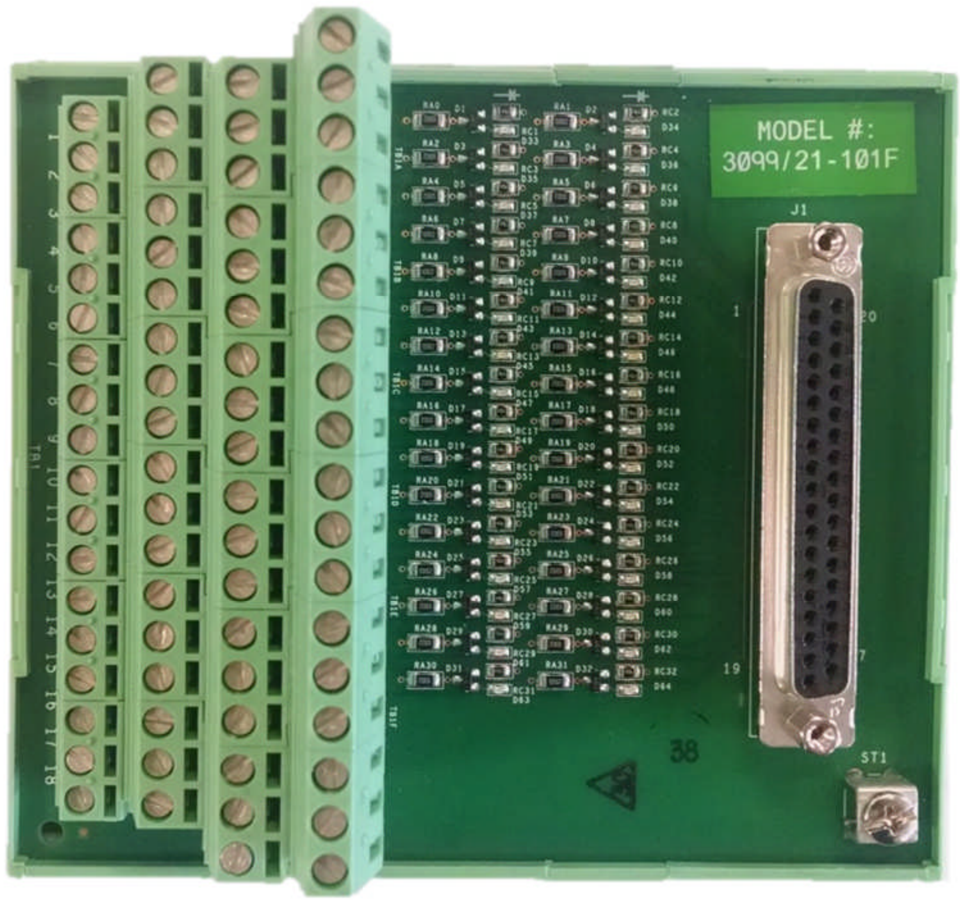


Figure 2-14 – RTP 3099/21-101 Termination Module

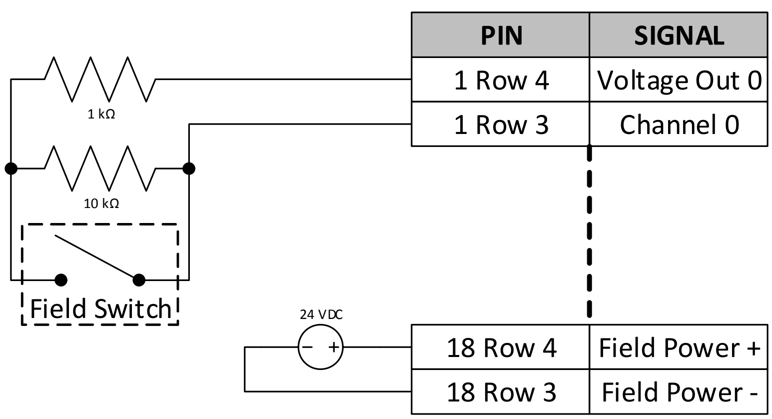


Figure 2-15 – 3099/21-101 Sample Wiring

Table 2-31 – RTP 3099/21-101 Termination Module Pinout

Pin	Signal	Pin	Signal	Pin	Signal
1 Row 4	Voltage Out 0	7 Row 4	Voltage Out 12	13 Row 4	Voltage Out 24
1 Row 3	Channel 0	7 Row 3	Channel 12	13 Row 3	Channel 24
1 Row 2	Voltage Out 1	7 Row 2	Voltage Out 13	13 Row 2	Voltage Out 25
1 Row 1	Channel 1	7 Row 1	Channel 13	13 Row 1	Channel 25
2 Row 4	Voltage Out 2	8 Row 4	Voltage Out 14	14 Row 4	Voltage Out 26
2 Row 3	Channel 2	8 Row 3	Channel 14	14 Row 3	Channel 26
2 Row 2	Voltage Out 3	8 Row 2	Voltage Out 15	14 Row 2	Voltage Out 27
2 Row 1	Channel 3	8 Row 1	Channel 15	14 Row 1	Channel 27
3 Row 4	Voltage Out 4	9 Row 4	Voltage Out 16	15 Row 4	Voltage Out 28
3 Row 3	Channel 4	9 Row 3	Channel 16	15 Row 3	Channel 28
3 Row 2	Voltage Out 5	9 Row 2	Voltage Out 17	15 Row 2	Voltage Out 29
3 Row 1	Channel 5	9 Row 1	Channel 17	15 Row 1	Channel 29
4 Row 4	Voltage Out 6	10 Row 4	Voltage Out 18	16 Row 4	Voltage Out 30
4 Row 3	Channel 6	10 Row 3	Channel 18	16 Row 3	Channel 30
4 Row 2	Voltage Out 7	10 Row 2	Voltage Out 19	16 Row 2	Voltage Out 31
4 Row 1	Channel 7	10 Row 1	Channel 19	16 Row 1	Channel 31
5 Row 4	Voltage Out 8	11 Row 4	Voltage Out 20	17 Row 4	No Connection
5 Row 3	Channel 8	11 Row 3	Channel 20	17 Row 3	No Connection
5 Row 2	Voltage Out 9	11 Row 2	Voltage Out 21	17 Row 2	No Connection
5 Row 1	Channel 9	11 Row 1	Channel 21	17 Row 1	No Connection
6 Row 4	Voltage Out 10	12 Row 4	Voltage Out 22	18 Row 4	Field Power +
6 Row 3	Channel 10	12 Row 3	Channel 22	18 Row 3	Field Power -
6 Row 2	Voltage Out 11	12 Row 2	Voltage Out 23	18 Row 2	No Connection
6 Row 1	Channel 11	12 Row 1	Channel 23	18 Row 1	No Connection

2.6.1.8 RTP 3000 Digital Outputs

The RPCS will have two (2) digital output card and termination module combinations configured for the system. The digital input card and termination module support 24 channels of 24 VDC output. Field cables will land on the termination module using 18 AWG wires terminated with ferrules. A termination module is connected to a digital output card through the RTP supplied cable (type 3055/00). The RTP card and termination modules for digital outputs are detailed in Table 2-32.

Table 2-32 –RTP Digital Output Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
SIL-3 24-Channel, Fault Detecting Digital Output Card, 24 VDC sourcing (breaks the positive)	RTP Corp.	3139	2	E3-DAS-DO-09 E3-DAS-DO-10
SIL-3 Single Termination Module - 24 channel 24 VDC sourcing (breaks the positive)	RTP Corp.	3099/52-001	2	E3-DIN-5-TM- DO-09 E3-DIN-5-TM- DO-10

2.6.1.8.1 RTP 3000 Digital Output Mounting

The RTP 3139 digital output cards may be installed in any available slot from 2-12. For the delivered RPCS, the card will be mounted as shown in Table 2-17. The termination modules are din-rail mounted in their specified cabinet using a Hammond Manufacturing din-rail rack mount kit (P/N: RMAD19003). They will be installed as listed in Table 2-18.

Table 2-33 – Digital Output Card Installation Location

I/O Card Device Name	E3-DAS Slot Number
E3-DAS-DO-09	9
E3-DAS-DO-10	10

Table 2-34 – Digital Output Termination Module Installation Location

Termination Module Device Name	Din Rail Kit Device Name	Location
E3-DIN-2-TM- DO-09	E3-DIN-5	PUR1-CAB-E3
E3-DIN-2-TM- DO-10	E3-DIN-5	PUR1-CAB-E3

2.6.1.8.2 RTP 3000 Digital Output Field Wiring

The RTP 3099/52-001 termination module (seen in Figure 2-16) field connection assignments are shown in Table 2-35. The termination module requires a 24 VDC input to power the digital output devices. A sample wiring diagram is shown in Figure 2-17.

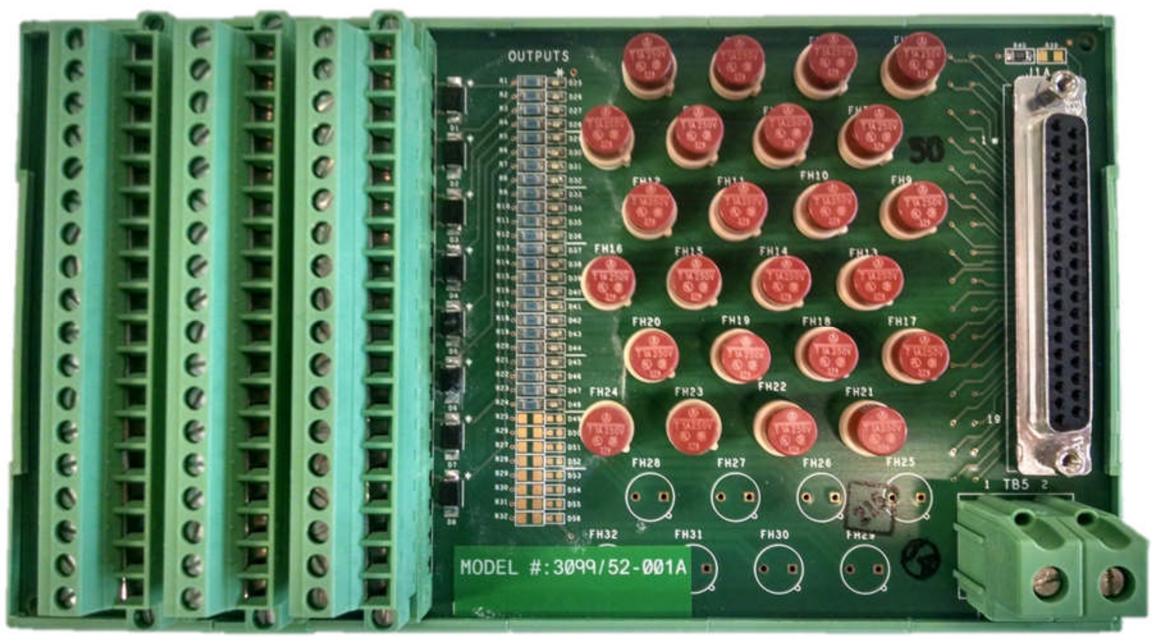


Figure 2-16 – RTP 3099/52-001 Termination Module

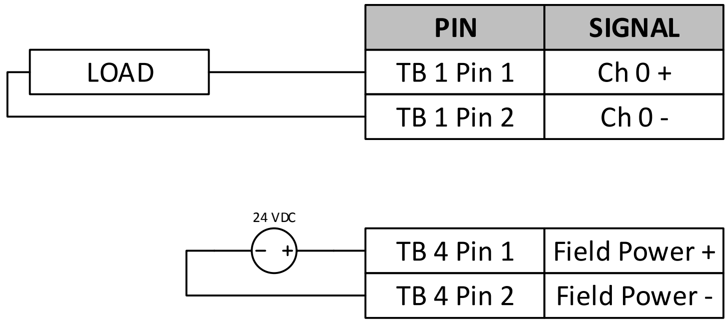


Figure 2-17 - 3099/52-001 Sample Wiring

Table 2-35 – RTP 3099/52-001 Termination Module Pinout

Pin	Signal	Pin	Signal	Pin	Signal
TB 1 PIN 1	Channel 0 +	TB 2 PIN 1	Channel 8 +	TB 3 PIN 1	Channel 16 +
TB 1 PIN 2	Channel 0 -	TB 2 PIN 2	Channel 8 -	TB 3 PIN 2	Channel 16 -
TB 1 PIN 3	Channel 1 +	TB 2 PIN 3	Channel 9 +	TB 3 PIN 3	Channel 17 +
TB 1 PIN 4	Channel 1 -	TB 2 PIN 4	Channel 9 -	TB 3 PIN 4	Channel 17 -
TB 1 PIN 5	Channel 2 +	TB 2 PIN 5	Channel 10 +	TB 3 PIN 5	No Connection
TB 1 PIN 6	Channel 2 -	TB 2 PIN 6	Channel 10 -	TB 3 PIN 6	No Connection
TB 1 PIN 7	Channel 3 +	TB 2 PIN 7	Channel 11 +	TB 3 PIN 7	No Connection
TB 1 PIN 8	Channel 3 -	TB 2 PIN 8	Channel 11 -	TB 3 PIN 8	No Connection
TB 1 PIN 9	Channel 4 +	TB 2 PIN 9	Channel 12 +	TB 3 PIN 9	No Connection
TB 1 PIN 10	Channel 4 -	TB 2 PIN 10	Channel 12 -	TB 3 PIN 10	No Connection
TB 1 PIN 11	Channel 5 +	TB 2 PIN 11	Channel 13 +	TB 3 PIN 11	No Connection
TB 1 PIN 12	Channel 5 -	TB 2 PIN 12	Channel 13 -	TB 3 PIN 12	No Connection
TB 1 PIN 13	Channel 6 +	TB 2 PIN 13	Channel 14 +	TB 3 PIN 13	No Connection
TB 1 PIN 14	Channel 6 -	TB 2 PIN 14	Channel 14 -	TB 3 PIN 14	No Connection
TB 1 PIN 15	Channel 7 +	TB 2 PIN 15	Channel 15 +	TB 3 PIN 15	No Connection
TB 1 PIN 16	Channel 7 -	TB 2 PIN 16	Channel 15 -	TB 3 PIN 16	No Connection
TB 1 PIN 17	No Connection	TB 2 PIN 17	No Connection	TB 3 PIN 17	No Connection
TB 1 PIN 18	No Connection	TB 2 PIN 18	No Connection	TB 3 PIN 18	No Connection
				TB 4 PIN 1	Field Power +
				TB 4 PIN 2	Field Power -

2.6.1.9 RTP 3000 Filler Cards

The RPCS will have two (2) filler cards. Filler cards are installed to help prevent debris from entering the chassis and to direct air flow. The RTP filler cards are detailed in Table 2-36.

Table 2-36 –RTP Filler Card Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Filler Card	RTP Corp.	3099/10-000	2	E3-DAS-FL-11 E3-DAS-FL-12

2.6.1.9.1 RTP 3000 Filler Card Mounting

The RTP 3099/10-000 filler cards may be installed in any available slot from 2-12. Filler cards are installed as a protective measure to keep debris from entering the chassis as well as provide

stability to the RTP I/O cards during shipment. For the delivered RPCS, the card will be mounted as shown in Table 2-37.

Table 2-37 – Digital Output Card Installation Location

Filler Card Device Name	E3-DAS Slot Number
E3-DAS-FL-11	11
E3-DAS-FL-12	12

2.7 Mirion Channel Configuration

2.7.1 Channel 1 DWK 250 Startup Channel

To monitor neutron flux at startup, the RPCS will use the Mirion DWK 250. The DWK 250 configuration is shown in Table 2-38. Refer to Appendix A drawing P-1680001 for a detailed layout and electrical schematic for the DWK 250. The following figures show the front and rear panel arrangement of the DWK 250 and the rear panel of the TKV 23 pre-amplifier.

Table 2-38 – Channel 1 DWK 250 Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Startup Channel	Mirion Technologies	DWK 250	1	E4-DWK-250-CH1
DWK 250 Startup Channel consists of the following modules				
High voltage supply	Mirion Technologies	348026	1	NH 32.51
AC input	Mirion Technologies	353984	1	NA 33.31
Decoder module	Mirion Technologies	353826	1	NB 22.11
Pulse decoupling	Mirion Technologies	353974	1	NE 37.21
I/O processor	Mirion Technologies	353972	2	NZ 21.21
I/O processor	Mirion Technologies	353967	1	NZ 12.21
Binary input	Mirion Technologies	353965	1	NB 21.21
Binary output	Mirion Technologies	353950	1	NB 28.16
Switch card	Mirion Technologies	348042	1	NS 01.12
Isolation amplifier	Mirion Technologies	PN0000151	2	NT 64.55
Power supply	Mirion Technologies	352030	1	NN 53.21
DWK 250 Startup Channel consist the following pre-amplifier				
Pre-amplifier	Mirion Technologies	353490	1	TKV 23.21

Figure 2-18 – Channel 1 DWK 250 Front Panel Arrangement

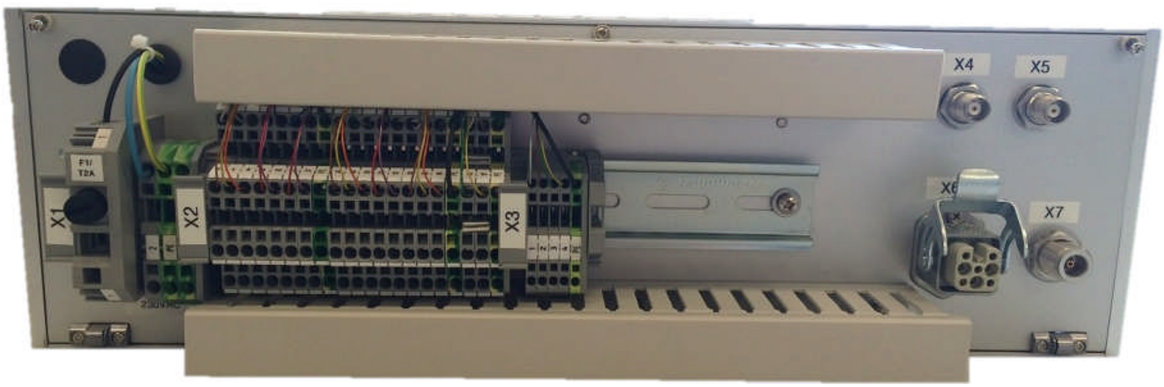


Figure 2-19 – Channel 1 DWK 250 Rear Panel Arrangement

Figure 2-20 – Channel 1 Pre-Amplifier TKV 23 Rear Panel Arrangement

2.7.1.1 Channel 1 DWK 250 Detector Hardware

Table 2-39 – Fission Chamber Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Fission chamber	Mirion Technologies	WL-6376A	1	N/A

2.7.1.2 Channel 1 DWK 250 Chassis Mounting

The DWK 250 chassis will be mounted in equipment cabinet PUR1-CAB-E4. It is rack-mounted using the built-in rack mounting plates of the chassis.

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

2.7.1.3 Channel 1 DWK 250 Pre-Amplifier Mounting

The Mirion TKV 23 is mounted within a chassis that will be mounted in equipment cabinet PUR1-CAB-E4. It is rack-mounted using the built-in rack mounting plates of the chassis.

2.7.1.4 DWK 250 Input Power

The DWK 250 is powered by 120VAC. The power supply cable will be terminated with a NEMA 5-15P plug and will receive power from the cabinet's 120VAC distribution. The power input source is detailed in Table 2-40.

Power will be sourced from PUR1-UPS-2 (RPS Battery Back-up). See Section 2.9.2.3 for power consumption specifications.

Table 2-40 – Channel 1 DAK 250 Input Power Source Location

Device Name	120VAC Source Device Name	120VAC Source Location
E4-DWK-250-CH1	E4-120VAC-PDU	PUR1-CAB-E4

2.7.2 Channel 2 DAK 250-g Intermediate Channel (Log N and Period)

To monitor log power and change rate, the RPCS will use the Mirion DAK 250-g. The DAK 250-g configuration is shown in Table 2-41. Refer to Appendix A drawing P-1680002 for a detailed layout and electrical schematic for the DAK 250-g. The following figures show the front and rear panel arrangement of the DAK 250-g and the rear panel of the TKV 23 pre-amplifier.

Table 2-41 – Channel 2 DAK 250-g Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Intermediate Channel log N and Period	Mirion Technologies	DAK 250-g	1	E4-DAK-250-g-CH2
DAK 250-g Intermediate Channel (log N and Period) consist the following modules				
High voltage supply	Mirion Technologies	348026	1	NH 32.51
High voltage supply	Mirion Technologies	348039	1	NH 36.52
Standard pulse input	Mirion Technologies	353912	1	NI 11.11
I/O processor	Mirion Technologies	353989	1	NZ 21.22
I/O processor	Mirion Technologies	353967	1	NZ 12.21
Binary input	Mirion Technologies	353965	1	NB 21.21

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Binary output	Mirion Technologies	353950	1	NB 28.16
Switch card	Mirion Technologies	348042	1	NS 01.12
Isolation amplifier	Mirion Technologies	PN0000151	2	NT 64.55
Power supply	Mirion Technologies	353490	1	NN 53.21
DAK 250-g Intermediate Channel (log N and Period) consist the following pre-amplifier				
Pre amplifier	Mirion Technologies	352013	1	NV 102.20 H

Figure 2-21 – Channel 2 DAK 250-g Front Panel Arrangement

Figure 2-22 – Channel 2 DAK 250-g Rear Panel Arrangement

Figure 2-23 – Channel 2 Pre-Amplifier NV 102 Rear Panel Arrangement

2.7.2.1 Channel 2 DAK 250-g Detector Hardware

Table 2-42 – Channel 2 Compensated Ion Chamber Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Compensated Ion chamber	Mirion Technologies	WL-23084	1	N/A

2.7.2.2 Channel 2 DAK 250-g Chassis Mounting

The DAK 250-g chassis will be mounted in equipment cabinet PUR1-CAB-E4. It is rack-mounted using the built-in rack mounting plates of the chassis.

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

2.7.2.3 Channel 2 DAK 250-g Pre-Amplifier Mounting

The Mirion NV 102 is mounted within a chassis that will be mounted in equipment cabinet PUR1-CAB-E4. It is rack-mounted using the built-in rack mounting plates of the chassis.

2.7.2.4 Channel 2 DAK 250-g Input Power

The DAK 250-g is powered by 120VAC. The power supply cable will be terminated with a NEMA 5-15P plug and will receive power from the cabinet's 120VAC distribution. The power input source is detailed in Table 2-43.

Power will be sourced from PUR1-UPS-2 (RPS Battery Back-up). See Section 2.9.2.3 for power consumption specifications.

Table 2-43 – Channel 2 DAK 250-g Input Power Source Location

Device Name	120VAC Source Device Name	120VAC Source Location
E4-DAK-250-g-CH2	E4-120VAC-PDU	PUR1-CAB-E4

2.7.3 Channel 3 DAK 250-g Intermediate Channel (Linear Power)

To monitor linear power, the RPCS will use the Mirion DAK 250-g. The DAK 250-g configuration is shown in Table 2-44. Refer to Appendix A drawing P-1680003 for a detailed layout and electrical schematic for the DAK 250-g. The following figures show the front and rear panel arrangement of the DAK 250-g and the rear panel of the TKV 23 pre-amplifier.

Table 2-44 – Channel 3 DAK 250-g Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Intermediate Channel Linear power	Mirion Technologies	DAK 250-g	1	E4-DAK-250-g-CH3
DAK 250-g Intermediate Channel (linear power) consist the following modules				
High voltage supply	Mirion Technologies	348026	1	NH 32.51
Decoder module	Mirion Technologies	353826	1	NB 22.11
Standard pulse input	Mirion Technologies	353912	1	NI 11.11
I/O processor	Mirion Technologies	353989	1	NZ 21.22
I/O processor	Mirion Technologies	353967	1	NZ 12.21
Binary input	Mirion Technologies	353965	1	NB 21.21
Binary output	Mirion Technologies	353950	1	NB 28.16
Switch card	Mirion Technologies	348042	1	NS 01.12
Relay card	Mirion Technologies	353860	1	NR 31.11
Switch card	Mirion Technologies	PN0000151	1	NT 64.55
Power supply	Mirion Technologies	353490	1	NN 53.21
DAK 250-g Intermediate Channel (linear power) consist the following pre-amplifier				
Pre amplifier	Mirion Technologies	352013	1	NV 102.20 H

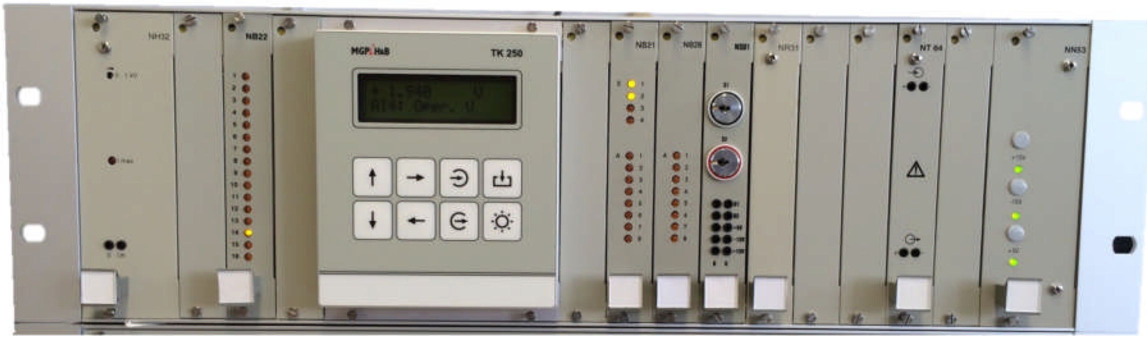


Figure 2-24 – Channel 3 DAK 250-g Front Panel Arrangement

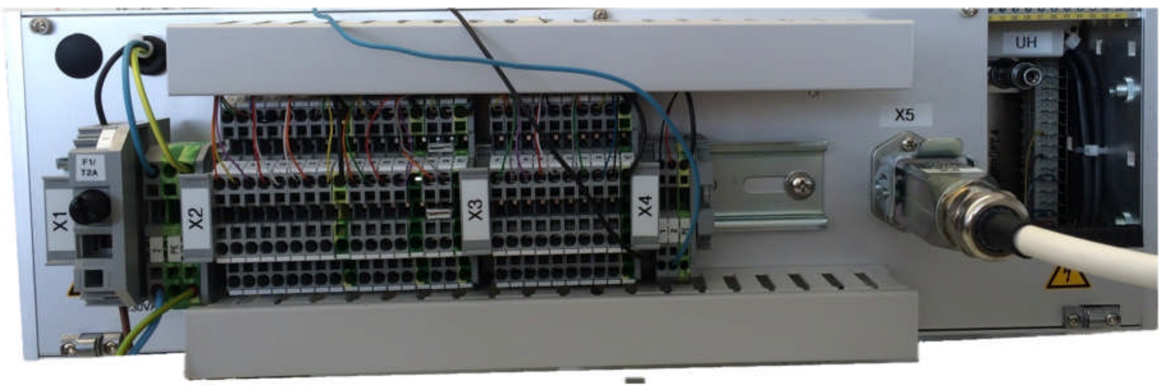


Figure 2-25 – Channel 3 DAK 250-g Rear Panel Arrangement

Figure 2-26 – Channel 3 Pre-Amplifier NV 102 Rear Panel Arrangement

2.7.3.1 Channel 3 DAK 250-g Detector Hardware

Device Description	Manufacturer	Part Number	Quantity	Device Name
Uncompensated Ion chamber	Mirion Technologies	WL-8075	1	N/A

2.7.3.2 Channel 3 DAK 250-g Chassis Mounting

The DAK 250-g chassis will be mounted in equipment cabinet PUR1-CAB-E4. It is rack-mounted using the built-in rack mounting plates of the chassis.

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

2.7.3.3 Channel 3 DAK 250-g Pre-Amplifier Mounting

The Mirion NV 102 is mounted within a chassis that will be mounted in equipment cabinet PUR1-CAB-E4. It is rack-mounted using the built-in rack mounting plates of the chassis.

2.7.3.4 Channel 3 DAK 250-g Input Power

The DAK 250-g is powered by 120VAC. The power supply cable will be terminated with a NEMA 5-15P plug and will receive power from the cabinet's 120VAC distribution. The power input source is detailed in Table 2-45.

Power will be sourced from PUR1-UPS-2 (RPS Battery Back-up). See Section 2.9.2.3 for power consumption specifications.

Table 2-45 – Channel 3 DAK 250-g Input Power Source Location

Device Name	120VAC Source Device Name	120VAC Source Location
E4-DAK-250-g-CH3	E4-120VAC-PDU	PUR1-CAB-E4

2.7.4 Channel 4 DGK 250 Safety Channel

The safety channel of the RPCS will be a Mirion DGK 250. The DAK 250-g configuration is shown in Table 2-46. Refer to Appendix A drawing P-1680004 for a detailed layout and electrical schematic for the DGK 250. The following figures show the front and rear panel arrangement of the DGK 250.

Table 2-46 – Channel 4 DGK 250 Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Safety Channel	Mirion Technologies	DGK 250	1	E4-DGK-250-CH4
DGK 250 Safety Channel consist the following modules				
High voltage supply	Mirion Technologies	348026	1	NH 32.51
DC input	Mirion Technologies	353918	1	NA 31.31
I/O processor	Mirion Technologies	353989	1	NZ 21.22

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
I/O processor	Mirion Technologies	353967	1	NZ 12.21
Binary input	Mirion Technologies	353965	1	NB 21.21
Binary Output	Mirion Technologies	353883	1	NB 28.11
Switch card	Mirion Technologies	348042	1	NS 01.12
Switch card	Mirion Technologies	PN0000151	1	NT 64.55
Power supply	Mirion Technologies	353490	1	NN 53.21

Figure 2-27 – Channel 4 DGK 250 Front Panel Arrangement

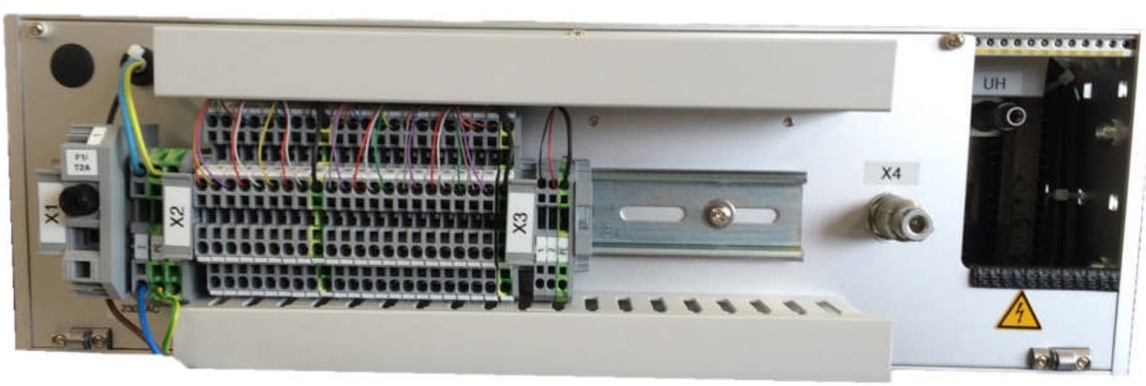


Figure 2-28 – Channel 4 DGK 250 Rear Panel Arrangement

2.7.4.1 Channel 4 DGK 250 Detector Hardware

Device Description	Manufacturer	Part Number	Quantity	Device Name
Uncompensated Ion chamber	Mirion Technologies	WL-8075	1	N/A

2.7.4.2 Channel 4 DGK 250 Chassis Mounting

The DGK 250 chassis will be mounted in equipment cabinet PUR1-CAB-E4. It is rack-mounted using the built-in rack mounting plates of the chassis.

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

2.7.4.3 Channel 4 DGK 250 Input Power

The DGK 250 is powered by 120VAC. The power supply cable will be terminated with a NEMA 5-15P plug and will receive power from the cabinet's 120VAC distribution. The power input source is detailed in Table 2-47.

Power will be sourced from PUR1-UPS-2 (RPS Battery Back-up). See Section 2.9.2.3 for power consumption specifications.

Table 2-47 – Channel 4 DGK 250 Input Power Source Location

Device Name	120VAC Source Device Name	120VAC Source Location
E4-DGK-250-CH4	E4-120VAC-PDU	PUR1-CAB-E4

2.8 Power Supplies

The RPCS will have one standalone power supply for the system. The power supply will be a current source.

2.8.1 Acopian LMR17882

To supply current to the electromagnets used in Shim Safety Rod 1 and Shim Safety Rod 2, a standalone current source will be used. One (1) Acopian current source will be provided by Scientech. The source can supply 0-100 mA with a maximum voltage of 30 V. The current source is detailed in Table 2-48.

Table 2-48 – Acopian LMR17882 Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Rack Mount Current Source 0-100mA, 30 V max.	Acopian	LMR17882	1	E4-CUR-PS

Figure 2-29 shows the physical arrangement of the current source's front and rear panels.

Figure 2-29 – Acopian LMR17882 Front and Rear Panels

2.8.1.1 Acopian LMR17882 Mounting

The Acopian current source will be mounted using the manufacturer's 19" rack mount kit. It will be installed in the cabinets listed in Table 2-49.

Table 2-49 – Acopian LMR17882 Location

Device Name	Location
E4-CUR-PS	PUR1-CAB-E4

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

2.8.1.2 Acopian LMR17882 Input Power

The Acopian current source is powered by 120VAC. The device will receive power from the 120VAC distribution noted in Table 2-50. The connection is made using a 3-wire, 16 AWG cable, terminating in a NEMA 5-15 plug. The terminal arrangement for the AC power input of the LMR17882 can be seen in Figure 2-30.

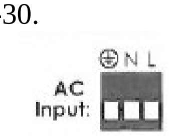


Figure 2-30 – LMR17882 AC Input Connections

Power will be sourced from PUR1-UPS-2 (RPS Battery Back-up). See Section 0 for power consumption specifications.

Table 2-50 – Acopian LMR17882 Input Source Location

PDU Device Name	120VAC Source Device Name	120VAC Source Location
E4-CUR-PS	E4-120VAC-PDU	PUR1-CAB-E4

2.8.1.3 Acopian LMR17882 Power Requirements

The current source must be able to source current through both electromagnets. Table 2-51 shows the compliance voltage requirements of the current source based on the resistances of the electromagnets from the Instruction Manual for Shim-Safety Control Rod Drive, Regulating Control Rod Drive, Fission Chamber Drive, Source Drive (Reference 1.4.3). Even at maximum operating current, the corresponding compliance voltage is well below the 30 V maximum rating.

Table 2-51 – Current Source Calculated Compliance Voltage

Coil Resistance (SS#1)	Coil Resistance (SS#2)	Measurement Circuit Resistance	Operating Current Level	Resulting Compliance Voltage
228 Ω	235 Ω	100 Ω	22 mA (minimum lifting current)	12.39 V
			30 mA (planned operating current)	16.89 V
			50 mA (maximum operating current)	28.15 V

2.9 Power Distribution Units

To distribute power within the equipment cabinets of the RPCS, two power distribution units (PDU) will be used. One type will be used for 24VDC power and one for 120VAC power. See PUR1-HDD-001-014 for diagrams of the PDU input and output connections.

2.9.1 24VDC Power Distribution Units

To supply the RPCS with redundant 24VDC power, two Scientech 24VDC power distribution units will be utilized. Refer to Appendix A drawing PUR1-HDD-001-06 for a detailed layout and component listing for the SC-PDU-24VDC.

See Section 2.9.2.3 for power consumption specifications.

Table 2-52 – RPCS 24VDC Power Distribution Unit Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Redundant 24VDC 3.5A power supplies, individual circuit breakers, 20 terminal blocks of power distribution.	Scientech	SC-PDU-24VDC	2	E3-24VDC-PDU E4-24VDC-PDU

2.9.1.1 SC-PDU-24VDC Mounting

The 24VDC power distribution units will be mounted using their built-in 19” rack mount kits. They will be installed in the cabinets listed in Table 2-53.

Table 2-53 – 24VDC Power Distribution Locations

PDU Device Name	PDU Location
E3-24VDC-PDU	PUR1-CAB-E3
E4-24VDC-PDU	PUR1-CAB-E4

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

2.9.1.2 SC-PDU-24VDC Power Input

The 24VDC power distribution units are powered by 120VAC. Two 120VAC connections are required for redundant power. These connections are made using a 3-wire, 16 AWG cable terminating in a NEMA 5-15 plug. The device will receive power from the 120VAC distribution noted in Table 2-54.

Power will be sourced from PUR1-UPS-2 (RPS Battery Back-up). See Section 2.9.2.3 for power consumption specifications.

Table 2-54 – 24VDC PDU Power Input Source Locations

PDU Device Name	120VAC Source Device Name	120VAC Source Location
E3-24VDC-PDU	E3-120VAC-PDU	PUR1-CAB-E3
E4-24VDC-PDU	E4-120VAC-PDU	PUR1-CAB-E4

E3-24VDC-PDU provides power to RCS devices and therefore its power originates from PUR1-UPS-1 (RCS Battery Back-up). E4-24VDC-PDU provides power to RPS SCRAM circuit relays and therefore its power originates from PUR1-UPS-2 (RPS Battery Back-up).

2.9.1.3 24VDC PDU Power Output Requirements

Table 2-55 and Table 2-56 show the devices connected to each 24VDC PDU and their corresponding power consumption. The power supplies used (Phoenix Quint-PS/1AC/24DC/3.5) can supply 3.5A at 24VDC (84W). Each PDU has two power supplies redundantly connected in parallel. Under normal operating conditions, the power supplies will share the load, however for the purposes of the calculations, it is assumed only one power supply is operational.

Note: RTP digital output power is derived from the components the outputs are controlling, not the maximum output of the digital output channel. Therefore, only the devices controlled by digital output cards are shown in the table(s) below.

Table 2-55 – E3-24VDC-PDU Power Output Requirements

Component Name	Manufacturer	Manufacturer Part Number	Datasheet Power Consumption (W)	Measured Power Consumption (W)
E3-DIN-3-TM-DI-05	RTP Corp.	3099/21-101	2.4	1.07
E3-DIN-3-TM-DI-06	RTP Corp.	3099/21-101	2.4	1.07
E3-DIN-4-TM-DI-07	RTP Corp.	3099/21-101	2.4	1.07
E3-DIN-4-TM-DI-08	RTP Corp.	3099/21-101	2.4	1.07
E3-HRN-1	Ametek	NT2-24D	1.2	0.69
E3-HRN-2	Ametek	NT2-24D	1.2	0.69
O1-ANN-CAB	Ronan Engineering Company	2-7-LB-1500-LED	5.712	3.63
O1-DIN-1-REL-1	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-2	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-3	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-4	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-5	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-6	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-7	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-08	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-09	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-10	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-11	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-12	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-13	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-14	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-15	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-1-REL-16	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-01	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-02	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-03	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-04	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-05	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-06	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-07	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-08	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-09	Panasonic	HC2-HL-DC24V-F	0.9	0.90

Component Name	Manufacturer	Manufacturer Part Number	Datasheet Power Consumption (W)	Measured Power Consumption (W)
O1-DIN-4-REL-10	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-11	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-12	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-13	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-DIN-4-REL-14	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O1-IND-GRN-1*	APEM	Q22F1BXXG24E	0.48	0.30
O1-IND-RED-1*	APEM	Q22F1BXXR24E	0.48	0.31
O1-SW-GRN-1*	NKK	LB26WKW01-5F24-JF	0.48	0.16
O1-SW-GRN-2*	NKK	LB26WKW01-5F24-JF	0.48	0.16
O1-SW-GRN-3*	NKK	LB15WKW01-5F24-JF	0.48	0.16
O1-SW-GRN-4*	NKK	LB15WKW01-5F24-JF	0.48	0.16
O1-SW-RED-1*	NKK	LB26WKW01-5C24-JC	0.48	0.17
O1-SW-RED-2*	NKK	LB26WKW01-5C24-JC	0.48	0.17
O1-SW-RED-3*	NKK	LB26WKW01-5C24-JC	0.48	0.17
O3-DIN-4-REL-01	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O3-DIN-4-REL-02	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O3-DIN-4-REL-03	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O3-DIN-4-REL-04	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O3-DIN-4-REL-05	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O3-DIN-4-REL-06	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O3-DIN-4-REL-07	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O3-DIN-4-REL-08	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O3-DIN-4-REL-09	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O3-DIN-4-REL-10	Panasonic	HC2-HL-DC24V-F	0.9	0.90
O3-DIN-4-REL-11	Panasonic	HC2-HL-DC24V-F	0.9	0.90
Total Power Required			58.932	47.95

*Power consumption for panel indicators includes the series resistor.

Table 2-56 – E4-24VDC-PDU Power Output Requirements

Component Name	Manufacturer	Manufacturer Part Number	Datasheet Power Consumption (W)	Measured Power Consumption (W)
E4-DIN-1-REL-1	Panasonic	HC2-HL-DC24V-F	0.9	0.90
E4-DIN-1-REL-2	Panasonic	HC2-HL-DC24V-F	0.9	0.90
E4-DIN-1-REL-3	Panasonic	HC2-HL-DC24V-F	0.9	0.90
E4-DIN-1-REL-4	Panasonic	HC2-HL-DC24V-F	0.9	0.90
E4-DIN-1-REL-5	Panasonic	HC2-HL-DC24V-F	0.9	0.90
E4-DIN-1-REL-6	Panasonic	HC2-HL-DC24V-F	0.9	0.90
E4-DIN-1-REL-7	Panasonic	HC2-HL-DC24V-F	0.9	0.90
Total Power Required			6.3	6.3

2.9.2 120VAC Power Distribution Units

To supply equipment cabinets PUR1-CAB-E3 and PUR1-CAB-E4 with 120 VAC power, four (4) rack mount power distribution units will be used. These PDUs will contain two (2) front, NEMA 5-15 outlets and ten (10) rear, NEMA 5-15 outlets. The PDUs are sourced by the two UPS units described in Section 3.7. E2-UPS-1 supplies the RCS power, while E2-UPS-2 supplies the RPS power.

Table 2-57 – RPCS 120VAC Power Distribution Unit Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Isobar 12-Outlet Network Server Surge Protector, 1U Rack-Mount, 15-ft. Cord, 3840 Joules, 5-15P, 15A	Tripp Lite	IBAR12	4	E3-120VAC-PDU E4-120VAC-PDU O2-120VAC-PDU O3-120VAC-PDU

Figure 2-31 – Tripp Lite IBAR12

2.9.2.1 IBAR12 Mounting

The Tripp Lite IBAR12 PDUs will be mounted using their built-in 19” rack mount kits. They will be installed in the cabinets listed in Table 2-58.

Table 2-58 – 120VAC Power Distribution Locations

PDU Device Name	PDU Location	Power Source
E3-120VAC-PDU	PUR1-CAB-E3	E2-UPS-1 (RCS Battery Backup)
E4-120VAC-PDU	PUR1-CAB-E4	E2-UPS-2 (RPS Battery Backup)
O2-120VAC-PDU	PUR1-CAB-O2	E2-UPS-1 (RCS Battery Backup)
O3-120VAC-PDU	PUR1-CAB-O3	E2-UPS-2 (RPS Battery Backup)

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

2.9.2.2 IBAR12 Power Input

The Tripp Lite IBAR12 PDUs are powered by 120VAC from the reactor room power conditioning system. The PDUs connect to the power conditioning system with their attached 15’ cable. The cable terminates in a NEMA 5-15P input plug. To split the load and to separate power from reactor control and reactor protection systems, E3-120VAC-PDU and O2-120VAC-PDU will be connected to E2-UPS-1, while E4-120VAC-PDU and O3-120VAC-PDU will connect to E2-UPS-2.

2.9.2.3 120VAC PDU Power Output Requirements

Table 2-59, Table 2-60, Table 2-61, and Table 2-62 show the devices connected to each 120 VAC PDU and their corresponding power consumption. Each IBAR12 can supply up to 15A, which is controlled with a built-in circuit breaker.

Table 2-59 – E3-120VAC-PDU Power Output Requirements

Component Name	Manufacturer	Manufacturer Part Number	Datasheet Power Consumption (VA)	Measured Power Consumption (VA)
E3-24VDC-PDU	Scientech	SC-PDU-24VDC	336.0	35
E3-DAS	RTP Corp.	3000D/R2-155	960.0	125
Total Power Required			1296	160

Table 2-60 – E4-120VAC-PDU Power Output Requirements

Component Name	Manufacturer	Manufacturer Part Number	Datasheet Power Consumption (VA)	Measured Power Consumption (VA)
E4-24VDC-PDU	Scientech	SC-PDU-24VDC	336.0	35
E4-CUR-PS	Acopian	LMR17882	5	19
E4-DAK-250-g-CH2	Mirion Technologies	DAK 250-g	40.0	43
E4-DAK-250-g-CH3	Mirion Technologies	DAK 250-g	40.0	38
E4-DGK-250-CH4	Mirion Technologies	DGK 250	40.0	38
E4-DWK-250-CH1	Mirion Technologies	DWK 250	40.0	35
Total Power Required			501	208

Table 2-61 – O2-120VAC-PDU Power Output Requirements

Component Name	Manufacturer	Manufacturer Part Number	Datasheet Power Consumption (VA)	Measured Power Consumption (VA)
O1-REC-1	Yokogawa	DX1004-3-4-2/USB1	60	41
O1-REC-2	Yokogawa	DX1004-3-4-2/USB1	60	41
O2-WKS	Dell	5810	229.69	79
O2-WKS-MON-1	SiriusView	LCDR8U19-12	18	45
O3-WKS-MON-1	SiriusView	LCDR8U19-12	18	45
Total Power Required			385.69	251

Table 2-62 – O3-120VAC-PDU Power Output Requirements

Component Name	Manufacturer	Down Current Consumption (mA)	Datasheet Power Consumption (VA)	Measured Power Consumption (VA)
O3-OPER-CLK	ENM (T50B2)	N/A	0.4	30
Source Drive	Diamond Power	315	37.8	37.8
Regulating Rod Drive	Diamond Power	350	42	42
Fission Chamber Drive	Diamond Power	360	43.2	43.2
Shim Safety Rod #1 Drive	Diamond Power	230	27.6	27.6
Shim Safety Rod #2 Drive	Diamond Power	230	27.6	27.6
Total Power Required			178.6	208.2

Note: Power consumption for rod drives was taken from Rod-FC-Source Drive Manual (Reference 1.4.3)

2.10 I/O Termination Blocks

Din-rail mounted termination blocks will be procured for landing field I/O connections within the operator console and equipment cabinets. The RPCS will utilize Phoenix Contact feed-through, ground and end stop blocks.

2.10.1 Feed-Through Terminal Block

To land field I/O terminations within the cabinets, Phoenix Contact feed-through terminal blocks will be utilized. The blocks are din-rail mounted. See Table 2-63 for details of the termination blocks.

Table 2-63 – Phoenix Feed-Through Block Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Feed-through terminal block, Connection method: Screw connection, AWG: 26 - 10, Width: 6.2 mm, Color: gray	Phoenix Contact	3046184	308	See Appendix B

2.10.2 Grounding Terminal Block

To land field terminations on the cabinet ground, Phoenix Contact ground modular terminal blocks will be utilized. The blocks are din-rail mounted. Two (2) ground blocks will be mounted at opposite ends of a set of any bank of feed-through terminal blocks. See Table 2-64 for details of the grounding termination blocks.

Table 2-64 – Phoenix Contact Ground Modular Termination Block Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Ground modular terminal block, Connection method: Screw connection, AWG: 24 - 8, Width: 8.2 mm, Height: 45.8 mm, Color: green-yellow	Phoenix Contact	0442079	12	E4-DIN-2-TB-GND-1 E4-DIN-2-TB-GND-2 O1-DIN-2-TB-GND-1 O1-DIN-2-TB-GND-2 O1-DIN-3-TB-GND-1 O1-DIN-3-TB-GND-2 O3-DIN-1-TB-GND-1 O3-DIN-1-TB-GND-2 O3-DIN-2-TB-GND-1 O3-DIN-2-TB-GND-2 O3-DIN-3-TB-GND-1 O3-DIN-3-TB-GND-2

2.10.3 1kΩ Terminal Block

The RTP digital inputs are line supervised. To sense open circuits, they require a 1kΩ series resistor. To implement this, a 1kΩ resistor will be installed within a terminal block. These

terminal blocks are detailed in Table 2-65. An example of a 1kΩ Terminal Block can be seen in Figure 2-32. These terminal blocks are din-rail mounted.

Table 2-65 – 1kΩ Terminal Block Detail

Device Description	Manufacturer	Part Number(s)	Quantity	Device Name(s)
Phoenix feed-through modular terminal block with 1kΩ resistor, Connection method: Screw connection, AWG: 24 - 10, Width: 6.2 mm, Color: gray	Phoenix Contact Vishay Dale	2775207 RS01A1K000FE12	128	See Appendix B

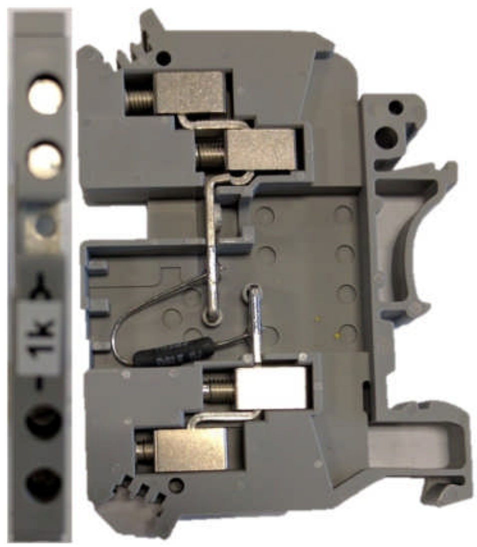


Figure 2-32 – 1kΩ Terminal Block

2.10.4 10kΩ Terminal Block

The RTP digital inputs are line supervised. To sense short circuits, they require a 10kΩ resistor in parallel with the switch contacts. To implement this, a 10kΩ resistor will be installed within a terminal block. These terminal blocks are detailed in Table 2-66. An example of a 10kΩ Terminal Block can be seen in Figure 2-33. These terminal blocks are also din-rail mounted.

Table 2-66 – 10kΩ Terminal Block Detail

Device Description	Manufacturer	Part Number(s)	Quantity	Device Name(s)
Phoenix feed-through modular terminal block with 10kΩ resistor, Connection method: Screw connection, AWG: 24 - 10, Width: 6.2 mm, Color: gray	Phoenix Contact Vishay Dale	2775207 RS01A10K00FE12	68	See Appendix B

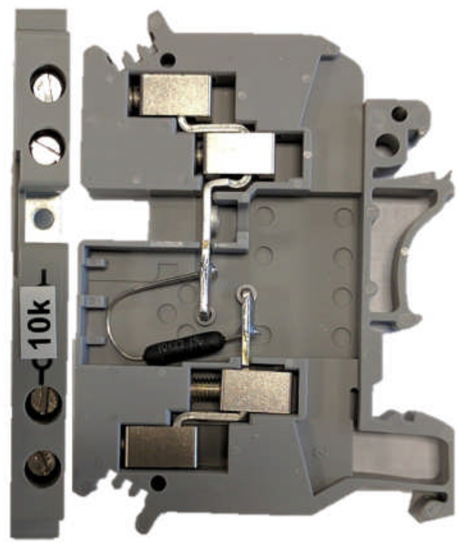


Figure 2-33 – 10kΩ Terminal Block

2.10.5 909Ω Terminal Block

The control panel indicators require a current limiting resistor of 909Ω. To implement this, a 909Ω resistor will be installed within a terminal block. These terminal blocks are detailed in Table 2-67.

Table 2-67 – 909Ω Terminal Block Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Phoenix feed-through modular terminal block with 909Ω resistor, Connection method: Screw connection, AWG: 24 - 10, Width: 6.2 mm, Color: gray	Phoenix Contact Vishay Dale	2775207 CMF60909R00FKEB	2	O1-DIN2-TB-1 O1-DIN2-TB-3

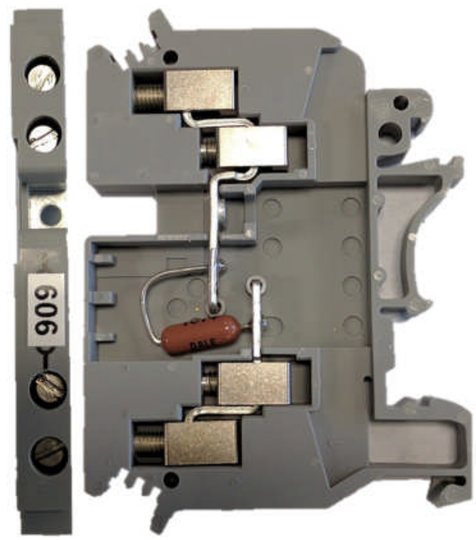


Figure 2-34 – 909Ω Terminal Block

2.10.6 1.1kΩ Terminal Block

The control panel indicators require a current limiting resistor of 1.1kΩ. To implement this, a 1.1kΩ resistor will be installed within a terminal block. These terminal blocks are detailed in Table 2-68.

Table 2-68 – 1.1kΩ Terminal Block Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Phoenix feed-through modular terminal block with 1.1kΩ resistor, Connection method: Screw connection, AWG: 24 - 10, Width: 6.2 mm, Color: gray	Phoenix Contact Vishay Dale	2775207 CMF601K1000FHEK	7	O1-DIN2-TB-05 O1-DIN2-TB-07 O1-DIN2-TB-09 O1-DIN2-TB-11 O1-DIN2-TB-13 O1-DIN2-TB-15 O1-DIN2-TB-17

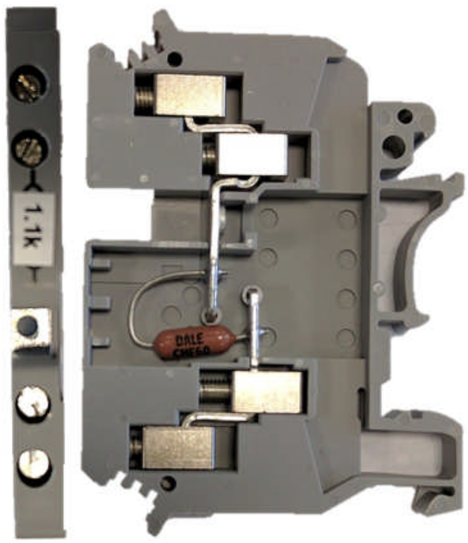


Figure 2-35 – 1.1kΩ Terminal Block

2.10.7 200Ω Terminal Block

To measure the magnet current, two 200 Ω resistors will be installed in parallel and placed in series with the magnet power current loop. This will create an effective resistance of 100 Ω. The voltage across that resistance will range from 0-5 VDC (with a current input from 0-50mA). These terminal blocks are detailed in Table 2-68.

Table 2-69 – 200Ω Terminal Block Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Phoenix feed-through modular terminal block with 200Ω resistor, Connection method: Screw connection, AWG: 24 - 10, Width: 6.2 mm, Color: gray	Phoenix Contact Vishay Dale	2775207 CPF1200R00BEE14	2	E3-DIN-1-TB-01 E3-DIN-1-TB-02

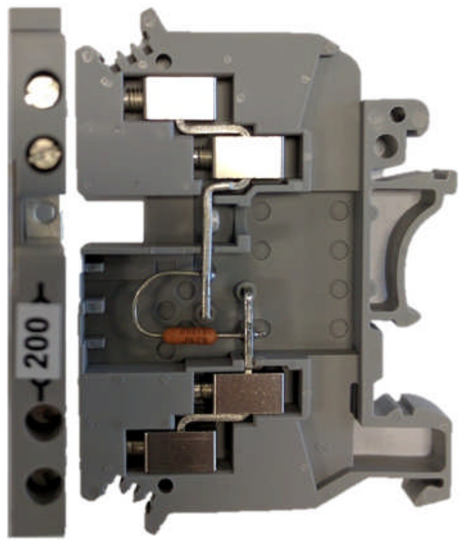


Figure 2-36 – 200Ω Terminal Block

2.10.8 End Block

To prevent horizontal movement, end blocks are installed to secure the feed-through termination blocks on the din-rail. The blocks use screw clamp to mount to din-rail. Two (2) end clamps will be mounted at opposite ends of a set of any bank of feed-through terminal blocks or din rail mounted relays. See Table 2-70 for details of the end blocks.

Table 2-70 – Phoenix Contact Ground Modular Termination Block Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Din Rail End Clamp Terminal Block, Gray	Phoenix Contact	0800886	22	N/A

2.11 Annunciator Cabinet

To annunciate specified SCRAM and setback conditions, the RPCS will contain an annunciator LED cabinet in the operator console. All annunciator tiles will be indicator only. SCRAM annunciator tiles will require interaction with the Annunciator Acknowledge (O1-SW-GRN-3) push-button indicator to reset a fault once the condition has cleared. Appendix A drawing PUR1-HDD-001-01 and PUR1-HDD-001-02 display the layout of the annunciator panel.

2.11.1 Ronan Annunciator

The annunciator used in the RPCS system will be a Ronan LB-1500 Lamp Cabinet. The cabinet is detailed in Table 2-71. The annunciator does not require dedicated power. Indicators will be driven directly from the digital outputs of the RTP 3000 TAS.

Table 2-71 – RPCS Ronan LB-1500 Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
2 high x 7 wide LED Lamp Cabinet, 24VDC	Ronan Engineering Company	2-7-LB-1500-LED	1	O1-ANN-CAB

Figure 2-37 shows the physical arrangement of the annunciator lamp cabinet rear panel. All cabling terminations land on the back of the annunciator.

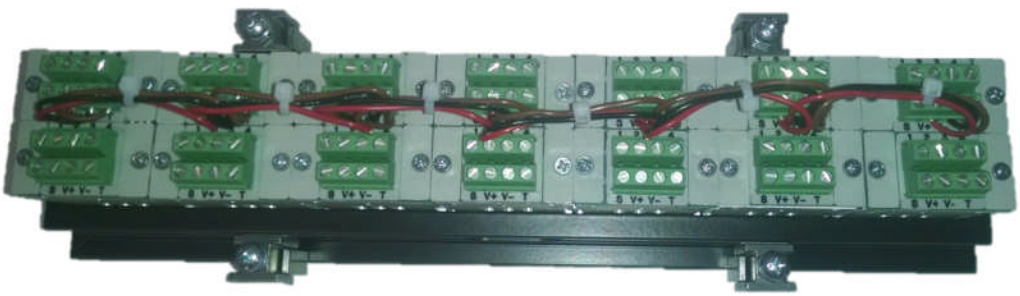


Figure 2-37 – Annunciator Lamp Cabinet Rear Panel

2.11.1.1 Ronan Annunciator Mounting

The annunciator will mount in a 2.60” x 12.47” (H x W) cutout in the indicator panel of the operator console. It is secured in the cutout using the Ronan clamp assembly (see Figure 2-38). The mounting location for the annunciator is defined in Table 2-72.

Table 2-72 – Annunciator Cabinet Mounting Location

Annunciator Device Name	Mounting Panel Name	Location
O1-ANN-CAB	O1-PNL-10U-1	PUR1-CAB-O1

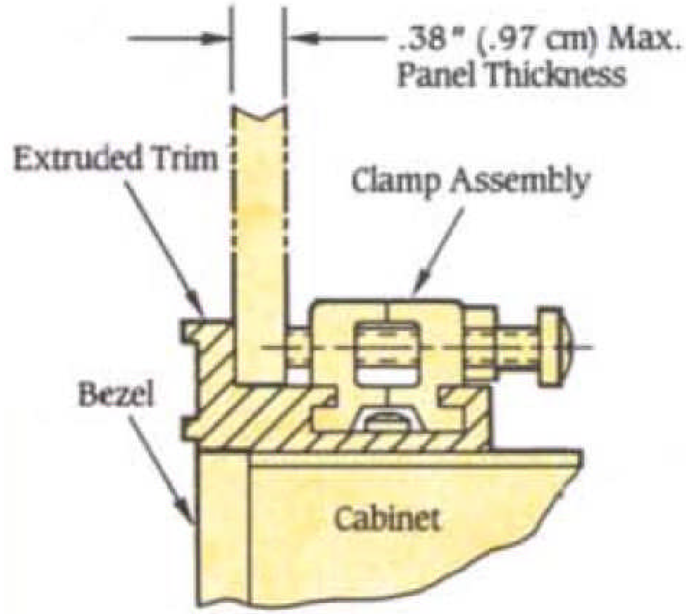


Figure 2-38 – Annunciator Cabinet Mounting Diagram

2.12 Control Room Horns

The RCS will provide two (2) horns for audible annunciation in the control room. One will sound for Class 0 Alarms and one will sound for annunciator alarms (Class 1 Alarm).

2.12.1 Ametek NT2 Horn

The Ametek NT2 horns provide sixteen (16) field configurable tones to distinguish between alarms. The horns also have volume control. The horns will be panel mounted in plate E3-PNL-3U-2 (see section 2.18.1) and powered by a 24 VDC digital output from the RTP 3000 TAS. The horns are detailed in Table 2-73.

Table 2-73 – Ametek NT2 Horn Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Horn, 88 dB @ 10 ft., 16 field selectable tones, volume control, suitable for NEMA 4 and 4X	AMETEK	NT2-24D	2	E3-HRN-1 E3-HRN-2

The input cabling to the horns will connect to the horns' terminal blocks. The terminal blocks are located on the rear of the horns. Figure 2-39 shows the physical arrangement of the horns' rear terminals.

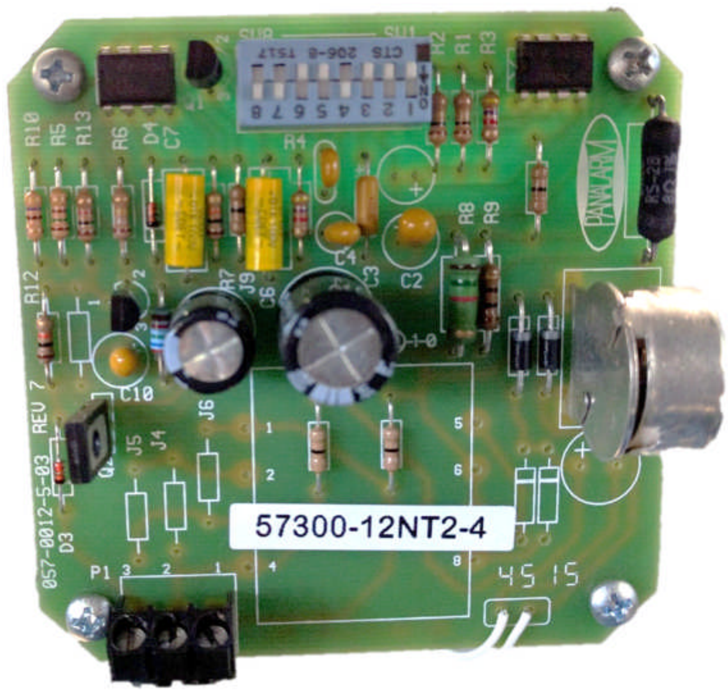


Figure 2-39 – Ametek NT2-24D Terminal Arrangement

2.12.1.1 Ametek NT2 Mounting

Each horn will mount in a 3.38” x 3.38” (H x W) cutout in panel E3-PNL-3U-2. It is secured to the panel using the manufacturer supplied mounting screws through 4 mounting holes (see Figure 2-40). The mounting locations for the horns are defined in Table 2-73.

Table 2-74 – Horn Mounting Locations

Annunciator Device Name	Mounting Panel Name	Location
E3-HRN-1	E3-PNL-3U-2	PUR1-CAB-E3
E3-HRN-2	E3-PNL-3U-2	PUR1-CAB-E3

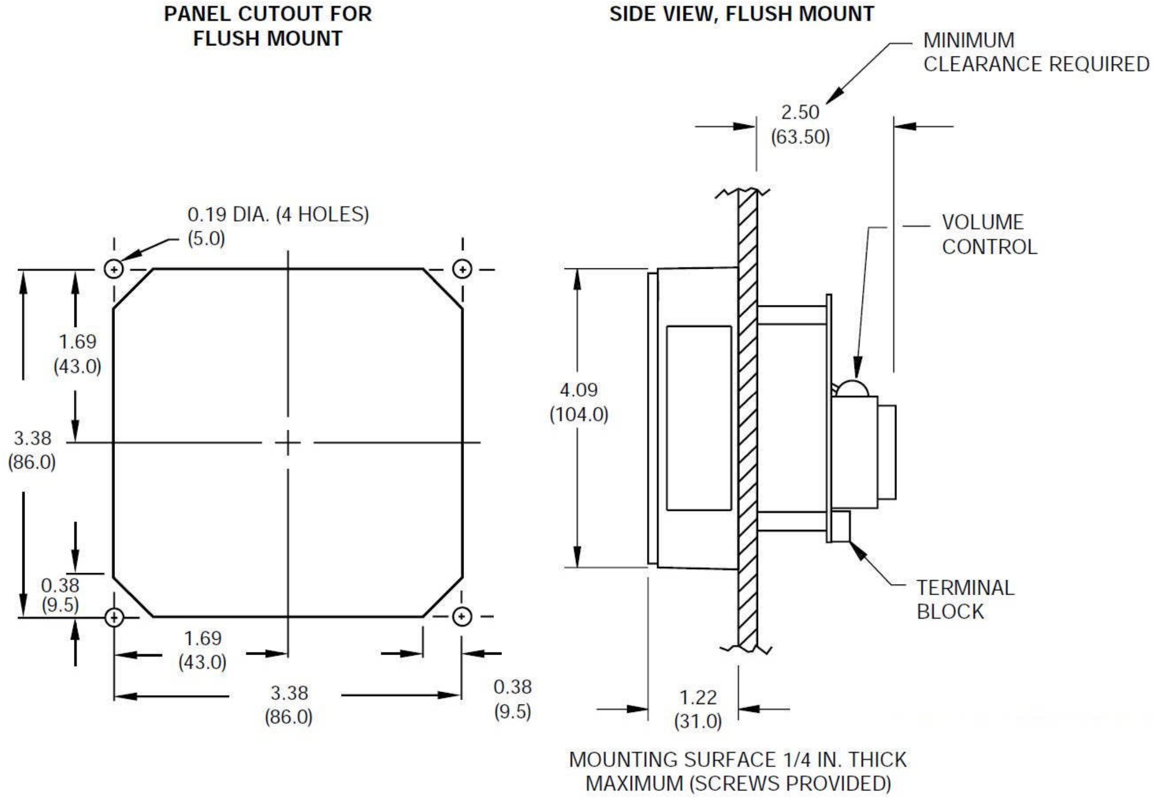


Figure 2-40 – Ametek NT2 Mounting Diagram

2.13 Indicator Panel

To indicate certain conditions and provide operator feedback to the system, LED indicators and LED indicators with pushbuttons will be provided for the operator console. It should be noted that the existing Manual Scram switches and the existing keyswitch will be installed in the indicator panel. For information on these devices, see Section 3.1.

2.13.1 Green Panel Indicator

A green LED indicator will be provided to indicate a "CHILLER ON" condition. The LED is panel mounted in plate O1-PNL-10U-1 (see section 2.18.1) and powered by a 24 VDC digital output from the RTP 3000 TAS. The LED is detailed in Table 2-75.

Table 2-75 – Green Panel Indicator Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
LED INDICATOR, 22MM, FLUSH, 24VDC, IP67, GREEN	APEM	Q22F1BXXG24E	1	O1-IND-GRN-1

The indicator will have flying leads soldered to its solder lug terminals. The leads will land on intermediate terminal blocks before passing to the RTP termination module. The solder lug terminals are located on the rear of the indicator. Figure 2-41 shows the physical arrangement of the indicators' rear terminals.

Figure 2-41 – Q22F1BXXG24E Terminals

To limit the current through the LED indicator, a 909 Ω resistor will be installed in series. The resistor will be installed within a terminal block. The terminal block is detailed in Section 2.10.5.

Table 2-76 – Green Indicator Current Limiting Resistor Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Metal Film Resistor - Through Hole 1/2W 1W 909ohms 1%	Vishay / Dale	CMF60909R00FKEB	1	N/A

2.13.2 Red Panel Indicator

A red LED indicator will be provided to indicate an "Environmental Health" warning condition. The LED is panel mounted in plate O1-PNL-10U-1 (see section 2.18.1) and powered by a 24 VDC digital output from the RTP 3000 TAS. The LED is detailed in Table 2-77.

Table 2-77 – Red Panel Indicator Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
LED INDICATOR, 22MM, FLUSH, 24VDC, IP67, RED	APEM	Q22F1BXXR24E	1	O1-IND-RED-1

The indicator will have flying leads soldered to its solder lug terminals. The leads will land on intermediate terminal blocks before passing to the RTP termination module. The solder lug terminals are located on the rear of the indicator. Figure 2-42 shows the physical arrangement of the indicators' rear terminals.

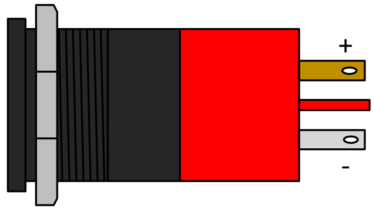


Figure 2-42 – Q22F1BXXR24E Terminals

To limit the current through the LED indicator, a 909 Ω resistor will be installed in series. The resistor will be installed within a terminal block. The terminal block is detailed in Section 2.10.5.

2.13.3 Green Illuminated Switch

A green LED indicator with latch-down pushbutton functionality will be provided to indicate "WATER PROCESS PUMP POWER" and "CHILLER POWER". Additionally, the push-button functionality provides the operator the ability to apply or remove power to each device. The illuminated switches are panel mounted in plate O1-PNL-10U-1 (see section 2.18.1) and the LEDs powered by a 24 VDC digital output from the RTP 3000 TAS. The illuminated switches are detailed in Table 2-78.

Table 2-78 – Green Illuminated Switch Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Illuminated Pushbutton Switch, 22mm, Green	NKK	LB26WKW01-5F24-JF	2	O1-SW-GRN-1 O1-SW-GRN-2

The illuminated switches will have flying leads soldered to its solder lug terminals. The leads will land on intermediate terminal blocks before passing to the RTP termination module and/or relay control. The solder lug terminals are located on the rear of the indicator. Figure 2-43 shows the physical arrangement of the indicators' rear terminals.

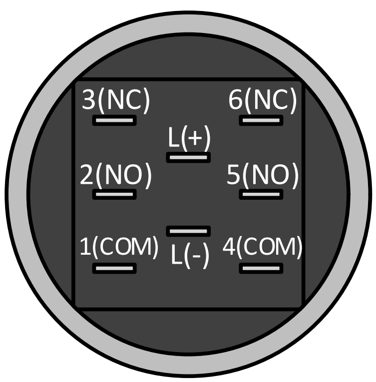


Figure 2-43 – LB26WKW01-5F24-JF Terminals

To limit the current through the LED indicator, a 1.1 kΩ resistor will be installed in series. The resistor will be installed within a terminal block. The terminal block is detailed in Section 2.10.6.

2.13.4 Green Momentary Illuminated Switch

A green LED indicator with momentary pushbutton functionality will be provided to indicate “Annunciator Acknowledge” and “Magnet Power”. Additionally, the push-button functionality provides the operator the ability to send operator feedback to the RPCS for each device. The illuminated switches are panel mounted in plate O1-PNL-10U-1 (see section 2.18.1) and the LEDs powered by a 24 VDC digital output from the RTP 3000 TAS. The illuminated switches are detailed in Table 2-79.

Table 2-79 – Green Momentary Illuminated Switch Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Illuminated Momentary Pushbutton Switch, 22mm, Green	NKK	LB15WKW01-5F24-JF	2	O1-SW-GRN-3 O1-SW-GRN-4

The illuminated switches will have flying leads soldered to its solder lug terminals. The leads will land on intermediate terminal blocks before passing to the RTP termination module and/or relay control. The solder lug terminals are located on the rear of the indicator. Figure 2-44 shows the physical arrangement of the indicators’ rear terminals.

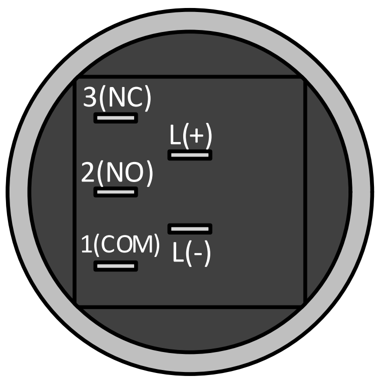


Figure 2-44 – LB15WKW01-5F24-JF Terminals

To limit the current through the LED indicator, a 1.1 kΩ resistor will be installed in series. The resistor will be installed within a terminal block. The terminal block is detailed in Section 2.10.6.

2.13.5 Red Illuminated Switch

A red LED indicator with latch-down pushbutton functionality will be provided to indicate “CONTROL ROOM ALARM”, “HOUSE ALARM, and “ISOLATE CONFINEMENT”. Additionally, the push-button functionality provides the operator the ability to engage each alarm. The illuminated switches are panel mounted in plate O1-PNL-10U-1 (see section 2.18.1) and the LEDs are powered by a 24 VDC digital output from the RTP 3000 TAS. The illuminated switches are detailed in Table 2-80.

Table 2-80 – Red Illuminated Switch Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Illuminated Pushbutton Switch, 22mm, RED	NKK	LB26WKW01-5C24-JC	3	O1-SW-RED-1 O1-SW-RED-2 O1-SW-RED-3

The illuminated switches will have flying leads soldered to its solder lug terminals. The leads will land on intermediate terminal blocks before passing to the RTP termination module and/or relay control. The solder lug terminals are located on the rear of the indicator. Figure 2-45 shows the physical arrangement of the indicators' rear terminals.

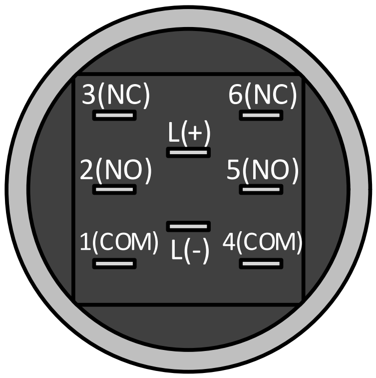


Figure 2-45 – LB26WKW01-5C24-JC Terminals

To limit the current through the LED indicator, a 1.1 kΩ resistor will be installed in series. The resistor will be installed within a terminal block. The terminal block is detailed in Section 2.10.6.

2.13.6 Panel Indicator Mounting

Each panel indicator will mount in 0.866 inch (20mm) hole in panel O1-PNL-10U-1. See Figure 2-46 for a diagram of the mounting hole. They are secured to the panel using the manufacturer supplied nut.

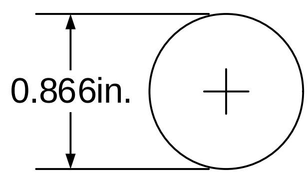


Figure 2-46 – Panel Indicator Panel Cutout

2.13.7 Illuminated Switch Mounting

Each illuminated switch will mount in 0.866 inch (20mm) hole in panel O1-PNL-10U-1. There is also a notch in the top of the hole for alignment. See Figure 2-47 for a diagram of the mounting hole. They are secured to the panel using the manufacturer supplied nut.

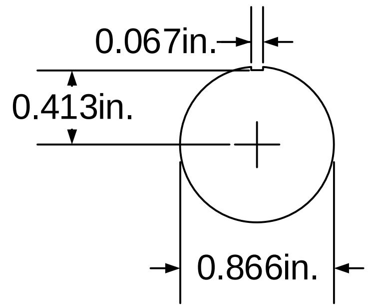


Figure 2-47 – Illuminated Switch Panel Cutout

2.14 Operator Console Paperless Recorders

The RPCS will include two digital, paperless recorders. The recorders will monitor signals as defined in Table 2-81.

Table 2-81 – Recorder Signal Definitions

Recorder 1 (O1-REC-1)	Recorder 2 (O1-REC-2)
Channel 1 – Counts per Second	Channel 1 Change Rate
Channel 2 – Power Level	Channel 2 Change Rate
Channel 4 – Power Level	Channel 3 Power Level
User Configurable	User Configurable

2.14.1 Yokogawa DX1004 Paperless Recorder

For the RPCS replacement project, two (2) Yokogawa DX1004 paperless recorders will be provided. These recorders provide four channels of input each. They also include a USB interface for data transfer and/or optional keyboard interface. The recorders are detailed in Table 2-82.

Table 2-82 – Yokogawa Paperless Recorder Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Yokogawa DX1000 Series Paperless Recorders 4= 4 Input Channels, 125ms Scan 3-4-2= 400 MB Memory w/Compact Flash Card USB1= USB Interface Option	Yokogawa	DX1004-3-4-2/USB1/M1	2	O1-REC-1 O1-REC-2

Cable connections are terminated on the rear of the recorders. Figure 2-48 shows the physical arrangement of the recorders' rear termination panel.

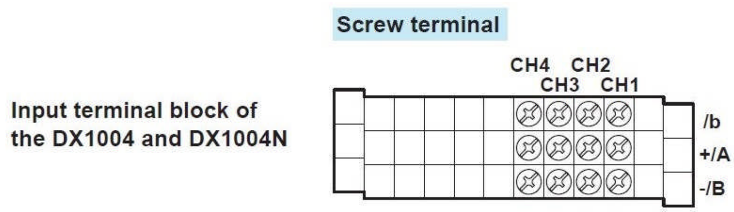


Figure 2-48 – Yokogawa DX1004 Rear Terminals

For 4-20 mA inputs into the Yokogawa recorders, a 250 Ω shunt resistor will be installed. The resistor will be installed across the "+" and "-" terminals of each specified input. These resistors will be utilized for the six permanent inputs. The resistor used is detailed in Table 2-83.

Table 2-83 – Yokogawa Shunt Resistor Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Metal Film Resistor - Through Hole 1/4watt 250ohms .05% 10ppm	Vishay / Dale	PTF65250R00AYEK	6	N/A

2.14.1.1 Yokogawa DX1004 Mounting

The Yokogawa paperless recorder will be panel mounted. To mount the recorders, follow the instructions in section 2.14.1.1.1 (instructions are derived from IM04L41B01-02E – Yokogawa DX Operation Guide, see Appendix H). The panel cutout required for each is shown in Figure 2-49. The recorder mounting locations are defined in Table 2-84.

Table 2-84 – Yokogawa Recorder Mounting Locations

Device Name	Mounting Panel Name	Location
O1-REC-1	O2-PNL-10U-1	PUR1-CAB-O1
O1-REC-2	O2-PNL-10U-1	PUR1-CAB-O1

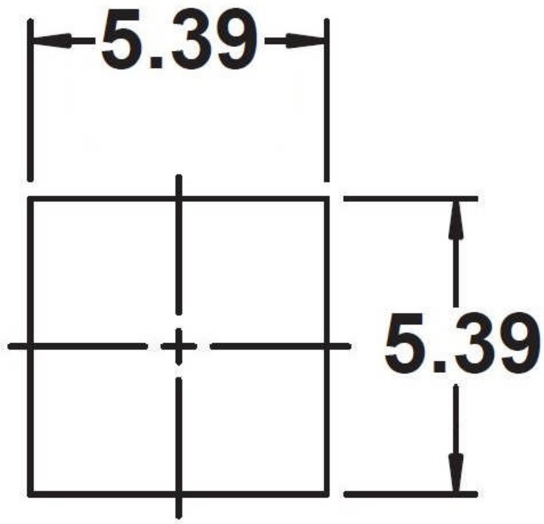


Figure 2-49 – Yokogawa Recorder Panel Cutout (inches)

2.14.1.1.1 Installation Procedure (Panel Mount Type)

Use a steel panel of thickness 2 mm to 26 mm.

1. Insert DX from the front of the panel.
2. Mount the DX to the panel using the mounting brackets that come with the package as shown in the figure below.
    a. Use two brackets to support the top and bottom or the left and right sides of the case (remove the seal that is covering the holes for the mounting brackets beforehand).
    b. The proper torque for tightening the mounting screws is 0.7 to 0.9 N•m.
    c. Mount the DX to the rack according to the procedure below.
        i. First, attach the two mounting brackets and temporarily fasten the attachment screws.
        ii. Next, fix the DX in place by tightening the attachment screws with the appropriate torque. When the DX is approximately perpendicular to the panel as you fasten the screws, press the mounting bracket against the case so that they are in contact with each other.

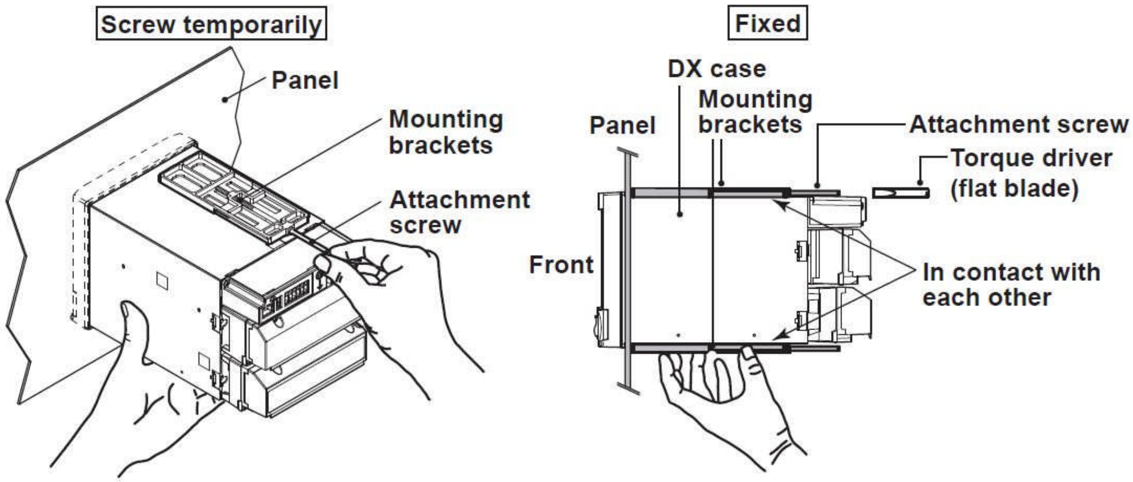


Figure 2-50 – Yokogawa DX Mounting

2.14.1.2 Yokogawa DX1004 Input Power

The Yokogawa recorders will be powered by 120VAC input from the power conditioning system. The connection to the Yokogawa recorder will be made with individual ring terminals (see Figure 2-51). The power cable will terminate with a NEMA 5-15P plug. The cables will connect to power using existing power outlets in the operator console.

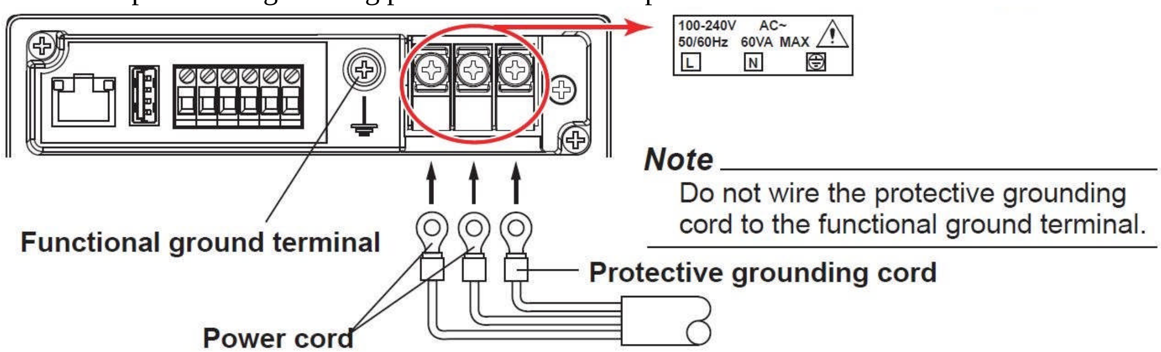


Figure 2-51 – Yokogawa DX Input Power Termination

See Section 2.9.2.3 for power consumption specifications.

2.15 Rod Control Joystick

A new single-axis joystick will be installed as for drive system motion control. The control system shall be designed such that only one drive system can be controlled by the joystick at one time.

2.15.1 ETI Systems Joystick

An ETI Systems single-axis joystick will be provided for the RPCS replacement project. The joystick switches on forward and back positions only and springs back to the center position. The joystick is detailed in Table 2-85.

Table 2-85 – ETI Systems Joystick Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Two Switch Joystick, single-axis, hand-grip, spring return, rubber boot, panel mount	ETI Systems	J50-IG02-SMB	1	O2-RCS-JS

Cable connections are terminated on the rear of the joystick. Figure 2-52 shows side and bottom views of the joystick.

Figure 2-52 – Joystick Rear Panel

2.15.1.1 Joystick Mounting

The J50-IG02-SMB is a panel mounted joystick. The drill drawing required for mounting can be seen in Figure 2-53. The joystick mounting location is defined in Table 2-86.

Table 2-86 – Joystick Mounting Location

Joystick Device Name	Mounting Panel Name	Location
O2-RCS-JS	O2-PNL-2U-1	PUR1-CAB-O2

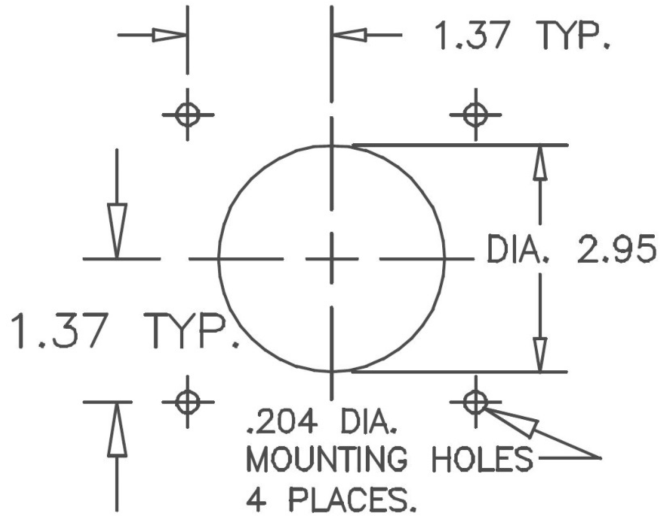


Figure 2-53 – Joystick Mounting Drill Drawing

2.16 Hour Meter

A new hour meter will be installed to track the time the system is in operation. Time will start when the operator console keyswitch is enabled.

2.16.1 ENM T50B2 AC Hour Meter

The RPCS will use a new ENM T50B2 hour meter to track the hours in operation. When the operator console keyswitch is enabled, the hour meter will start logging time. The meter is powered by 120 VAC, which will be switched in by a relay. The hour meter is detailed in Table 2-85.

Table 2-87 – ENM Hour Meter Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Hour Meter, Quartz, 2.8 in. Round, < 0.4 Watts, 115 VAC, AC, 6 digit	ENM	T50B2	1	O3-OPER-CLK

Cable connections are terminated on the rear of the meter with blade terminals. Figure 2-54 shows the physical arrangement of the hour meter's rear panel.

Figure 2-54 – Hour Meter Rear Panel

2.16.1.1 Hour Meter Mounting

The T50B2 is panel mounted. The drill drawing required for mounting can be seen in Figure 2-55. The hour meter mounting location is defined in Table 2-88.

Table 2-88 – Hour Meter Mounting Location

Hour Meter Device Name	Mounting Panel Name	Location
O3-OPER-CLK	O3-PNL-2U-1	PUR1-CAB-O3

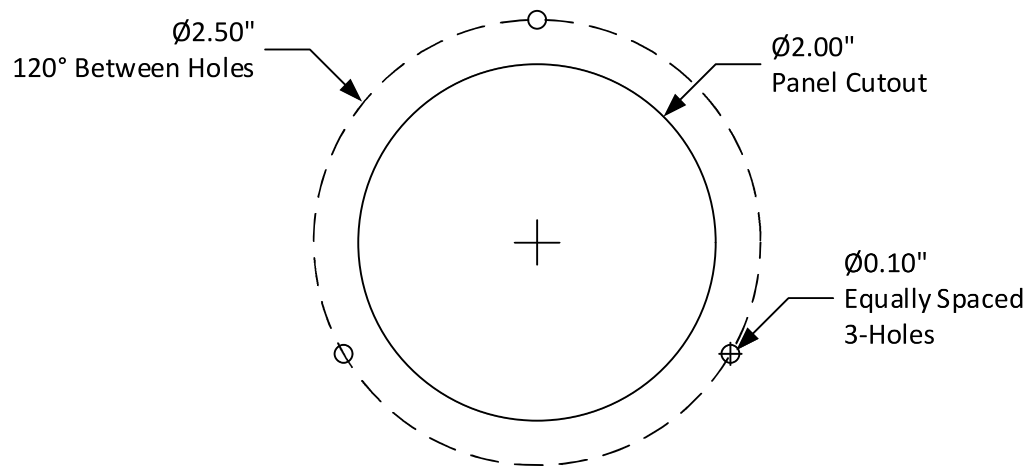


Figure 2-55 – Hour Meter Mounting Drill Drawing

2.17 Relays

For control, power, and I/O purposes, several relays will be used throughout the RPCS replacement project. The relays will have din-rail mounts as well as built in LED status indication. All relays will be double pole, double throw relays as well. To meet these specifications, the following relays will be provided.

2.17.1 24 VDC Relays

To implement RCS control, some external system inputs, and RPS SCRAM inputs 24VDC Panasonic electromagnetic relays will be used. The relays are detailed in Table 2-89.

Table 2-89 – 24 VDC Relay Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Electromechanical Relay 24VDC 650Ohm 7A DPDT (27.2x20.8x35.2)mm Plug-In General Purpose Relay	Panasonic	HC2-HL-DC24V-F	49	E4-DIN-1-REL-01 E4-DIN-1-REL-02 E4-DIN-1-REL-03 E4-DIN-1-REL-04 E4-DIN-1-REL-05 E4-DIN-1-REL-06 E4-DIN-1-REL-07 E4-DIN-1-REL-08 O1-DIN-1-REL-01 O1-DIN-1-REL-02 O1-DIN-1-REL-03 O1-DIN-1-REL-04 O1-DIN-1-REL-05 O1-DIN-1-REL-06 O1-DIN-1-REL-07 O1-DIN-1-REL-08

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
				O1-DIN-1-REL-09 O1-DIN-1-REL-10 O1-DIN-1-REL-11 O1-DIN-1-REL-12 O1-DIN-1-REL-13 O1-DIN-1-REL-14 O1-DIN-1-REL-15 O1-DIN-1-REL-16 O1-DIN-4-REL-01 O1-DIN-4-REL-02 O1-DIN-4-REL-03 O1-DIN-4-REL-04 O1-DIN-4-REL-05 O1-DIN-4-REL-06 O1-DIN-4-REL-07 O1-DIN-4-REL-08 O1-DIN-4-REL-09 O1-DIN-4-REL-10 O1-DIN-4-REL-11 O1-DIN-4-REL-12 O1-DIN-4-REL-13 O1-DIN-4-REL-14 O3-DIN-4-REL-01 O3-DIN-4-REL-02 O3-DIN-4-REL-03 O3-DIN-4-REL-04 O3-DIN-4-REL-05 O3-DIN-4-REL-06 O3-DIN-4-REL-07 O3-DIN-4-REL-08 O3-DIN-4-REL-09 O3-DIN-4-REL-10 O3-DIN-4-REL-11

2.17.2 240 VAC Relays

To determine the ready status of the chiller, a 240 VAC relay will be required. The relay is detailed in Table 2-90.

Table 2-90 – 240 VAC Relay Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
General Purpose Relays POWER RELAY DPDT 240VAC, 15A, PLUG IN	Magnecraft / Schneider Electric	782XBXM4L-240A	1	PUR1-201-REL-1

2.17.3 Relay Mounting

All Panasonic HC relays will mount in a Panasonic relay base that is din-rail mounted. The din-rail mounts will all be mounted on Hammond Manufacturing din-rail rack mount kits (RMAD19003BK, section 2.18.2). The Magnecraft/Schneider Electric relay will be mounted on a similar relay base that also mounts on din-rail. The relay mounts are detailed in Table 2-91. Figure 2-56 shows a schematic of the relay mount pinout. All relays are 2 form C type relays, therefore the pinout is identical, even though they may be mount in different relay bases Cable terminations will be landed with ring terminals on the screw terminals of the relay mounts. The relay mounting locations are shown in Table 2-92.

Table 2-91 –Relay Mount Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Relay Socket Din rail mount	Panasonic	HC2-SFD-S	26	N/A
Relay Sockets & Hardware DIN/PM Socket 8-Pin, Screw Term	Magnecraft / Schneider Electric	70-459-1	1	N/A

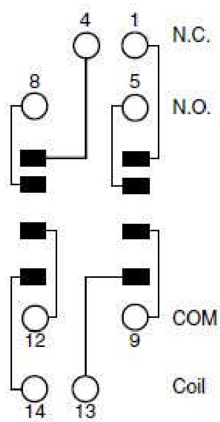


Figure 2-56 – Relay Base Schematic

Table 2-92 – Relay Installation Locations

Switch Device Name	Din Rail Kit Device Name	Location
E4-DIN-1-REL-01	E4-DIN-1	PUR1-CAB-E4
E4-DIN-1-REL-02	E4-DIN-1	PUR1-CAB-E4
E4-DIN-1-REL-03	E4-DIN-1	PUR1-CAB-E4
E4-DIN-1-REL-04	E4-DIN-1	PUR1-CAB-E4
E4-DIN-1-REL-05	E4-DIN-1	PUR1-CAB-E4
E4-DIN-1-REL-06	E4-DIN-1	PUR1-CAB-E4
E4-DIN-1-REL-07	E4-DIN-1	PUR1-CAB-E4
E4-DIN-1-REL-08	E4-DIN-1	PUR1-CAB-E4
O1-DIN-1-REL-01	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-02	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-03	O1-DIN-1	PUR1-CAB-O1

Switch Device Name	Din Rail Kit Device Name	Location
O1-DIN-1-REL-04	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-05	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-06	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-07	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-08	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-09	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-10	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-11	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-12	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-13	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-14	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-15	O1-DIN-1	PUR1-CAB-O1
O1-DIN-1-REL-16	O1-DIN-1	PUR1-CAB-O1
O1-DIN-4-REL-01	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-02	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-03	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-04	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-05	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-06	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-07	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-08	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-09	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-10	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-11	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-12	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-13	O1-DIN-4	PUR1-CAB-O1
O1-DIN-4-REL-14	O1-DIN-4	PUR1-CAB-O1
O3-DIN-4-REL-01	O3-DIN-4	PUR1-CAB-O3
O3-DIN-4-REL-02	O3-DIN-4	PUR1-CAB-O3
O3-DIN-4-REL-03	O3-DIN-4	PUR1-CAB-O3
O3-DIN-4-REL-04	O3-DIN-4	PUR1-CAB-O3
O3-DIN-4-REL-05	O3-DIN-4	PUR1-CAB-O3
O3-DIN-4-REL-06	O3-DIN-4	PUR1-CAB-O3
O3-DIN-4-REL-07	O3-DIN-4	PUR1-CAB-O3
O3-DIN-4-REL-08	O3-DIN-4	PUR1-CAB-O3
O3-DIN-4-REL-09	O3-DIN-4	PUR1-CAB-O3
O3-DIN-4-REL-10	O3-DIN-4	PUR1-CAB-O3
O3-DIN-4-REL-11	O3-DIN-4	PUR1-CAB-O3
PUR1-201-REL-1	N/A	Process System Box

2.18 Cabinet Hardware

2.18.1 Blanking Plates

To prevent debris from entering the front of the equipment cabinets and to mount operator console hardware, 19” rack blanking plates will be installed. The panels are constructed of 14-guage steel. The plates are all painted with semi-gloss black paint. Table 2-93 details the

blanking plates used in the RPCS replacement project. For panel mount equipment, drill drawings of the blanking plates can be seen in PUR1-HDD-001-18.

Table 2-93 – Blanking Plate Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
1U, Steel Rack Panel, Black	Hammond Manufacturing	PBPS19001BK2	3	O1-PNL-1U-5 O2-PNL-1U-5 O3-PNL-1U-5
2U, Steel Rack Panel, Black	Hammond Manufacturing	PBPS19003BK2	15	E1-PNL-2U-1 E2-PNL-2U-1 E2-PNL-2U-4 E2-PNL-2U-5 E3-PNL-2U-1 E4-PNL-2U-1 E4-PNL-2U-3 O1-PNL-2U-2 O1-PNL-2U-3 O2-PNL-2U-1 O2-PNL-2U-2 O2-PNL-2U-3 O3-PNL-2U-1 O3-PNL-2U-2 O3-PNL-2U-3
3U, Steel Rack Panel, Black	Hammond Manufacturing	PBPS19005BK2	4	E1-PNL-3U-2 E2-PNL-3U-2 E3-PNL-3U-2 E4-PNL-3U-2
7U, Steel Rack Panel, Black	Hammond Manufacturing	PBPS19012BK2	4	E1-PNL-7U-6 E2-PNL-7U-6 E3-PNL-7U-5 E4-PNL-7U-4
10U, Steel Rack Panel, Black	Hammond Manufacturing	PBPS19017BK2	10	E1-PNL-10U-3 E1-PNL-10U-4 E1-PNL-10U-5 E2-PNL-10U-3 E3-PNL-10U-3 E3-PNL-10U-4 O1-PNL-10U-1 O1-PNL-10U-4 O2-PNL-10U-4 O3-PNL-10U-4

2.18.1.1 Blanking Plate Mounting

The blanking plates are mounted using the built in slots for 19" racks. The plate mounting locations are defined in Table 2-94.

Table 2-94 – Blanking Plate Mounting Locations

Device Name	Location
E1-PNL-2U-1	PUR1-CAB-E1

Device Name	Location
E1-PNL-3U-2	PUR1-CAB-E1
E1-PNL-10U-3	PUR1-CAB-E1
E1-PNL-10U-4	PUR1-CAB-E1
E1-PNL-10U-5	PUR1-CAB-E1
E2-PNL-2U-1	PUR1-CAB-E2
E2-PNL-3U-2	PUR1-CAB-E2
E2-PNL-10U-3	PUR1-CAB-E2
E2-PNL-2U-4	PUR1-CAB-E2
E2-PNL-2U-5	PUR1-CAB-E2
E3-PNL-2U-1	PUR1-CAB-E3
E3-PNL-3U-2	PUR1-CAB-E3
E3-PNL-10U-3	PUR1-CAB-E3
E3-PNL-10U-4	PUR1-CAB-E3
E4-PNL-2U-1	PUR1-CAB-E4
E4-PNL-3U-2	PUR1-CAB-E4
E4-PNL-2U-3	PUR1-CAB-E4
O1-PNL-10U-1	PUR1-CAB-O1
O1-PNL-2U-2	PUR1-CAB-O1
O1-PNL-2U-3	PUR1-CAB-O1
O1-PNL-10U-4	PUR1-CAB-O1
O2-PNL-2U-1	PUR1-CAB-O2
O2-PNL-2U-2	PUR1-CAB-O2
O2-PNL-2U-3	PUR1-CAB-O2
O2-PNL-10U-4	PUR1-CAB-O2
O3-PNL-2U-1	PUR1-CAB-O3
O3-PNL-2U-2	PUR1-CAB-O3
O3-PNL-2U-3	PUR1-CAB-O3
O3-PNL-10U-4	PUR1-CAB-O3

2.18.2 Din-Rail Rack Mount Kits

For hardware that is mounted using din-rail, there will be several din-rail rack mount kits installed. The din-rail rack mount kits used in the RPCS replacement project will be Hammond Manufacturing RMAD19003. The racks provide adjustable depth and 17 inches of standard 35 mm din-rail. Table 2-95 details the din-rail rack mount kits supplied for the RPCS replacement project.

Table 2-95 – Din-Rail Rack Mount Kit Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
DIN Rail Mounting Kit; 19 in.; Black	Hammond Manufacturing	RMAD19003BK	17	E2-DIN-1 E2-DIN-2 E3-DIN-1 E3-DIN-2 E3-DIN-3 E3-DIN-4 E3-DIN-5 E4-DIN-1 E4-DIN-2 O1-DIN-1 O1-DIN-2 O1-DIN-3 O1-DIN-4 O3-DIN-1 O3-DIN-2 O3-DIN-3 O3-DIN-4

2.18.2.1 Din-Rail Rack Mount Kit Mounting

The rack mount kits are mounted using the built in brackets for 19" racks. The din-rail rack mount kit locations are defined in Table 2-96.

Table 2-96 – Din Rail Kit Mounting Locations

Device Name	Location
E2-DIN-1	PUR1-CAB-E2
E2-DIN-2	PUR1-CAB-E2
E3-DIN-1	PUR1-CAB-E3
E3-DIN-2	PUR1-CAB-E3
E3-DIN-3	PUR1-CAB-E3
E3-DIN-4	PUR1-CAB-E3
E3-DIN-5	PUR1-CAB-E3
E4-DIN-1	PUR1-CAB-E4
E4-DIN-2	PUR1-CAB-E4
O1-DIN-1	PUR1-CAB-O1
O1-DIN-2	PUR1-CAB-O1
O1-DIN-3	PUR1-CAB-O1
O1-DIN-4	PUR1-CAB-O1
O3-DIN-1	PUR1-CAB-O3
O3-DIN-2	PUR1-CAB-O3
O3-DIN-3	PUR1-CAB-O3
O3-DIN-4	PUR1-CAB-O3

2.18.3 Rack Shelf

To provide a mounting location for the RPCS workstation computer (Section 2.4.1), a rack mounted shelf will be installed in the operator console. The shelf is detailed in Table 2-97.

Table 2-97 – Rack Mounted Shelf Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
2U Unvented Rack Mount Shelf	Hammond Manufacturing	RASU190320BK1	1	O2-WKS-SHLF

2.18.3.1 Rack Shelf Mounting

The shelf is mounted using the built in brackets for 19” racks. The shelf mounting location is defined in Table 2-98.

Table 2-98 – Rack Mount Shelf Location

Device Name	Location
O2-WKS-SHLF	PUR1-CAB-O1

2.18.4 Cable Management

For cable management within the operator console, rack mounted cable troughs will be utilized.

2.18.4.1 Hammond Cable Trough

Hammond Manufacturing cable troughs will be used to route cables through the bottom of the operator console cabinets. The cable troughs used are detailed in Table 2-99.

Table 2-99 – Cable Trough Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Cable Management Trough 3.5"x19"x4.9"	Hammond Manufacturing	PCMT19003BK1	6	E2-CM-TRO-1 E3-CM-TRO-1 E4-CM-TRO-1 O1-CM-TRO-1 O2-CM-TRO-1 O3-CM-TRO-1

2.18.4.1.1 Cable Trough Mounting

The cable troughs are mounted using the built in brackets for 19” racks. The cable trough mounting locations are defined in Table 2-100.

Table 2-100 – Cable Trough Mounting Locations

Device Name	Location
E2-CM-TRO-1	PUR1-CAB-E2
E3-CM-TRO-1	PUR1-CAB-E3
E4-CM-TRO-1	PUR1-CAB-E4
O1-CM-TRO-1	PUR1-CAB-O1
O2-CM-TRO-1	PUR1-CAB-O2
O3-CM-TRO-1	PUR1-CAB-O3

2.19 Third Party Software

A number of third party software applications are utilized in the RPCS. Refer to Appendix F to see the list of software information and location.

Third party software loaded on the RPCS workstation includes the following:

- Adobe Reader
- Intel Fortran Redistributable
- Intel Visual Fortran Composer
- Java
- NetSNMP
- Microsoft Office Professional
- Microsoft Visual Studio Professional
- Microsoft Windows 10 Professional
- ODBC Server
- R*TIME Viewer
- R*TIME Database Utility
- R*TIME Server
- RTP NetSuite
- SQL Server 2014 Express

Additional software such as device drivers may also be installed as part of the configuration process. Documentation on the installation and configuration of the third party software is documented in the System Configuration Manual (Reference 1.4.6) developed for the project.

The specific software packages installed on the various RCI systems are described in Appendix F.

3 Existing Hardware

This section defines the various existing components of the Purdue Research Reactor and how they interface to the RPCS replacement system.

3.1 Manual SCRAM Switches and Keyswitch

Existing switches that will be reused in the replacement RPCS include both Manual SCRAM buttons (console and hallway) and the operator console keyswitch. The switches are detailed below.

3.1.1 Manual SCRAM Switches

Red pushbutton switches serve as manual SCRAM switches. These switches will be reused for the replacement RPCS. These buttons will cause a SCRAM of the reactor by breaking magnet power. The switches are detailed in **Error! Reference source not found.**.

Table 3-1 – Manual SCRAM Switch Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Manual Scram Pushbutton Switch	Microswitch	TR11A	2	HALL-MSCR O1-PNL-1-MSCR

Cabling to the switches will have ring terminals installed, terminating on its screw terminals. The leads will land on intermediate terminal blocks before passing to the coil of their respective relay controls. The screw terminals are located on the rear of the switch.

3.1.1.1 Manual SCRAM Switch Mounting

The operator console manual SCRAM switch will be mounted plate O1-PNL-10U-1 (see section 2.18.1), while the hallway SCRAM switch will retain its current mounting location. Figure 3-1 shows the mounting holes required for the Manual SCRAM switch.

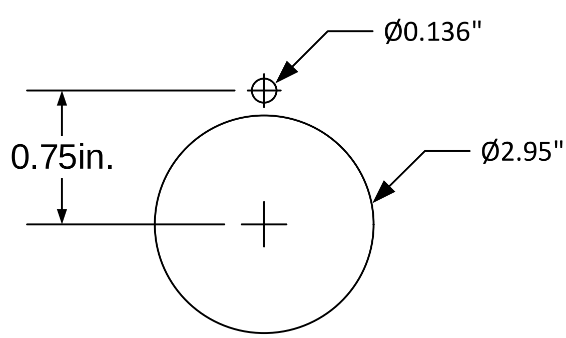


Figure 3-1 – Manual SCRAM Mounting Holes

3.1.1.2 Manual SCRAM Logical Circuit

The circuits for the two manual SCRAM switches are identical. The output of the switches will control a relay. The relay is DPDT. One side of the relay output will be in-line with the magnet power current loop, while the other side will be monitored by the RCS. A sample circuit is shown in Figure 3-2.

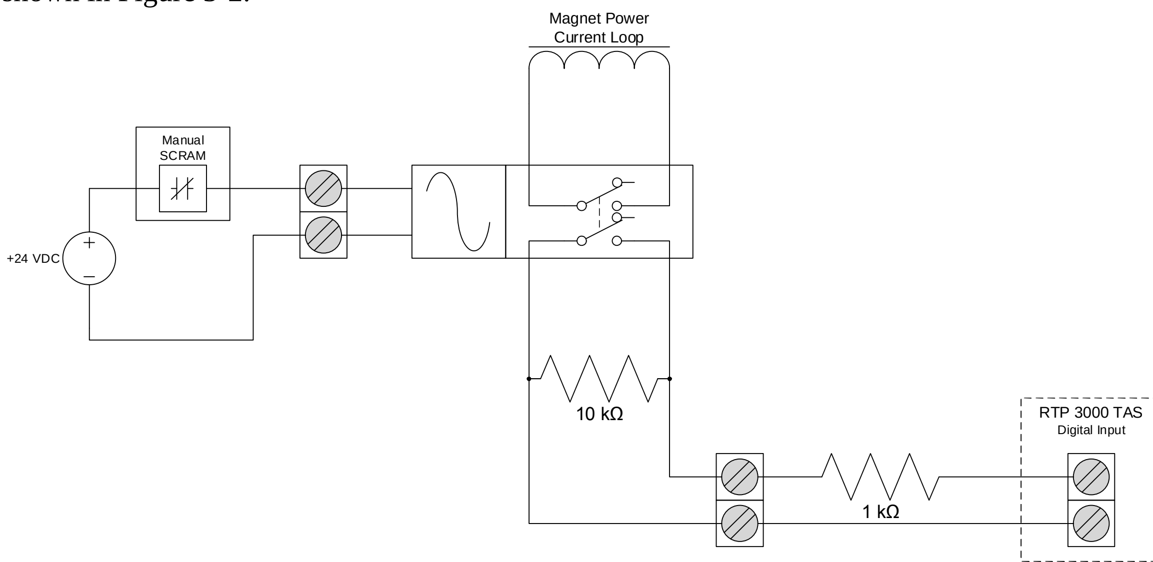


Figure 3-2 – Manual SCRAM Logical Circuit

3.1.2 Keyswitch

These switches will be reused for the replacement RPCS. This switch must be engaged to complete the magnet power circuit. Enabling this switch also starts the system hour meter. The switch is detailed in Table 3-2.

Table 3-2 – Keyswitch Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Keyswitch, Class 9001	Square D	TS1K1A	1	O1-PNL-1-KSW

Cabling to the switch will have ring terminals installed, terminating on its screw terminals. The leads will land on intermediate terminal blocks before passing to the coil of its corresponding relay. The screw terminals are located on the rear of the switch.

3.1.2.1 Keyswitch Mounting

The keyswitch will be mounted plate O1-PNL-10U-1 (see section 2.18.1). Figure 3-3 shows the mounting holes required for the keyswitch.

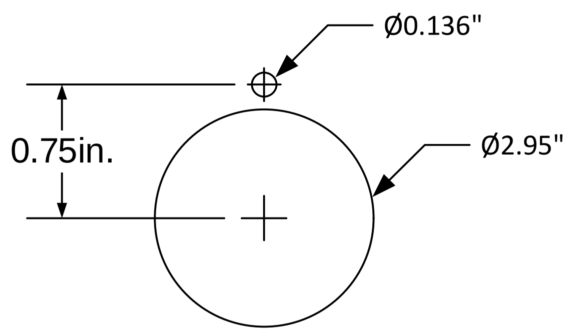


Figure 3-3 – Keyswitch Mounting Holes

3.1.2.2 Manual SCRAM and Keyswitch Logical Circuit

The output of the keyswitch will be used control a relay. The relay is DPDT. One side of the relay output will be in-line with the magnet power current loop, while the other side will be monitored by the RCS. A sample circuit is shown in Figure 3-4.

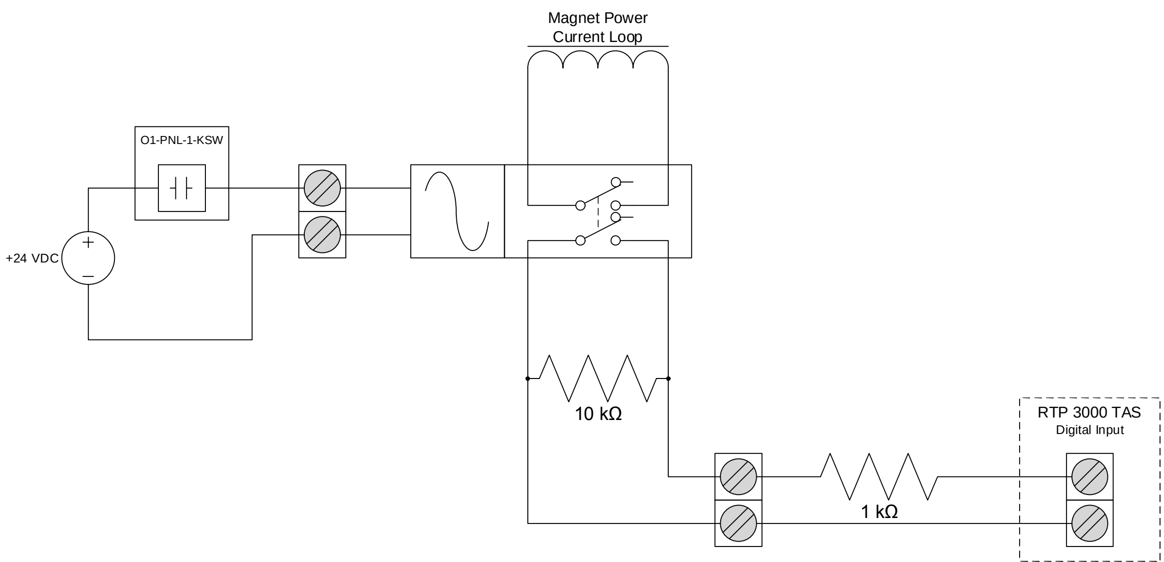


Figure 3-4 – Keyswitch Logical Circuit

3.2 HVAC

The HVAC system does not reside in the Purdue Reactor Room; however the HVAC system will send a status signal to the RPCS system. Additionally, the RPCS will have control of the HVAC system by enabling or disabling a leg of the AC power to the system.

3.2.1 HVAC Logical Circuit

The HVAC will provide a digital output indicating the state of the system. The RCS system will have control of the HVAC system by switching on or off one leg of the AC input power to the HVAC system. This is accomplished by utilizing the Isolate Confinement switch on the operator console or the computer interface. See Figure 3-5 for a diagram of a HVAC logical circuit.

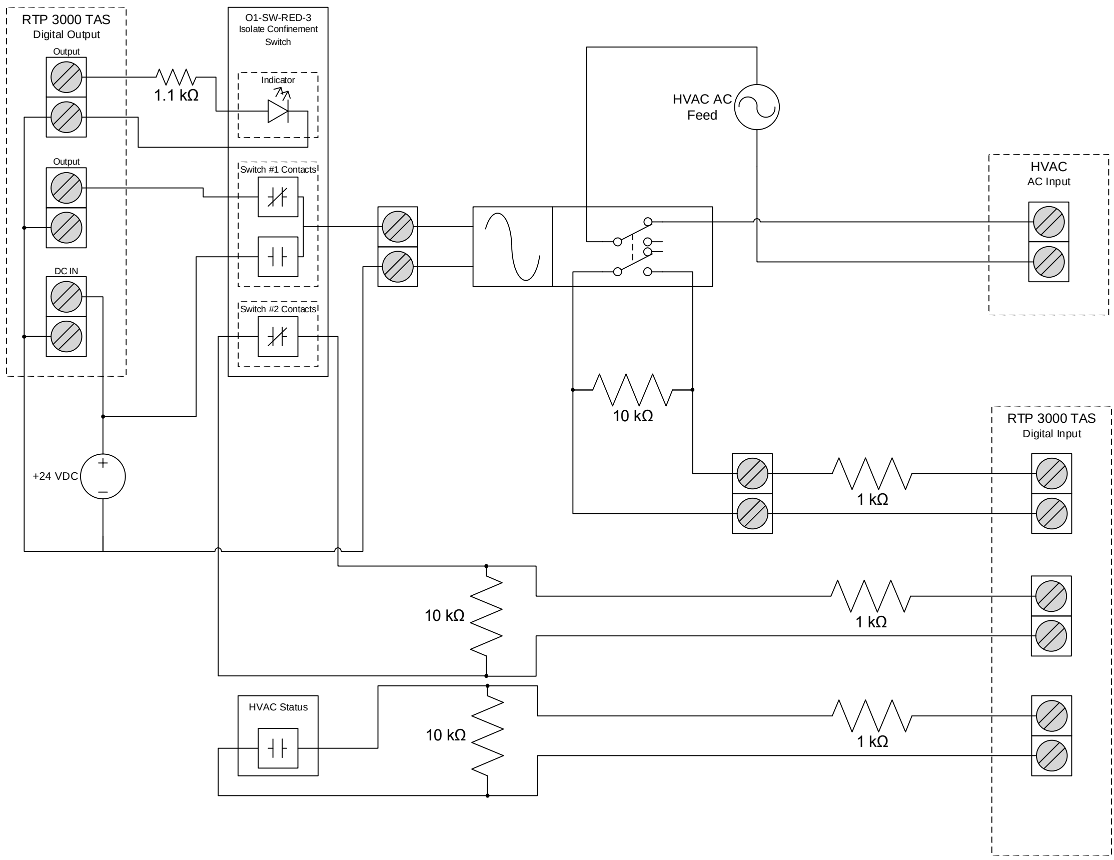


Figure 3-5 – HVAC Logical Circuit

3.3 Radiation Area Monitors

Three (3) radiation area monitors (RAM) are installed throughout the Purdue Reactor Room. The RAMs are detailed in Table 3-3.

Table 3-3 – Radiation Area Monitor Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Area Radiation Monitor	Thermo Scientific	RMS-3	3	POOL-RAM MU-WATER-RAM OC-RAM

Purdue University is responsible for providing cabling from the RAMs to the RPCS termination blocks. Figure 3-6 shows the physical arrangement of the RAM terminals. The cabling will connect to intermediate terminal blocks before passing to the coil of their respective relay controls or RTP 3000 TAS termination modules.

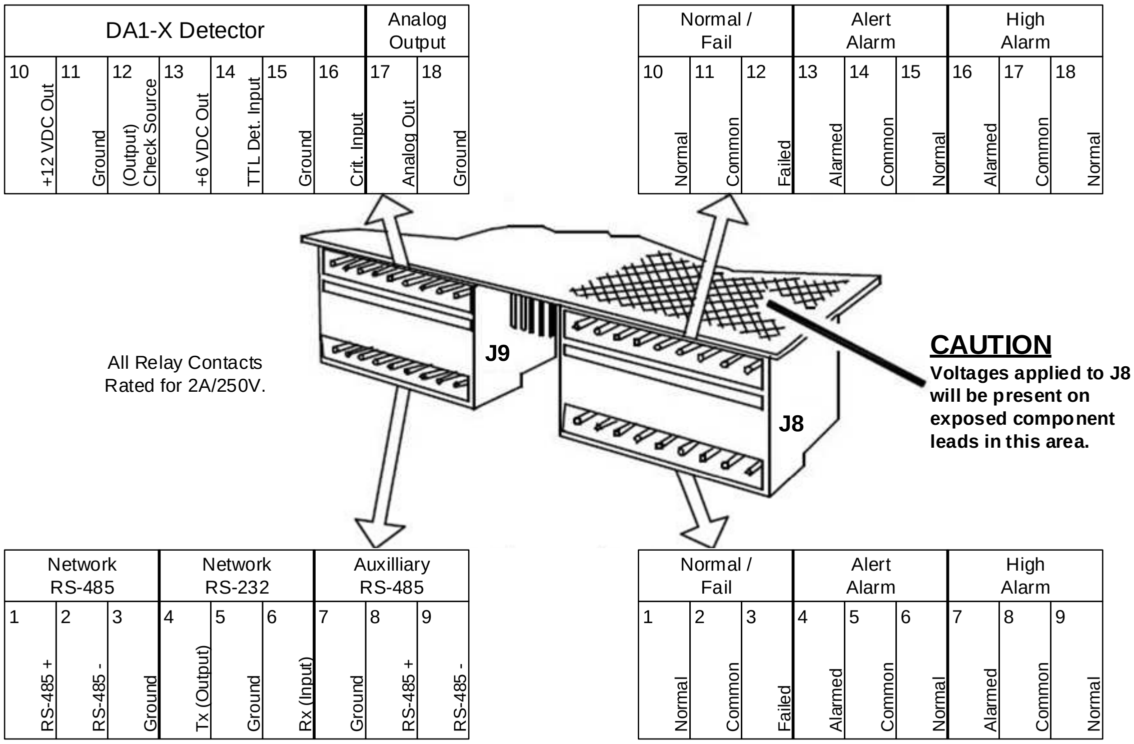


Figure 3-6 – RAM Terminal Connections

3.3.1 Radiation Area Monitor Logical Circuit

Each RAM will provide an analog output of the current dose rate. The RAMs also provide three (3) digital outputs: High Alarm, Fail, and Alert. The High Alarm output will control a DPDT relay. One relay output is in-line with the magnet power current loop, while the other output is monitored by the RCS. See Figure 3-7 for a diagram of a RAM logical circuit.

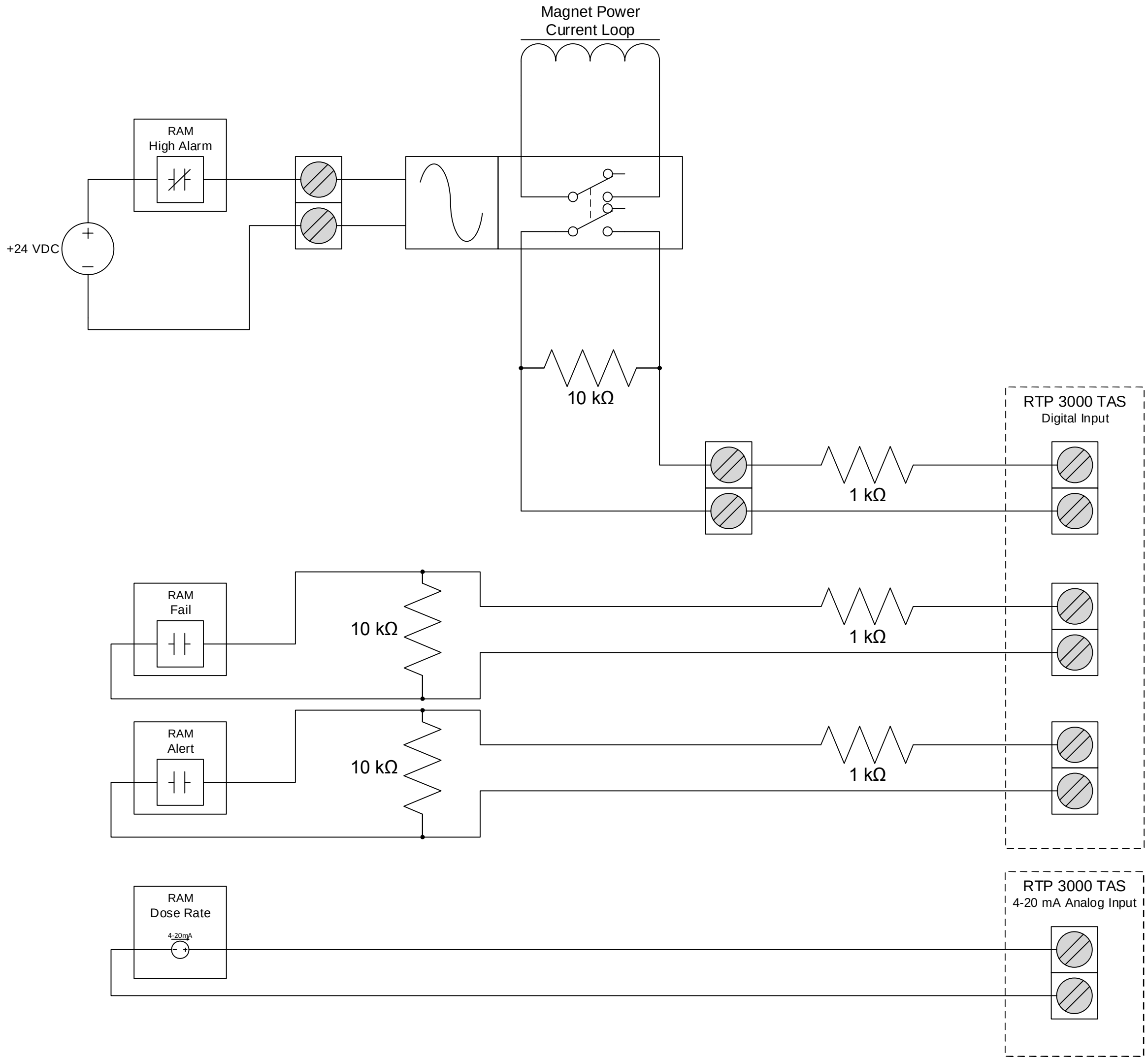


Figure 3-7 – RAM Logical Circuit

3.4 Continuous Air Monitor

One (1) continuous air monitors (CAM) resides in the the Purdue Reactor Room. The CAM is detailed in Table 3-4.

Table 3-4 – Continuous Air Monitor Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Beta particulate monitor	Thermo Scientific	AMS-4	1	PUR1-CAM

Purdue University is responsible for providing cabling from the CAM to the RPCS termination blocks. Figure 3-8 shows the physical arrangement of the CAM terminals. The cabling will

connect to intermediate terminal blocks before passing to the coil of their respective relay controls or RTP 3000 TAS termination modules.

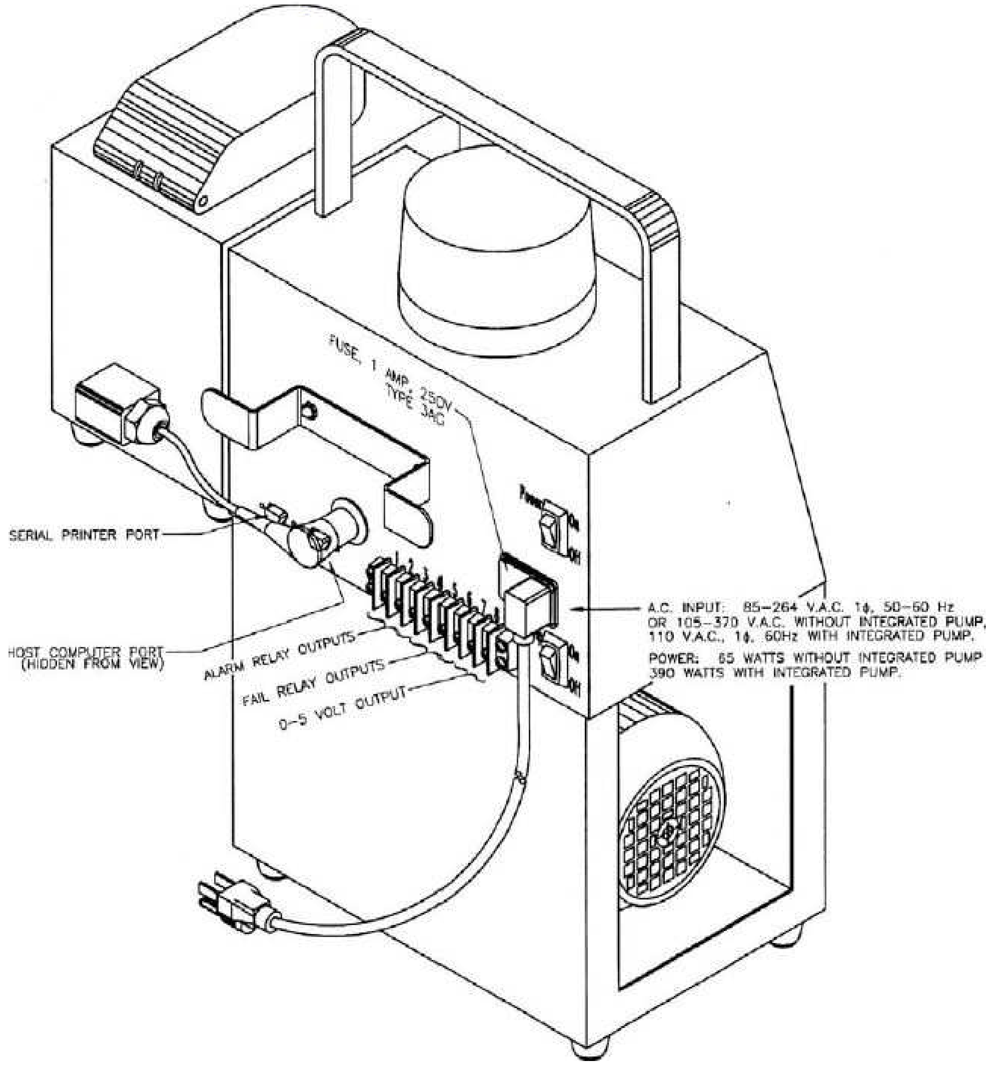


Figure 3-8 – CAM Terminal Connections

3.4.1 Radiation Area Monitor Logical Circuit

The CAM will provide an analog output of the current dose rate. The CAM also provides two (2) digital outputs: High Alarm, and Fail. The High Alarm output will control a DPDT relay. One relay output is in-line with the magnet power current loop, while the other output is monitored by the RCS. See Figure 3-9 for a diagram of the CAM logical circuit.

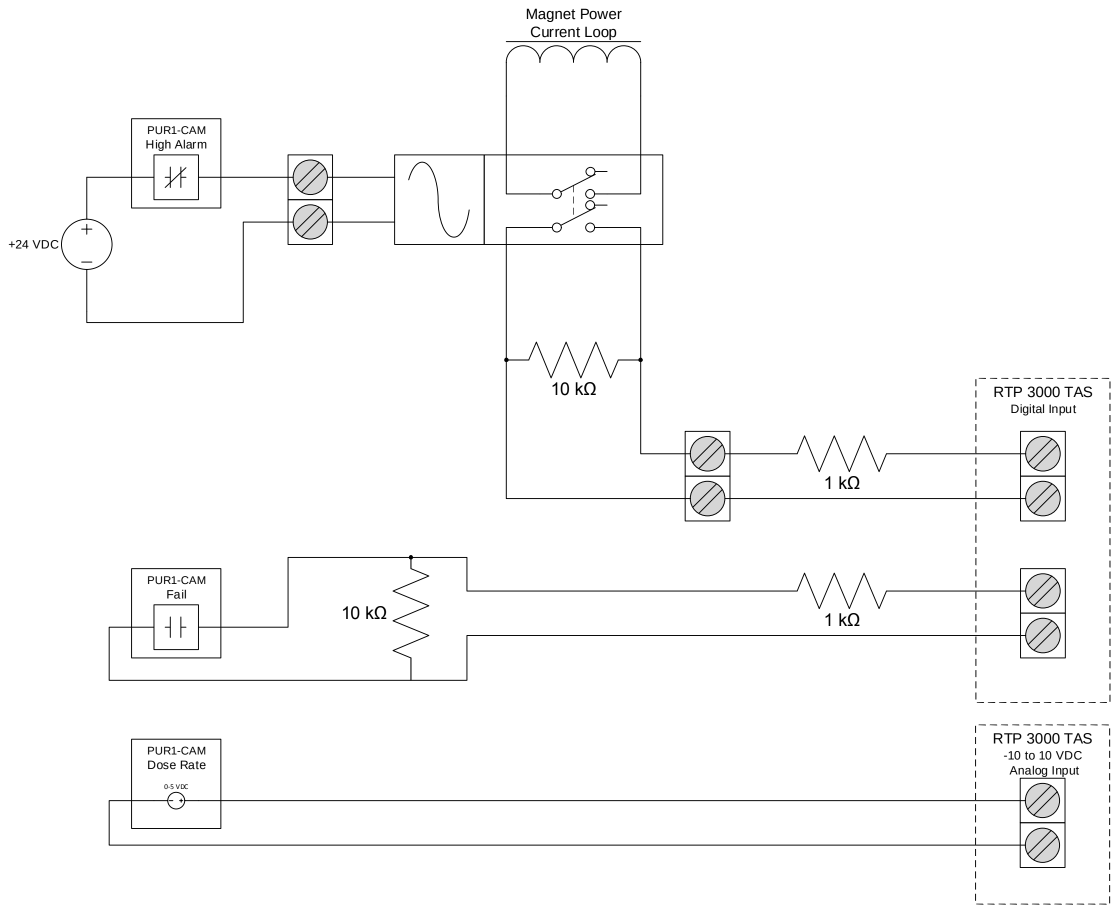


Figure 3-9 – CAM Logical Circuit

3.5 Negative Air Pressure Monitor

There will be two (2) negative air pressure monitors installed in the reactor room. The air pressure monitor will provide an input into the RCS to indicate the air pressure status. The negative air pressure monitor is detailed in Table 3-5.

Table 3-5 – Negative Air Pressure Monitor Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Digihelic® Differential Pressure Controller	Dwyer	Series DH3	2	PUR1-NEG-AIR-ADJ PUR1-NEG-AIR-OUT

Purdue University will provide cabling from the negative air pressure monitor to the RPCS termination blocks. The pressure controllers use a standard 15-pin, male, high density D-Sub connector. Table 3-6 shows the pinout of the manufacturer provided cable. The I/O cabling will

connect to intermediate terminal blocks before passing to the corresponding RTP 3000 TAS digital input termination module.

Table 3-6 – Negative Air Pressure Cable Detail

Function	15 PIN Connector Terminal	Cable Color
12-24 VAC/VDC Power	1	Brown
12-24 VAC/VDC Power	6	Yellow
4-20mA XMTR Output -	2	Black
4-20mA XMTR Output +	11	Red
SP1 Relay N/O	12	Vilolet
SP1 Relay Com	13	Grey
SP1 Relay N/C	14	White
SP2 or Alarm Relay N/O	15	Blue
SP2 or Alarm Relay Com	10	Green
SP2 or Alarm Relay N/C	5	Orange

3.5.1 Negative Air Pressure Logical Circuit

The negative air pressure monitor will pass one dry contact digital output to the RCS. This will indicate whether the air pressure is within the limits set by Purdue. See Figure 3-10 for a diagram of the negative air pressure logical circuit.

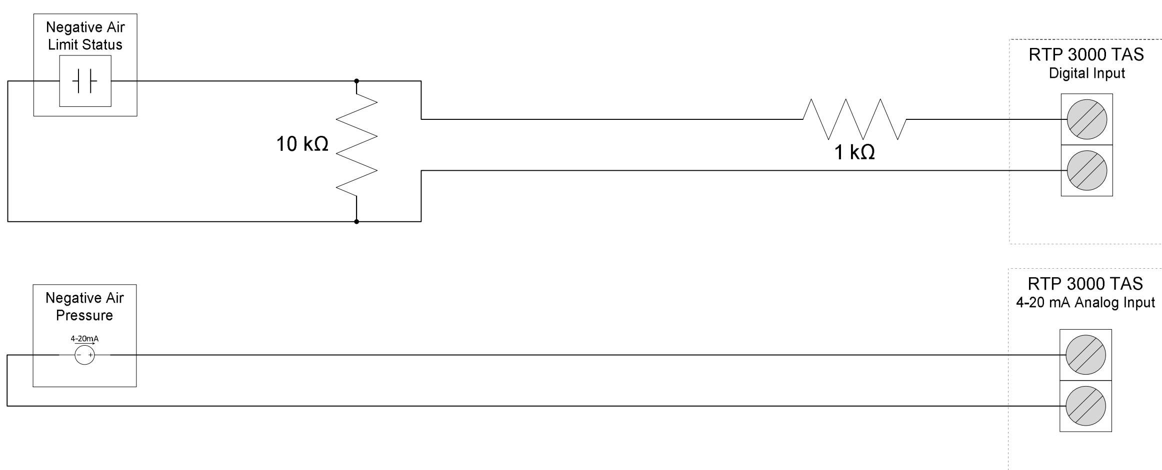


Figure 3-10 – Negative Air Pressure Logical Circuit

3.6 Reactor Water Makeup

Reactor water makeup consists of a water pump, water chiller, and a water chemistry monitor. The water makeup components are detailed in Table 3-7.

Table 3-7 – Water Makeup Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
Water process pump	Existing	N/A	1	PUR1-MU-PUMP
Water process chiller	Existing	N/A	1	PUR1-MU-CHILL
Water chemistry monitor, composed of two chemistry sensors providing conductivity, temperature and pH.	Rosemount	See Section 3.6.3.1	1	PUR1-MU-CHEM

3.6.1 Water Process Pump

The water pump will provide a digital output indicating the state of the device. The RCS system will have control of the HVAC system by switching on or off Relay K202. This is accomplished by utilizing the Water Process Pump Power switch on the operator console or the computer interface. See Figure 3-11 for a diagram of the Water Process Pump logical circuit.

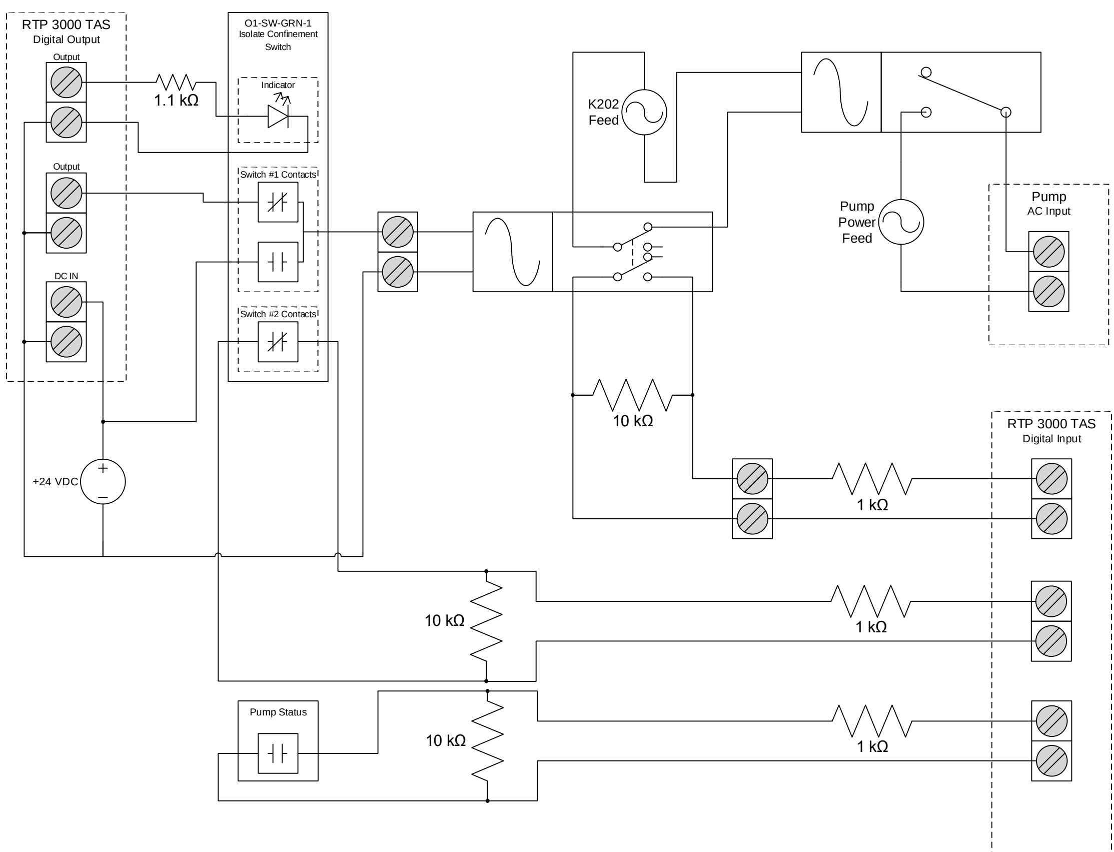


Figure 3-11 – Water Process Pump Logical Circuit

3.6.2 Water Process Chiller

The water chiller provides a digital output indicating whether or not it is currently running. Additionally, a “Chiller Ready” signal will be sent to the RCS via a 240VAC relay (see section 2.17.2). The RCS system will have control of the chiller by switching on or off Relay K203. This is accomplished by utilizing the Chiller Power switch on the operator console or the computer interface. See Figure 3-12 for a diagram of the Water Process Chiller logical circuit.

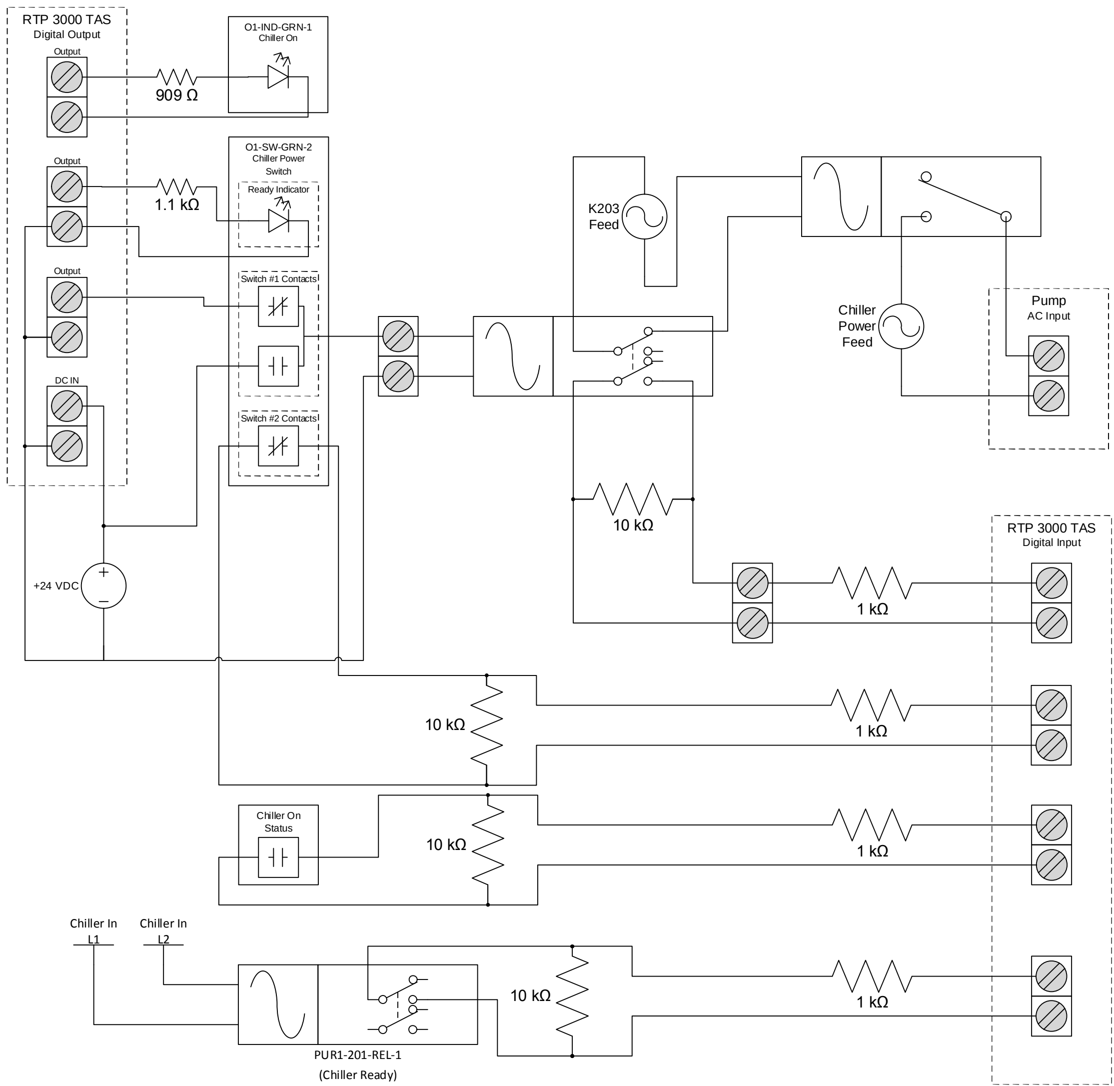


Figure 3-12 – Water Process Chiller Logical Circuit

3.6.3 Water Chemistry Monitor

The water chemistry monitor will include an analyzer and two (2) water chemistry sensors. These will be used to monitor the upstream and downstream water conductivity and temperature. The water chemistry hardware is detailed in Table 3-8 below.

Table 3-8 – Water Chemistry Detail

Device Description	Manufacturer	Part Number	Quantity	Device Name(s)
56 Advanced Dual Sensor Analyzer	Rosemount	56-03-20-30-DP	1	E2-MU-CHEM
400VP Conductivity probe with temperature measurement	Rosemount	400VP-11	2	MU-CHEM-UP MU-CHEM-DOWN

The chemistry probes attach to the analyzer using their included Rosemount 23747-11 cables. The analyzer will then send 4-20 mA signals for temperature and conductivity to the RCS. Figure 3-13 shows the output wiring terminations to the 56 main PCB of the Rosemount analyzer.

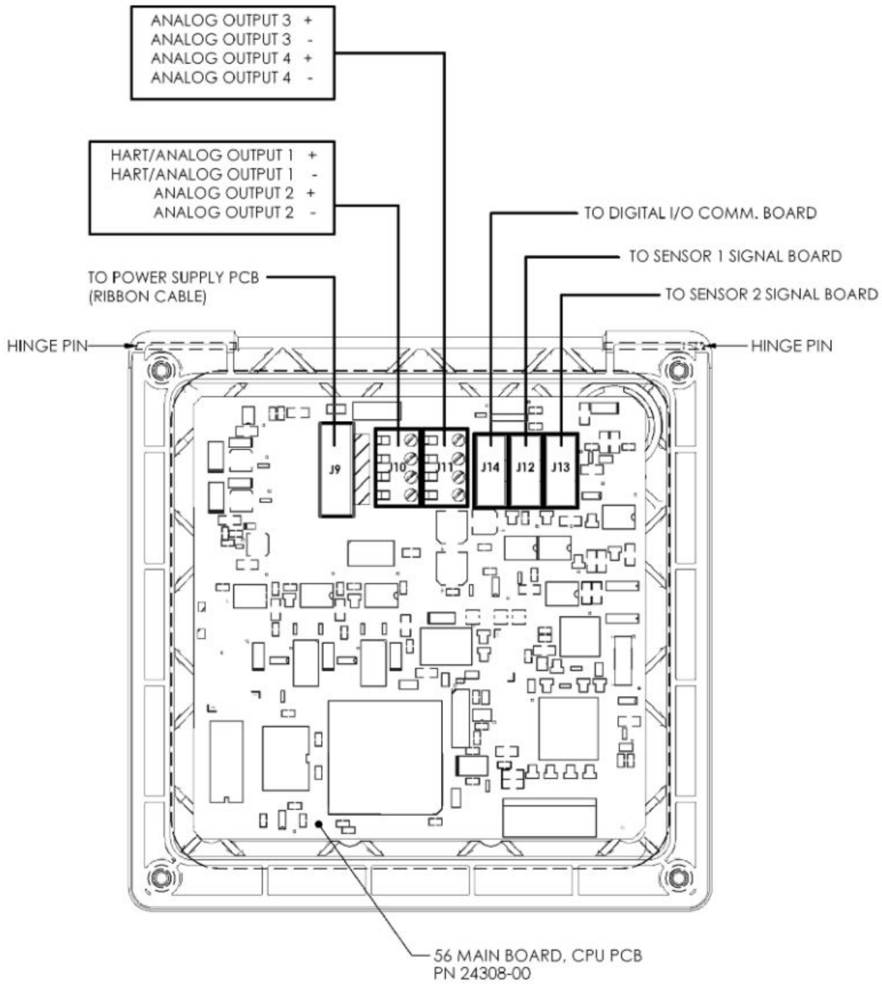


Figure 3-13 – Rosemount 56 Output Terminations

3.6.3.1 Rosemount Analyzer Mounting

The Rosemount Analyzer will be panel mounted per the manufacturer's specification. The panel cutout required and a diagram for securing the analyzer in the panel is shown in Figure 3-14. The analyzer mounting location is defined in Table 3-9.

Table 3-9 – Rosemount 56 Analyzer Mounting Location

Device Name	Mounting Panel Name	Location
E2-MU-CHEM	E2-PNL-10U-1	PUR1-CAB-E2

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

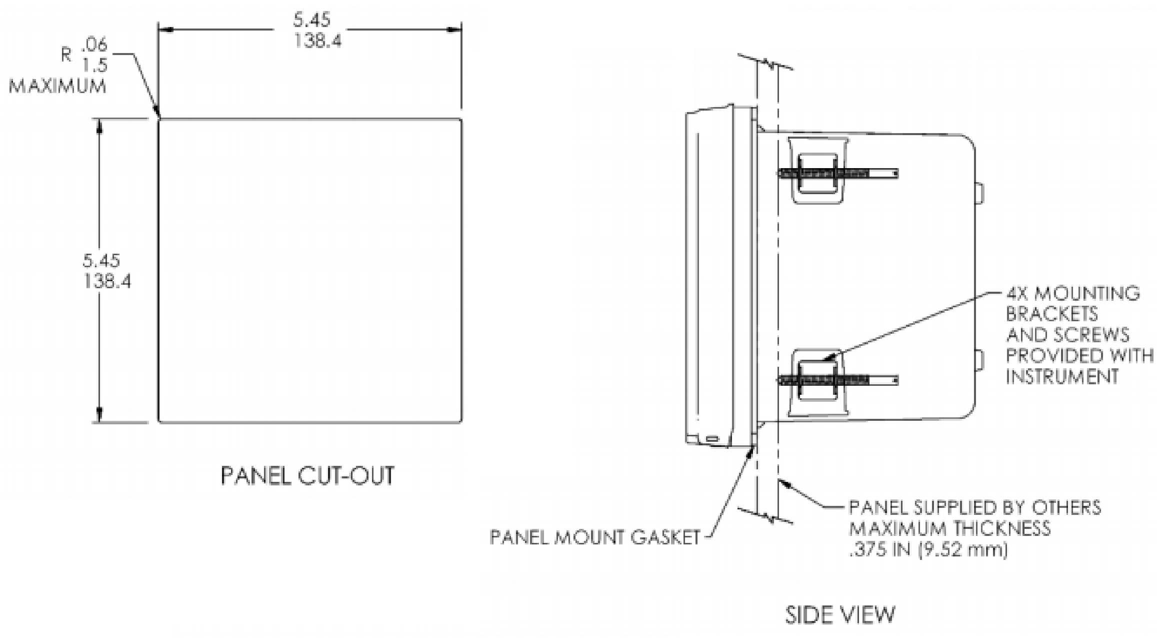


Figure 3-14 – Rosemount 56 Analyzer Mounting

3.6.3.2 Water Chemistry Logical Circuit

The Rosemount 56 will pass four (4) 4-20 mA analog output signals to the RCS. These will represent the upstream and downstream water conductivity and temperature readings. See Figure 3-15 for a diagram of the negative air pressure logical circuit.

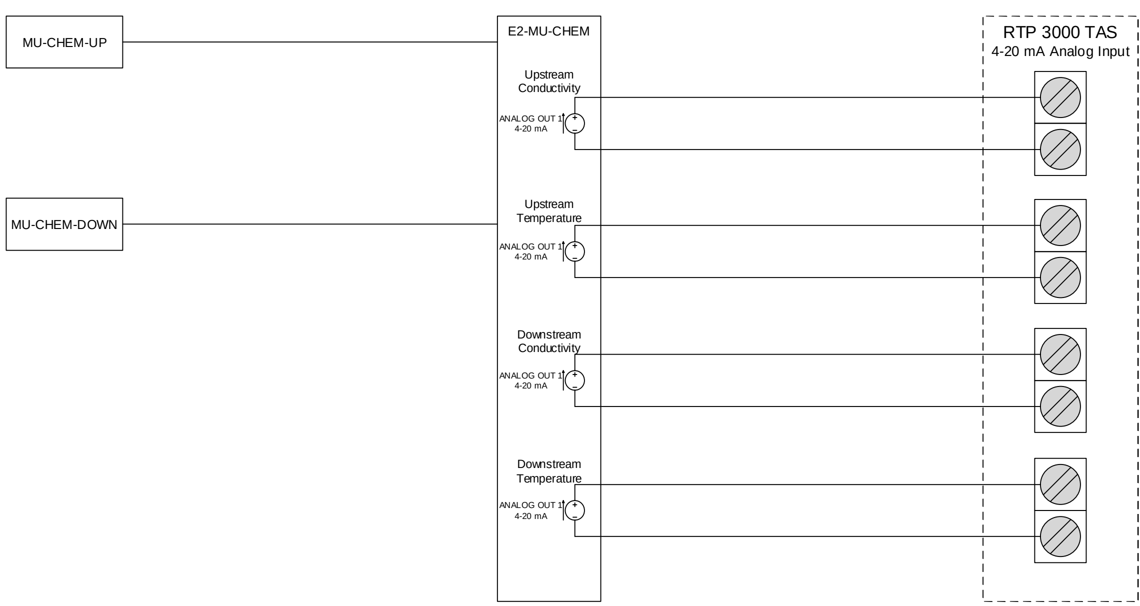


Figure 3-15 – Water Chemistry Logical Circuit

3.7 Power Conditioning System

The RPCS replacement will include two (2) new uninterruptable power supply (UPS) units and these will comprise the RPCS power conditioning system. The UPS units are detailed in Table 3-10.

Table 3-10 – UPS Detail

<table>
<tr><th>Device Description</th><th>Manufacturer</th><th>Part Number</th><th>Quantity</th><th>Device Name(s)</th></tr>
<tr><td>SmartPro 120V 3kVA 2.88kW Line-Interactive Sine Wave UPS, 4U 2-Post Reduced-Depth Rackmount, Extended Run, SNMPWEBCARD Option</td><td>Tripp-Lite</td><td>SMART3000CRMXL</td><td rowspan="2">2</td><td rowspan="2">E2-UPS-1
E2-UPS-2</td></tr>
<tr><td>External 48V 4U Rack/Tower Battery Pack for select UPS Systems</td><td>Tripp-Lite</td><td>BP48V48RT4U</td></tr>
</table>

3.7.1.1 UPS Mounting

The UPS units will be mounted using the manufacturer’s 19” rack mount kit. They will be installed in the cabinet listed in Table 3-11.

Table 3-11 – UPS Mounting Location

Device Name	Location
E2-UPS-1 E2-UPS-2	PUR1-CAB-E2

For a detailed configuration of the cabinets, please refer to the drawings in Appendix A.

3.7.1.2 UPS Circuit Theory

The UPS units communicate with the RCS using TCP/IP using SNMP. Therefore, there is only one data connection to each UPS. To see the Ethernet connections, see PUR1-HDD-001-013.

To isolate input power between the RCS and RPS, the two UPS units will be designated for one system each.

Table 3-12 – UPS Output Designation

Device Name	Power Provided To:
E2-UPS-1	RCS
E2-UPS-2	RPS

3.8 House Alarm

The RPCS will have control of the building House Alarm as a safety measure. The RPCS controls the alarm with a new relay controlled by the House Alarm switch on the operator

console or through the RPCS computer interface. See Figure 3-16 for a diagram of a House Alarm logical circuit.

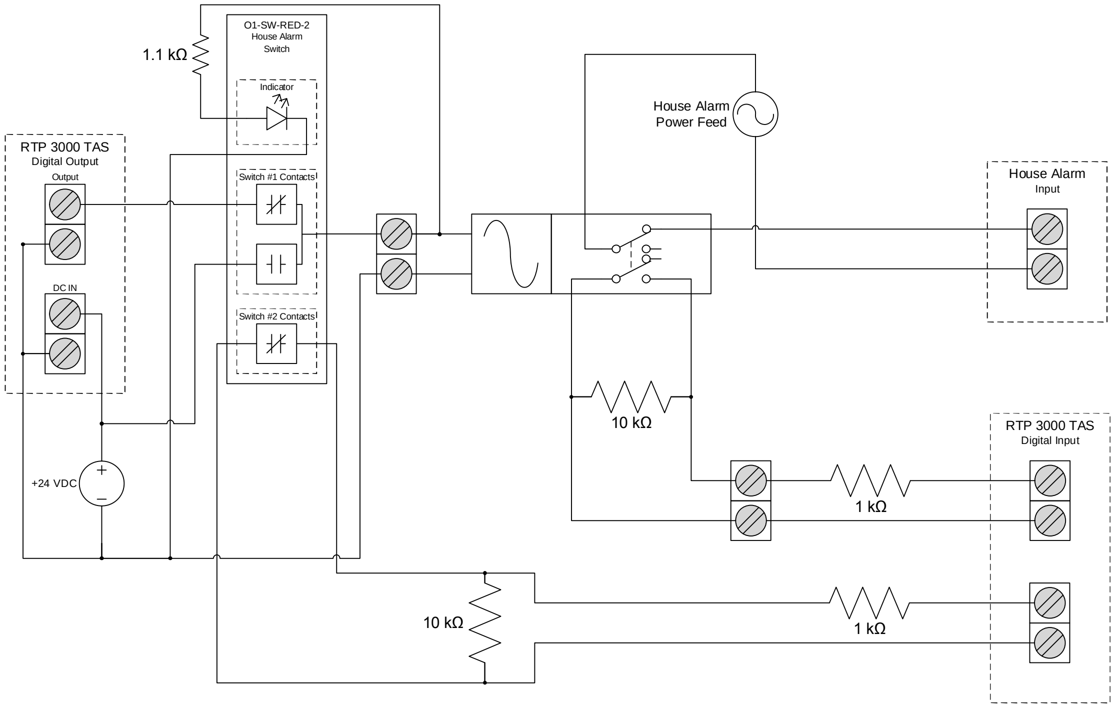


Figure 3-16 – House Alarm Logical Circuit

In addition to the circuit above, there is a Test Circuit installed for both the House Alarm and Control Room Alarm (see Figure 3-17). This allows both of the indicators to be tested without activating the alarms. The circuit is installed between the 24 VDC return line and the alarm control relay.

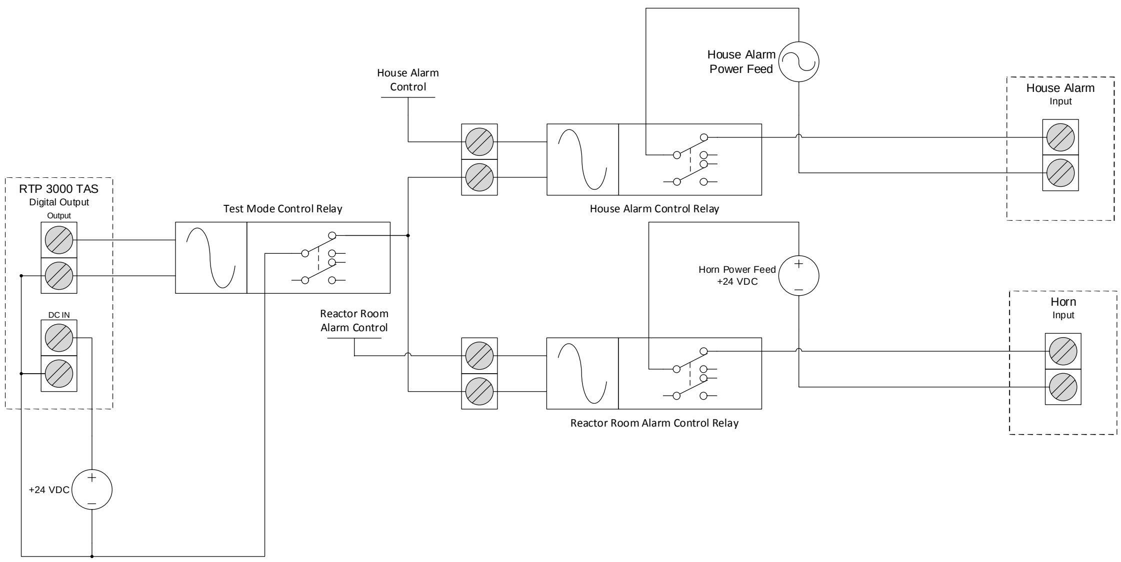


Figure 3-17 – Test Mode Logical Circuit

3.9 Drive Systems

The drive systems can be seen in the original plant drawings 700236-1041, 700237-1040, 700290-1044, and 700307-1045. Additionally, the internal cable connections can be seen in PUR1-HDD-001-11. The figures below depict sample logical circuits of the various I/O signals of the drive systems.

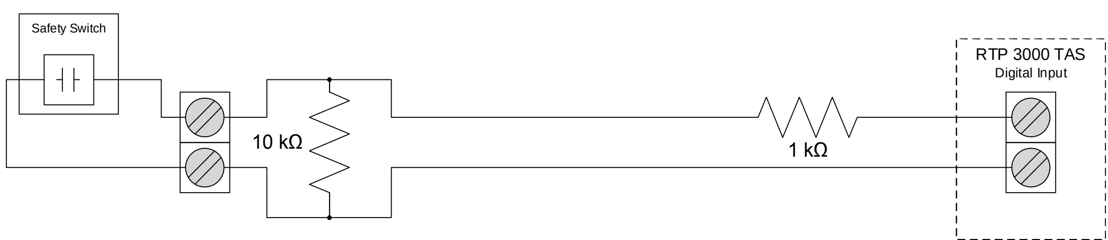


Figure 3-18 – Safety Switch Logical Circuit

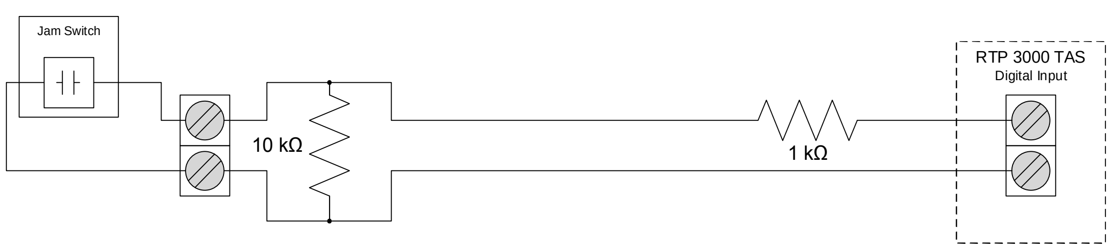


Figure 3-19 – Jam Switch Logical Circuit

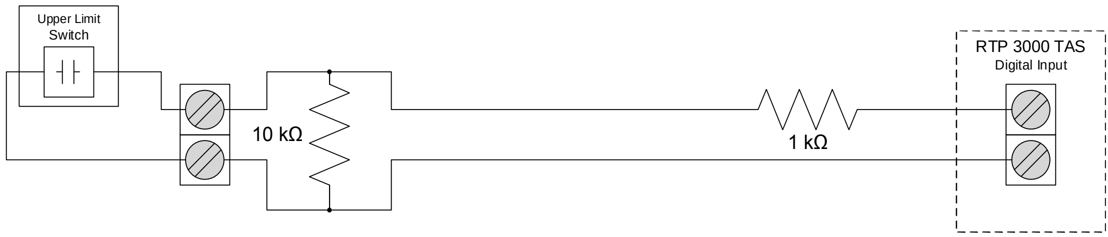


Figure 3-20 – Upper Limit Switch Logical Circuit

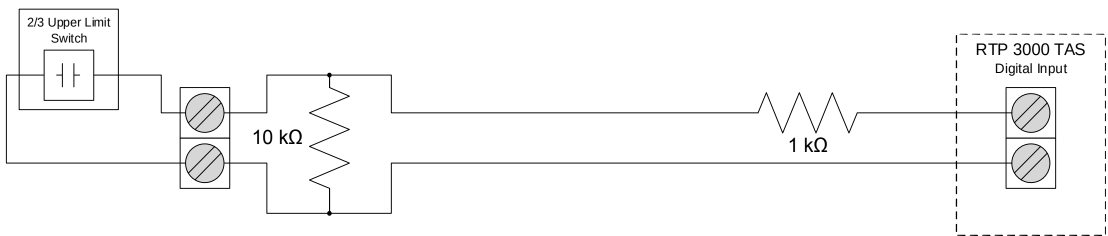


Figure 3-21 – 2/3 Upper Limit Switch Logical Circuit

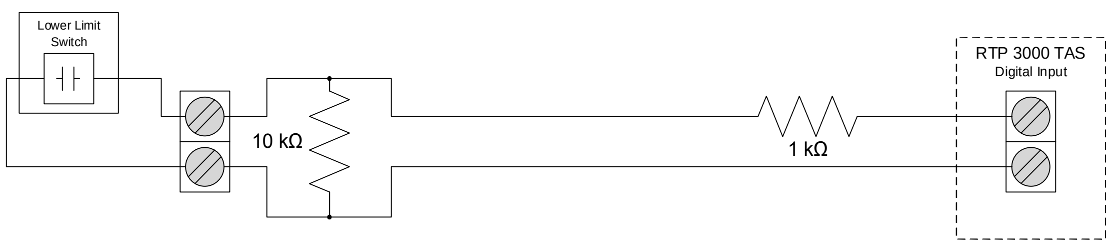


Figure 3-22 – Lower Limit Switch Logical Circuit

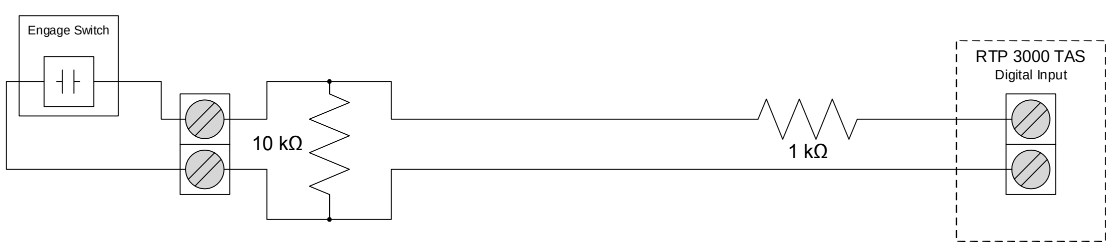


Figure 3-23 – Engage Switch Logical Circuit

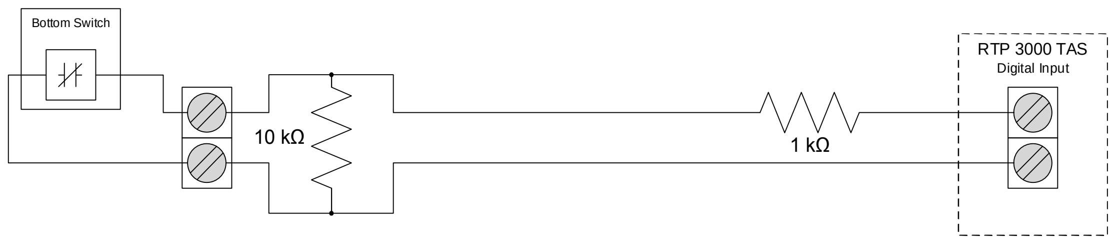


Figure 3-24 – Bottom Switch Logical Circuit

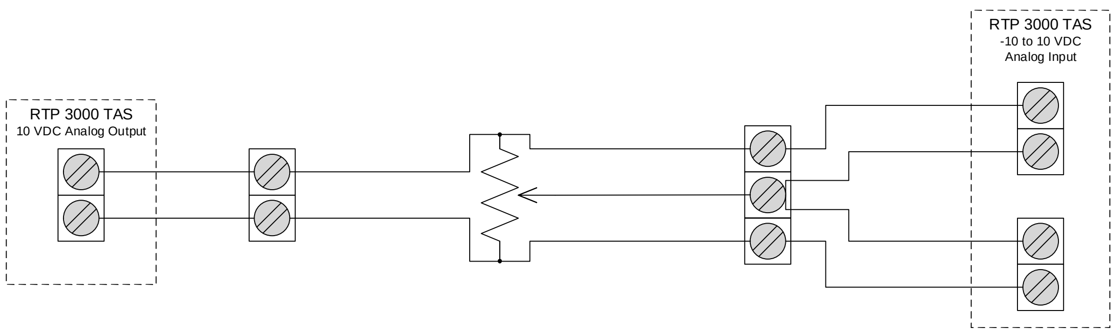


Figure 3-25 – Helipot Positioning Logical Circuit

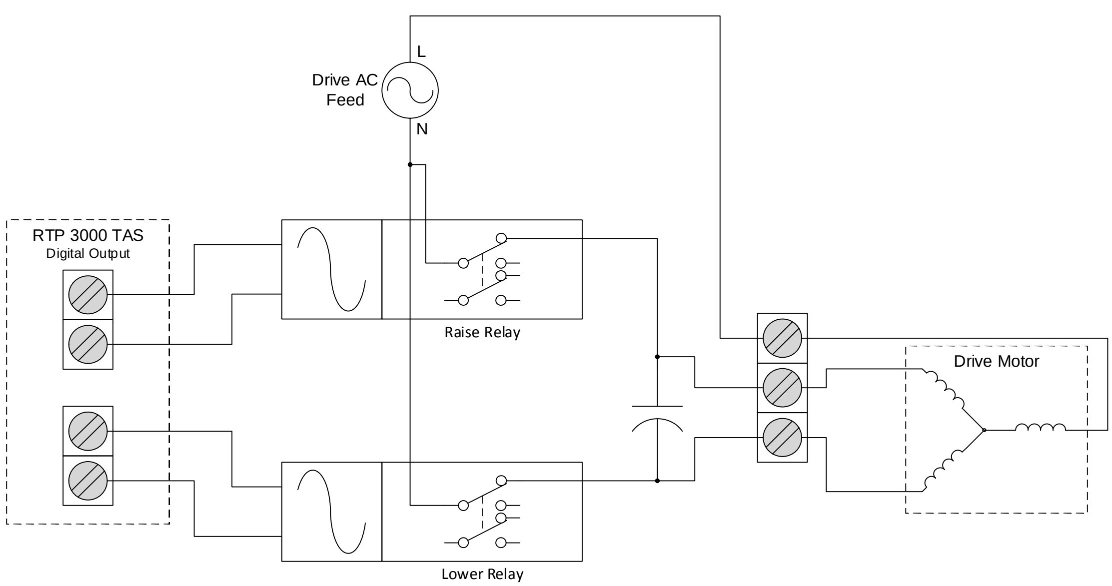


Figure 3-26 – Raise/Lower Drive Logical Circuit

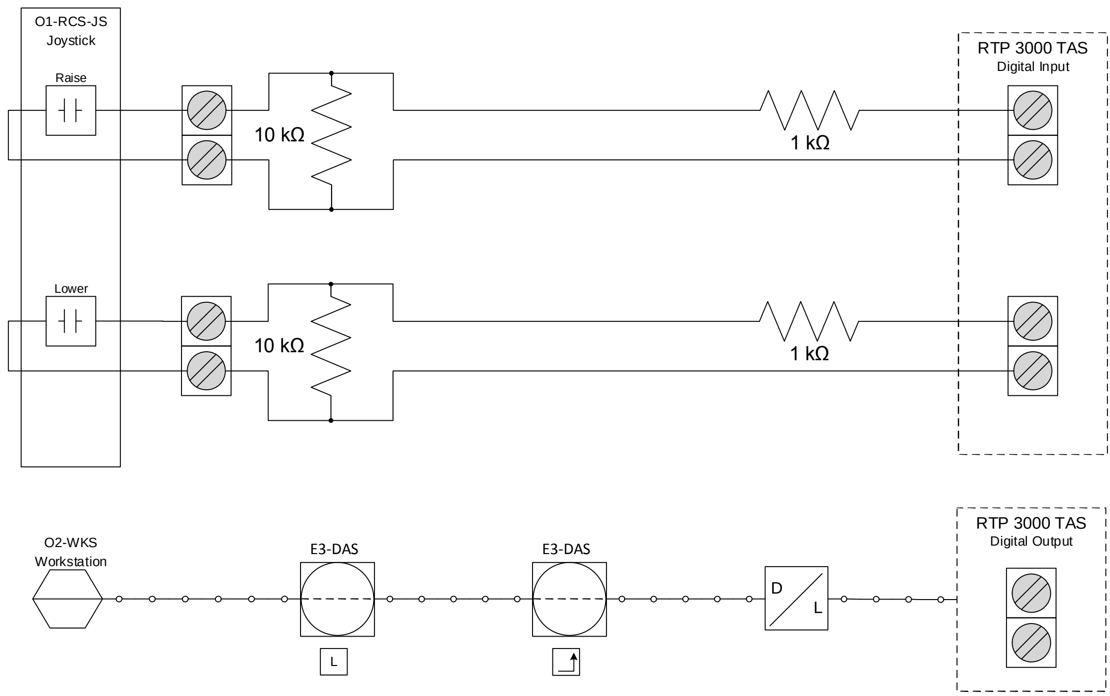


Figure 3-27 – Raise/Lower Control Logical Circuit

Appendix A Drawings

Appendix A contains all the drawings associated with the project. Electronic copies of the drawings are included as Microsoft Visio (.vsd or .vsdx) or Portable Document Format (.pdf) files named as indicated below.

PUR1-HDD-001-01 – Operator Console Layout Rev 2.vsdx
- Provides the overview layout of the operator console upper front, lower front, and rear sections.

PUR1-HDD-001-02 – Operator Console Detail Rev 3.vsdx
- Provides the detailed layout of the operator console racks individually and with dimensions.

PUR1-HDD-001-03 – Cabinet Layout Overview Rev 2.vsdx
- Provides the overview equipment cabinet layout with a front and rear view of all four equipment cabinets.

PUR1-HDD-001-04 – Cabinet Layout Detail Rev 2.vsdx
- Provides the detailed layout of the each equipment rack individually and with dimensions.

PUR1-HDD-001-05 – RTP Chassis Overview Rev 0.vsdx
- Provides the detailed view of the RTP chassis including RTP I/O cards and RTP chassis components.

PUR1-HDD-001-06 – SCI-PDU-24VDC Detail Rev 0.vsdx
- Provides the detailed layout of the 24VDC power supplies and distribution.

PUR1-HDD-001-11 – Drive System Wiring Diagrams Rev 2.vsdx
- Provides the internal pinout and wiring of the existing drive systems. These are an updated version of the PUR1 drawings 7003441222, 7003431223, 7003421224, and 7003411225.

PUR1-HDD-001-12 – Drive System Termination Blocks Rev 2.vsdx
- Provides the detailed layout of the termination blocks used to land the cables from the drive systems.

PUR1-HDD-001-13 Network Cabling Rev 1.vsdx
- Provides cabling diagram for all Ethernet cables.

PUR1-HDD-001-14 Power Cabling Rev 1.vsdx
- Provides cabling diagrams of the power input from AC and DC sources to all associated RCS and RPS hardware.

PUR1-HDD-001-15 Operator Console Wiring Rev 1.vsdx
- Provides cabling diagrams for all hardware installed in the operator console.

PUR1-HDD-001-16 RPS Wiring Rev 3.vsdx
- Provides cabling diagrams for all hardware associated with the RPS.

PUR1-HDD-001-17 RCS DAS Wiring Rev 3.vsdx
- Provides cabling diagrams for all immediate input and output connections to and from the RCS DAS hardware.

PUR1-HDD-001-18 Panel Drill Drawings Rev 2.vsdx

- Provides drill drawings for all plates needing modifications for mounting.

DWK 250 Arrangement Diagram P-1680001 G11, P11 ed1.pdf

- Provides detailed diagram the Mirion DWK 250 (Channel 1).

DAK 250-g Arrangement Diagram P-1680002 G11, P11 ed1.pdf

- Provides detailed diagram the Mirion DAK 250-g (Channel 2).

DAK 250-g Arrangement Diagram P-1680003 G11, P11 ed1.pdf

- Provides detailed diagram the Mirion DAK 250-g (Channel 3).

DGK 250 Arrangement Diagram P-1680004 G11, P11 ed1.pdf

- Provides detailed diagram the Mirion DGK 250 (Channel 4).

MT_RMS_MGPI HuB_Block Diagrams_all4channels_Purdue_20160331.pdf

- Provides block diagrams of all four Mirion detector channels.

Channel 1 Block Diagram PJ0000396 P21 eD1.pdf

- Provides block diagram of Mirion detector channel 1.

Channel 2 Block Diagram PJ0000396 P22 eD1.pdf

- Provides block diagram of Mirion detector channel 2.

Channel 3 Block Diagram PJ0000396 P23 eD1.pdf

- Provides block diagram of Mirion detector channel 3.

Channel 4 Block Diagram PJ0000396 P24 eD1.pdf

- Provides block diagram of Mirion detector channel 4.

Appendix B Equipment List with Specifications

Appendix B is located on the first sheet of the file noted below. This sheet contains all detailed specifications for all hardware included in the system.

(See file Appendix B and C – Equipment Data (Rev 3).xlsx)

The following table shows the Appendix B workbook sheets and the corresponding description for the RPCS.

Table 3-13 – Appendix B and C – Equipment Data (Rev 3).xlsx details

Workbook Sheet Name	Sheet Description
Appendix B – Equipment List	Lists all hardware included in the RPCS project
Appendix B – Matrix	This matrix indicates the drawings and sheet numbers associated with each component.

Appendix C Equipment List by Location

Appendix C displays all of the equipment for the RPCS replacement project sorted by the equipment container.

The following table shows the Appendix C workbook sheets and the corresponding container description for the RPCS.

Table 3-14 – Appendix B and C – Equipment Data (Rev 3).xlsx details

Workbook Sheet Name	Location Description
Appendix C – Equipment Cabinets	Consists of the four 35U cabinets in the reactor room
Appendix C – Operator Console	Consists of the three cabinets and desktop of the operator console
Appendix C – Process System Box	Junction box containing cabling terminations for water process system.
Appendix C – Reactor Room	Reactor Room, not including the operator console, equipment cabinets, or process system box.
Appendix C – Hallway	Hallway immediately outside reactor room.

Appendix D Recommended Spare Parts List

The following table (Table 3-15) lists the spare parts recommended for the Purdue RPCS. The spare parts are sorted by Manufacturer.

Table 3-15 – Recommended Spare Parts

Manufacturer	Part Number	Description	Recommended Quantity	Comments
Acopian	LMR17882	Rack Mount Current Source 0-100mA, 30 V max.	1	Current lead time 8 weeks.
Ametek	NT2-24D	Horn, 88 dB @ 10 ft., 16 field selectable tones, volume control, suitable for NEMA 4 and 4X	1	Current lead time 6-8 weeks.
APEM	Q22F1BXXG24E	LED INDICATOR, 22MM, FLUSH, 24VDC, IP67, GREEN	1	Typically ships from stock.
APEM	Q22F1BXXR24E	LED INDICATOR, 22MM, FLUSH, 24VDC, IP67, RED	1	Typically ships from stock.
Dell	5810	Precision Workstation T5810	1	Current lead time 2 weeks.
ETI Systems	J50-IG02-SMB	Two Switch Joystick, single-axis, hand-grip, spring return, rubber boot, panel mount	1	Current lead time 8-10 weeks. Spare joystick will ship with system.
NKK	LB15WKW01-5F24-JF	Illuminated Momentary Pushbutton Switch, 22mm, Green	1	Current lead time 4-6 weeks.
NKK	LB26WKW01-5C24-JC	Illuminated Pushbutton Switch, 22mm, RED	1	Current lead time 4-6 weeks.
NKK	LB26WKW01-5F24-JF	Illuminated Pushbutton Switch, 22mm, Green	1	Current lead time 4-6 weeks.
N-Tron	1005TX	5-port Industrial Gigabit Ethernet Switch	1	Typically ships from stock.

Manufacturer	Part Number	Description	Recommended Quantity	Comments
Panasonic	HC2-HL-DC24V-F	Electromechanical Relay 24VDC 650Ohm 7A DPDT (27.2x20.8x35.2)mm Plug-In General Purpose Relay	3	Typically ships from stock.
Phoenix Contact	2866747	DIN rail power supply unit 24 V DC/3.5 A, primary-switched mode, 1-phase.	1	Used in SC-PDU-24VDC. Typically ships from stock.
RTP Corp.	3000ACPWR	115 / 230 VAC Power Supply Module	1	Current lead time 12 weeks.
RTP Corp.	3122	SIL-3 16-Channel 16 Bit Analog Output Card, -10 to +10 or 0 to 10 volts	1	Current lead time 12 weeks.
RTP Corp.	3139	SIL-3 24-Channel, Fault Detecting Digital Output Card, 24 VDC sourcing (breaks the positive)	1	Current lead time 12 weeks.
RTP Corp.	3000/01	RTP 3000 TAS Chassis Processor	1	Current lead time 12 weeks.
RTP Corp.	3000/06	RTP 3000 TAS Node Processor	1	Current lead time 12 weeks.
RTP Corp.	3099/21-101	SIL-3 Single Termination Module - 32 channel supervised digital input, 24 VDC	1	Current lead time 12 weeks.
RTP Corp.	3099/21-102	SIL-3 Single Termination Module - 32 channel voltage input	1	Current lead time 12 weeks.
RTP Corp.	3099/21-207	SIL-3 Single Termination Module - 32 channel current input, supplies power from 300ma resettable fuses	1	Current lead time 12 weeks.
RTP Corp.	3099/22-100	SIL-3 Single Termination Module - 16 channel isolated analog output	1	Current lead time 12 weeks.
RTP Corp.	3099/52-001	SIL-3 Single Termination Module - 24 channel 24 VDC sourcing (breaks the positive)	1	Current lead time 12 weeks.
RTP Corp.	3126-X	SIL-3 32-Channel High Availability Isolated Digital Input Card	1	Current lead time 12 weeks.
RTP Corp.	3126-Y	SIL-3 32-Channel High Availability Single Ended AI Card, 16-bit A/D, 1KHz scan rate	1	Current lead time 12 weeks.
SiriusView	LCDR8U19-12	19” LCD Rack Mount Monitor	1	Typically ships from stock.

Manufacturer	Part Number	Description	Recommended Quantity	Comments
Cooper Industries	Bussmann® type GDA-4A	Fuse, 5 x 20 mm, rated 4 A / 250 V	2	RTP Power Supply F3 Typically ships from stock.
Littlefuse	216010	Fuse, 5 x 20 mm, rated 10 A / 250 V	2	RTP Power Supply F4 Typically ships from stock.
Littelfuse or Wickmann	0665 001.HXSL or 37411000410	Fuse, Time Lag Sub Mini, rated 1 A / 250 V	5	RTP Power Supply FH1, RTP 3099/52-001 Typically ships from stock.

Appendix E Cable Connections

Appendix E contains three (3) sheets. They are defined in the table below.

(See file Appendix E –Cable Connections (Rev 3).xlsx)

Table 3-16 – Appendix E – Cable Connections (Rev 3).xlsx details

Workbook Sheet Name	Sheet Description
Appendix E – Type Definition	Defines the types of cables supplied for the RPCS replacement system
Appendix E – Cable List	Contains a table of cables sorted by cable number defining the individual cable terminations by device and port. This table also contains cable type and location information for each cable
Appendix E – Matrix	This matrix indicates the drawings and sheet numbers associated with each cable.

Appendix F Software List

Table 3-17 lists the operating system and third party software that will be installed on the RPCS workstation.

Table 3-17 – Third Party Software Detail

Software	Manufacturer	Version	Description
Adobe Reader	Adobe	11	Adobe Reader DC
Subversion	CollabNet	1.9.1	Subversion Server
Cygwin	Cygwin	2.852	Cygwin
Fortran Redistributables	Intel	11.1.070	Intel Fortran Redistributables
Windows 10	Microsoft	10	Windows 10 Professional
Office	Microsoft	2016	Microsoft Office 2013 Professional (Word, Excel, Access, etc.)
Visual Studio	Microsoft	2012	Microsoft Visual Studio 2012
SQL 2014 Express	Microsoft	2014	SQL Server
Open Access SDK	Progress	8.0	DataDirect ODBC 64bit drivers
NetSuite	RTP Corp.	9.0	RTP NetSuite 9.0
Crystal Reports	SAP AG	13.0.13	Crystal Reports For Visual Studio
R*TIME Server	Scientech	14.1	R*TIME Server 14
R*TIME Viewer	Scientech	4.10.8	R*TIME Viewer 4.10
Database Utility	Scientech	3.8.6	R*TIME Database Utility
Subversion GUI	Tortoise	1.9.1	TortoiseSVN Client
WinZip	WinZip	20.0	WinZip 20

Appendix G TCP/IP Host Names and Addresses

Appendix G contains a list of Hostnames and IP Addresses for the RPCS hardware using TCP/IP communication.

Table 3-18 – Hostname Detail

Hostname	IP Address	Description
O2_WKS_1	192.168.0.10	RPCS workstation Ethernet port 1
O2_WKS_2 (reserved)	192.168.1.10	RPCS workstation Ethernet port 2
LSD_WKS (reserved)	192.168.1.15	Reserved for large screen display workstation
E3_DAS_1	192.168.0.20	RTP3000 Controller
E3_DAS_2	192.168.0.21	RTP3000 Controller
E3-DAS (reserved)	192.168.0.22	RTP3000 Controller
E3-DAS (reserved)	192.168.0.23	RTP3000 Controller
E2_UPS_1	192.168.0.30	UPS 1
E2_UPS_2	192.168.0.31	UPS 2

Appendix H Hardware Data Sheets

Manufacturer or vendor datasheets are included for the hardware included in the RPCS replacement system.

(See directory - Appendix H - Data Sheets)

The following list shows the subfolders contained in the directory of Appendix H - Data Sheets.

- Acopian
- Altech
- Ametek
- Apem
- Dell
- ENM
- ETI Systems
- Hammond Manufacturing
- L-com
- NKK
- N-Tron
- Panasonic
- Panduit
- Phoenix
- Ronan
- RTP 3000 TAS
- Tripp Lite
- Vishay Dale
- Yokogawa

Appendix I   I/O List

The RPCS I/O list contains information used to generate the R*TIME database. The workbook defines point names and descriptions for all hardware database points (points with physical inputs into the RTP I/O hardware) and soft database points (virtual points used in software algorithms). It contains the setpoints for alarming and defines input ranges. Additionally, where applicable it contains references to input and output devices and channels.

(See file Appendix I – RPCS IO List (Rev 3).xlsx)