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SYSTEM DESIGN SPEC FOR ROTARY MODE CORE SAMPLE
TRUCKS NO 2 & 3 & 4 PROGRAMMABLE LOGIC CONTROLLER

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7. Abstract

The system this document describes controls several functions of the Core Sample Truck(s) used to obtain nuclear waste samples from various underground storage tanks at Hanford. The system will monitor the sampling process and provide alarms and other feedback to insure the sampling process is performed within the prescribed operating envelope. The intended audience for this document is anyone associated with rotary or push mode core sampling.

This document describes the Alarm and Control logic installed on Rotary Mode Core Sample Trucks (RMCST) #2, 3, and 4. It is intended to define the particular requirements of the RMCST alarm and control operation (not defined elsewhere) sufficiently for detailed design to implement on a Programmable Logic Controller (PLC).

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**SYSTEM DESIGN SPECIFICATION
FOR ROTARY MODE
CORE SAMPLE TRUCKS 2, 3, AND 4
PROGRAMMABLE LOGIC CONTROLLER**

AUGUST 1995

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1.0 INTRODUCTION

1.1 PURPOSE

The system this document describes controls several functions of the Core Sample Truck(s) used to obtain nuclear waste samples from various underground storage tanks at Hanford. The system will monitor the sampling process and provide alarms and other feedback to insure the sampling process is performed in a safe manner.

1.2 SCOPE

This document describes the Alarm and Control logic installed on Rotary Mode Core Sample Trucks (RMCST) #2, 3, and 4. It is intended to define the particular requirements of the RMCST alarm and control operation (not defined elsewhere) sufficiently for detailed design to implement on a Programmable Logic Controller (PLC).

1.3 OVERVIEW

The taking of core samples from waste tanks at Hanford has been occurring for quite some time using Core Sample Truck (CST) #1. A safety issue was raised, some years ago, concerning the use of CST #1 because there was no way to determine the temperature of the drill bit during sampling. This was a concern because the possibility of the drill bit reaching a temperature that could ignite some of the waste/gases present in the tanks. To prevent this from happening, CST #1 is prohibited from operating in Rotary Mode and can only operate in Push Mode. This was done because CST #1 has no automatic interlocks to shut down operations if sampling operations are attempted outside of the prescribed envelope.

In order to resume rotary mode core sampling operations it was determined that a system to monitor CST operating parameters, provide alarms and, if necessary, automatic shut down of the CST. The primary operating parameters are Down Force, Drill RPM, Purge Gas Flow and pressure. The operating envelope/limitations are defined in the SARR, WHC-SD-WM-SARR-031, SAFETY ANALYSIS FOR PUSH-MODE AND ROTARY-MODE CORE SAMPLING. The first CST to implement this system was RMCST #2. The same system is also used on RMCST #3 and 4.

1.4 DEFINITIONS

CPU - Central Processing Unit (brain of PLC)
CST - Core Sample Truck
CSCM - Computer Software Configuration Management Plan
EPROM - Erasable Programmable Read Only Memory (firmware)

FIRMWARE - Software that resides in PROM or EPROM

GB - Grapple Box

I/O - Input/Output (to the PLC)

PLC - Programmable Logic Controller

PLC Software - The program resident in the PLC memory (EPROM) that, by monitoring the various inputs, actuates the outputs to implement the operational sequence.

RMCST - Rotary Mode Core Sample Truck

SARR - Safety Analysis Report Reference

SOV - Solenoid Operated Valve

SDS - System Design Specification

SR - Shielded Receiver

2.0 GENERAL DESCRIPTION

The RMCST has a drill rig mounted on a truck that can travel to different waste tank locations to drill and remove cores (samples) for laboratory analysis later. The Drill Rig Engine provides the motive force and controls for the Drill Rig. The Drill Rig head rotates and pushes/pulls the drill string components to acquire the sample.

The operational alarm logic monitors HI/LOW alarm contacts and implements the alarm sequence when an alarm contact actuates. The control logic allows the operation of SOV 14 through 17 (purge gas valves) and the hoist motor and its associated components, provided the proper interlocks are satisfied. If certain conditions (related to safety) occur, the PLC will shut off the drill rig engine.

2.1 PRODUCT PERSPECTIVE

The PLC is a completely self-contained component of the RMCST control system. Programming changes in the PLC require the use of vendor specific peripherals to make the change, print out the memory contents (in ladder logic form), and program an EPROM. The software is unique to this brand of PLC and can not be used on other systems. However, the same "logic" could be implemented on many other brands of PLC.

2.2 PRODUCT FUNCTIONS

The PLC system will monitor various switch and alarm inputs and actuate outputs based on the logic in firmware. For a detailed description see section 3.1 Functional Requirements. The following is a summary of these functions.

- Alarm (Strobe, Horn, Lights) Test
- Alarm Sequence (Strobe, Horn, Lights) control for:
 - Purge Gas High/Low Flow
 - Purge Gas High/Low Temperature
 - Hydrostatic Head Low Alarm
 - High RPM
 - High Down Force
 - Instrument Enclosure High/Low Temperature
 - Exhauster Shutdown
- Drill String Low Pressure Lights
- Shielded Receiver Pressure Light
- SOV 14-17 Control Logic
- Automatic Drill Rig Engine Shutoff
- Hoist Motor & Brake Control Logic
- Drill/Sample Change Mode Control

2.3 USER CHARACTERISTICS

The users of this system will be the RMCST Operators. The operators are trained on the operation of the CST and it's associated equipment. There is no need for specific training on the PLC use/operation.

2.4 GENERAL CONSTRAINTS

The system must be capable of being installed on a vehicle. Also, the system must be able to self-start and run with no user/operator input shortly after power is applied. Adherence to the National Electric Code, (NFPA 70) 1993 edition is required as specified by DOE Order 6430.1A GENERAL DESIGN CRITERIA.

2.5 ASSUMPTIONS AND DEPENDENCIES

It is assumed that 120 volt AC power is available to supply the PLC and that the PLC can handle 120 volt AC and 24 volt DC I/O signals. Also, the PLC will be placed in a protective enclosure with temperature control and no exposure to the weather.

3.0 SPECIFIC REQUIREMENTS

3.1 Functional Requirements

3.1.1 Alarm Sequence

The alarm sequence will have 3 major divisions: Initial Alarm, Alarm Acknowledged and Alarm Cleared. There may also be timers associated with the alarm logic. The state of the light tells the operator the alarm status:

- A fast flashing light will indicate an initial alarm condition that is not acknowledged by the operator. Unless otherwise stated, alarms in this state will also actuate the strobe light and horn.
- A steady light will indicate an alarm that has been acknowledged but the initial alarm condition still exists. No alarms in this state will actuate the strobe light or horn.
- A slow flashing light will indicate an alarm condition that is acknowledged by the operator, but has cleared. No alarms in this state will actuate the strobe light or horn.

A typical alarm sequence follows:

- The alarm sequence is started by the ALARM contact starting a timer (unless otherwise stated), in whatever mode. When the timer times out the alarm sequence will enter the Initial Alarm state. The horn and strobe turn on and the ALARM light flashes fast.
- When the operator pushes the ACKNOWLEDGE button the alarm sequence will enter the Alarm Acknowledged state. The horn and strobe turn off and the ALARM light goes on steady.
- When the ALARM condition clears the alarm sequence will enter the Alarm Clear state. The horn and strobe stay off and the ALARM light flashes slow.

At this point 2 things can occur: the ALARM condition can reoccur or the operator can RESET the alarm.

- If the ALARM condition reoccurs the alarm sequence will re-enter the Alarm Acknowledged state. The horn and strobe stay off and the alarm light goes on steady.
- If the operator pushes the RESET button the alarm sequence is ended; the ALARM light, horn, and strobe are off.

Note: Some alarms will be active during particular operating modes: while the drill string is rotating (rotary mode), during drill string pushing (push mode), during recovery of the sample (recovery mode) and a few alarms are active at all times. The PLC will be able to determine which mode the truck is in.

3.1.2 The Alarm Test Feature

If the operator presses the ALARM TEST button, the horn will sound, the strobe will light and all the alarm panel lights will illuminate.

3.1.3 Power On/Power Loss Requirements

The critical alarm counter/timers will "ride through" or ignore a power loss and restoration as though the power loss had not occurred. It is not required to perform any operations during the power loss. Loss of power to the PLC will cause the drill rig engine (if running) to turn off (via the normally energized K5 drill rig engine shutdown relay).

3.1.4 Initial Conditions

When power is initially applied the PLC will execute a diagnostic check of itself. Upon successful completion of the diagnostic the PLC will execute the logic in it's EPROM. If the PLC fails the diagnostic it halts operation. There are no alarms or alarm conditions to indicate if the PLC has failed it's self diagnostics.

3.1.5 Detailed Operational Alarm and Control Requirements

The following details the requirements for each alarm condition monitored. Most alarms have a time delay to ignore momentary nuisance trips. Most alarms are also only active during one particular mode. Some alarms have special features which are discussed individually below.

3.1.6 Purge Gas High Flow Alarm

The three PURGE GAS HIGH FLOW ALARM contacts will be summed in 2-out-of-3 logic which will start a 10 second timer if in rotary mode.

When the timer times out, the alarm sequence will enter Initial Alarm state. The horn and strobe actuate and the PURGE GAS HIGH FLOW alarm light flashes fast.

When the operator pushes the ACKNOWLEDGE button the alarm sequence will enter the Alarm Acknowledged state. The horn and strobe turn off and the PURGE GAS HIGH FLOW alarm light goes on steady.

When the alarm condition clears, the alarm sequence will enter the Alarm Cleared state. The horn and strobe stay off and the PURGE GAS HIGH FLOW alarm light flashes slow.

From the Alarm Cleared state, 2 things can occur: the alarm condition can reoccur or the operator can RESET the alarm.

- If the alarm condition reoccurs, the alarm sequences re-enters the Alarm Acknowledged state. The horn and strobe stay off and the PURGE GAS HIGH FLOW alarm light goes on steady.
- If the operator pushes the RESET button the alarm sequence will end. The horn and strobe stay off and the PURGE GAS HIGH FLOW alarm light is turned off.

3.1.7 Purge Gas Low Flow Alarm

The three purge gas meters alarm contacts will be summed in 2-out-of-3 logic which will start a 10 second timer, but only in rotary mode.

When the timer times out, the alarm sequence will enter Initial Alarm state. The horn and strobe actuate and the PURGE GAS LOW FLOW alarm light flashes fast.

When the operator pushes the ACKNOWLEDGE button the alarm sequence will enter the Alarm Acknowledged state. The horn and strobe turn off and the PURGE GAS LOW FLOW alarm light goes on steady.

When the alarm condition clears, the alarm sequence will enter the Alarm Cleared state. The horn and strobe stay off and the PURGE GAS LOW FLOW alarm light flashes slow.

From the Alarm Cleared state, 2 things can occur: the alarm condition can reoccur or the operator can RESET the alarm.

- If the alarm condition reoccurs, the alarm sequences re-enters the Alarm Acknowledged state. The horn and strobe stay off and the PURGE GAS LOW FLOW alarm light goes on steady.
- If the operator pushes the RESET button the alarm sequence will end. The horn and strobe stay off and the PURGE GAS LOW FLOW alarm light is turned off.

3.1.8 Purge Gas High Temperature Alarm

The alarm sequence is started by the PURGE GAS HIGH TEMP contact starting a 10 second timer if in rotary mode.

When the timer times out, the alarm sequence will enter Initial Alarm state. The horn and strobe actuate and the PURGE GAS HIGH TEMP alarm light flashes fast.

When the operator pushes the ACKNOWLEDGE button the alarm sequence will enter the Alarm Acknowledged state. The horn and strobe turn off and the PURGE GAS HIGH TEMP alarm light goes on steady.

When the alarm condition clears, the alarm sequence will enter the Alarm Cleared state. The horn and strobe stay off and the PURGE GAS HIGH TEMP alarm light flashes slow.

From the Alarm Cleared state, 2 things can occur: the alarm condition can reoccur or the operator can RESET the alarm.

- If the alarm condition reoccurs, the alarm sequences re-enters the Alarm Acknowledged state. The horn and strobe stay off and the PURGE GAS HIGH TEMP alarm light goes on steady.
- If the operator pushes the RESET button the alarm sequence will end. The horn and strobe stay off and the PURGE GAS HIGH TEMP alarm light is turned off.

3.1.9 Purge Gas Low Temperature Alarm

The alarm sequence is started by the PURGE GAS LOW TEMP ALARM contact starting a 10 second timer but only in rotary mode.

When the timer times out, the alarm sequence will enter Initial Alarm state. The horn and strobe actuate and the PURGE GAS LOW TEMP alarm light flashes fast.

When the operator pushes the ACKNOWLEDGE button the alarm sequence will enter the Alarm Acknowledged state. The horn and strobe turn off and the PURGE GAS LOW TEMP alarm light goes on steady.

When the alarm condition clears, the alarm sequence will enter the Alarm Cleared state. The horn and strobe stay off and the PURGE GAS LOW TEMP alarm light flashes slow.

From the Alarm Cleared state, 2 things can occur: the alarm condition can reoccur or the operator can RESET the alarm.

- If the alarm condition reoccurs, the alarm sequence re-enters the Alarm Acknowledged state. The horn and strobe stay off and the PURGE GAS LOW TEMP alarm light goes on steady.
- If the operator pushes the RESET button the alarm sequence will end. The horn and strobe stay off and the PURGE GAS LOW TEMP alarm light is turned off.

3.1.10 Cabinet Temperature Hi/Low Alarm

The alarm sequence is started by the CABINET TEMP HIGH contact or CABINET TEMP LOW ALARM contact starting a 10 second timer, in all modes.

When the timer times out, the alarm sequence will enter Initial Alarm state. The horn and strobe do not actuate and the CABINET TEMP HI/LOW alarm light flashes fast. If the CABINET TEMP HI/LO ALARM is not unacknowledged by the operator for 60 seconds, another timer will actuate the horn and strobe.

When the operator pushes the ACKNOWLEDGE button the alarm sequence will enter the Alarm Acknowledged state. The horn and strobe turn off and the CABINET TEMP HI/LOW alarm light goes on steady.

When the alarm condition clears, the alarm sequence will enter the Alarm Cleared state. The horn and strobe stay off and the CABINET TEMP HI/LOW alarm light flashes slow.

From the Alarm Cleared state, 2 things can occur: the alarm condition can reoccur or the operator can RESET the alarm.

- If the alarm condition reoccurs, the alarm sequence re-enters the Alarm Acknowledged state. The horn and strobe stay off and the CABINET TEMP HI/LOW alarm light goes on steady.
- If the operator pushes the RESET button the alarm sequence will end. The horn and strobe stay off and the CABINET TEMP HI/LOW alarm light is turned off.

3.1.11 Hydrostatic Head Low Flow Alarm

The alarm sequence is started by the HYDROSTATIC HEAD LOW FLOW ALARM contact starting a 5 second timer but only if SOV-16 is ON.

When the timer times out, the alarm sequence will enter Initial Alarm state. The horn and strobe actuate and the HYDROSTATIC HEAD LOW FLOW alarm light flashes fast.

When the operator pushes the ACKNOWLEDGE button the alarm sequence will enter the Alarm Acknowledged state. The horn and strobe turn off and the HYDROSTATIC HEAD LOW FLOW alarm light goes on steady.

When the alarm condition clears, the alarm sequence will enter the Alarm Cleared state. The horn and strobe stay off and the HYDROSTATIC HEAD LOW FLOW alarm light flashes slow.

From the Alarm Cleared state, 2 things can occur: the alarm condition can reoccur or the operator can RESET the alarm.

- If the alarm condition reoccurs, the alarm sequences re-enters the Alarm Acknowledged state. The horn and strobe stay off and the HYDROSTATIC HEAD LOW FLOW alarm light goes on steady.
- If the operator pushes the RESET button the alarm sequence will end. The horn and strobe stay off and the HYDROSTATIC HEAD LOW FLOW alarm light is turned off.

The alarms described above are used only on RMCST #2. The same "logic" is used on RMCST #3 and #4 but the flow sensors have been replaced by a single pressure switch that trips at a purge gas pressure of 60 PSI falling. This signal is then fed into the alarm sequence described above with the signal name (HYDROSTATIC HEAD LOW FLOW ALARM) and alarm light name plates changed to indicate a loss of purge gas pressure. Future plans include modifying RMCST #2 to match RMCST #3 and #4.

3.1.12 High RPM Alarm

The alarm sequence is started by the HIGH RPM ALARM contact starting a 10 second timer.

When the timer times out, the alarm sequence will enter Initial Alarm state. The horn and strobe actuate and the HIGH RPM alarm light flashes fast.

When the operator pushes the ACKNOWLEDGE button the alarm sequence will enter the Alarm Acknowledged state. The horn and strobe turn off and the HIGH RPM alarm light goes on steady.

When the alarm condition clears, the alarm sequence will enter the Alarm Cleared state. The horn and strobe stay off and the HIGH RPM alarm light flashes slow.

From the Alarm Cleared state, 2 things can occur: the alarm condition can reoccur or the operator can RESET the alarm.

- If the alarm condition reoccurs, the alarm sequences re-enters the Alarm Acknowledged state. The horn and strobe stay off and the HIGH RPM alarm light goes on steady.
- If the operator pushes the RESET button the alarm sequence will end. The horn and strobe stay off and the HIGH RPM alarm light is turned off.

3.1.13 High Downward Force Alarm

The alarm sequence is started by the HIGH DOWNWARD FORCE ALARM contact starting a 5 second timer but only in rotary mode.

When the timer times out, the alarm sequence will enter Initial Alarm state. The horn and strobe actuate and the HIGH DOWNWARD FORCE alarm light flashes fast.

When the operator pushes the ACKNOWLEDGE button the alarm sequence will enter the Alarm Acknowledged state. The horn and strobe turn off and the HIGH DOWNWARD FORCE alarm light goes on steady.

When the alarm condition clears, the alarm sequence will enter the Alarm Cleared state. The horn and strobe stay off and the HIGH DOWNWARD FORCE alarm light flashes slow.

From the Alarm Cleared state, 2 things can occur: the alarm condition can reoccur or the operator can RESET the alarm.

- If the alarm condition reoccurs, the alarm sequences re-enters the Alarm Acknowledged state. The horn and strobe stay off and the HIGH DOWNWARD FORCE alarm light goes on steady.
- If the operator pushes the RESET button the alarm sequence will end. The horn and strobe stay off and the HIGH DOWNWARD FORCE alarm light is turned off.

3.1.14 Drill String Low Pressure Light

When the DRILL STRING LOW PRESSURE contact actuates 3 lights will illuminate. These lights are located at each end of the platform and one is on the Instrument Enclosure. The horn and strobe will not actuate.

3.1.15 SOV 14-17 Control Logic

The purge gas control valves SOV14 through SOV17 are controlled by the PURGE GAS ON/OFF, PRESSURIZE SHIELDED RECEIVER ON/OFF, PRESSURIZE DRILL STRING ON/OFF and MODE: DRILL/SAMPLE Δ [SAMPLE CHANGE] switches. Only valid switch combinations will allow a SOV to be turned ON or OFF. If an invalid switch combination occurs, nothing will happen and the unlit SOV lights will flash indicating to the operator an invalid switch combination exists. The valid switch combinations are listed in the following table.

VALID SWITCH COMBINATIONS FOR THE SAMPLE TRUCK								
SWITCH NAME & POSITION				VALVE & ACTION				
PURGE GAS	PRESS SR	PRESS DS	MODE	SOV14	SOV15	SOV16	SOV17	ACTION
OFF	OFF	OFF	DRILL	OFF	OFF	OFF	OFF	VENT GB
ON	OFF	OFF	DRILL	ON	OFF	OFF	ON	VENT SR
OFF	OFF	OFF	SAMPLE Δ	OFF	OFF	OFF	ON	VENT SR
OFF	ON	OFF	SAMPLE Δ	OFF	ON	OFF	OFF	VENT GB
OFF	OFF	ON	SAMPLE Δ	OFF	OFF	ON	ON	VENT SR
OFF	ON	ON	SAMPLE Δ	OFF	ON	ON	OFF	VENT GB

If a SOV is energized when the operator actuates the wrong switch, it will remain energized; if a SOV is de-energized when the operator actuates the wrong switch, it will remain de-energized.

If SOV-14 is open, it will be shut if the EXHAUSTER SHUTDOWN contact is in the alarm condition for 10 seconds or more. Once off (due to the EXHAUSTER SHUTDOWN contact) SOV-14 will remain OFF until the operator turns the PURGE GAS switch to the OFF position.

3.1.16 Automatic Drill Rig Engine Shutoff

The AUTOMATIC DRILL RIG ENGINE SHUTOFF will occur if:

- the PURGE GAS LOW FLOW condition exists for 35 seconds,
- or the HIGH DOWNWARD FORCE condition exists for 45 seconds,
- or the HIGH RPM condition exists for 45 seconds,
- or the INDETERMINATE condition (RPM sensor failure) exists for 45 seconds,
- or the EXHAUSTER SHUTDOWN condition exists for 10 seconds.

If the alarm condition does not clear within the stated times, the AUTOMATIC DRILL RIG ENGINE SHUTOFF will occur. It will remove power to both the starter coil and the drill rig engine fuel injectors; thus stopping the engine by depriving it of fuel and ignition power. The engine can not be restarted until a 30 second DRILL RIG ENGINE RESTART INHIBIT time has passed.

3.1.17 Hoist Motor and Brake Control Logic

Hoist motor Up operation: The Hoist motor will operate in the UP direction when the operator puts the HOIST MOTOR switch in the UP position, subject to the following:

1. If the SAMPLING POSITION/GRAPPLE LOWER switch is in SAMPLE POSITION: the UP motion will cease when the LOAD CELL READOUT LOW ALARM CONTACT indicates tension on the line exceeds a preset minimum.
2. If the SAMPLING POSITION/GRAPPLE LOWER switch is in the GRAPPLE LOWER position: the UP motion will cease when the TORPEDO DETECTOR indicates the sampler is near the top. The operator can raise the sample the last little bit and release the pintle rod by using the UP LIMIT BYPASS switch. The up motion is halted altogether when a high limit is detected in the line by the LOAD CELL READOUT HIGH ALARM CONTACT indicates tension is on the line is greater than a preset value.

Hoist motor Down operation: The Hoist motor will operate in the DOWN direction when the operator puts the HOIST MOTOR switch in the DOWN position and when the SAMPLING POSITION/GRAPPLE LOWER switch is in the GRAPPLE LOWER position. The DOWN motion will cease when the TORPEDO DETECTOR indicates the sampler is near the top. The operator can lower the torpedo past the torpedo detector by using the DOWN BYPASS switch. Once past downward motion can continue until the HOIST CABLE SLACK DETECTOR halts motion altogether.

Motor/Brake Coordination: The Hoist motor and the Brake will be coordinated to prevent the cable from un-spooling on the winch or from the motor attempting to turn while the brake is engaged. This prevents the inertia of the winch and cable to unspool on the reel causing slack cable.

When the Hoist motor UP/DOWN switch is operated then the brake immediately releases. A moment later the contactor is actuated allowing the motor to operate.

When the HOIST UP/DOWN switch is released and returns to the OFF position, the motor is immediately turned off, a moment later (0.2 second) the brake will be applied. This small delay allows the motor/drum assembly time to stop spinning.

3.2 External Interface Requirements

3.2.1 User Interfaces

The user interface is through the switches and lights on the Instrument Enclosure and Control Console. Operation of the PLC is transparent to the user.

3.2.2 Hardware Interfaces

To modify the program in the PLC the hand-held programmer attaches to the PLC. For operation of the RMCST the PLC must be powered by 115 VAC @ 60 Hz (nominal). The PLC interfaces to the alarm lights, valves SOV-14, SOV-15, SOV-16, SOV-17, alarm contacts, switches, hoist motor and the K5 drill rig engine shutdown relay through the PLC output modules. The PLC will use the appropriate I/O modules for hardware interfaces to 120 volt AC and 24 volt DC signals.

3.2.3 Software Interfaces

The PLC does not interface with any other system so no software interfaces are required.

3.2.4 Communication Interfaces

No communication interfaces, other than the vendor supplied peripherals, are needed. These peripherals are to be used only during the changing of the PLC logic and only by qualified personnel.

3.3 PERFORMANCE REQUIREMENTS

The PLC must have the following characteristics:

- 40 input channels for 115 volt AC signals
- 48 output channels for 115 volt AC signals
- 16 input channels for 24 volt DC signals (current sinking type)
- 64 presetable internal timers/counters
- 192 logical/virtual coils

These characteristics match the present PLC and include spare channels and functions for future upgrades and changes.

3.4 DESIGN CONSTRAINTS

The PLC system must fit in a limited amount of space as shown on the Instrument Enclosure drawings listed in section 4.0 REFERENCES.

3.4.1 Standards Compliance

Adherence to the National Electric Code, (NFPA 70) 1993 edition is required as specified by DOE Order 6430.1A GENERAL DESIGN CRITERIA. Also, the Standard Engineering Practices, WHC-CM-6-1, must be adhered to.

3.4.2 Resource Limitations

The amount of physical space available for the PLC system is limited. See the Instrument Enclosure drawings listed in section 4.0 REFERENCES for more details.

3.5 Attributes

The PLC system is a "turn key" unit. That is to say it requires no specific user/operator input to begin operation. You simply turn it on and after a brief power-up self diagnostic the unit operates normally.

3.6 Other Requirements

3.6.1 Data

This system does not process data in the conventional "computer data" sense. This system is a process control system not a data processing system. The output of this system is in the form of control signals to devices.

3.6.2 Operations

The operation of the PLC is transparent to the user/operator and the system requires no special start-up, shutdown, backup or recovery operations. There is no preventive maintenance needs and the remedial maintenance needs are satisfied by simply replacing the failed module (input, output, CPU, etc.).

3.6.3 Site Adaptation

There are no adaptation requirements for the PLC system to be used on the RMCST.

3.6.4 Options

There are several other brands of PLCs that could have been used for this application. The particular brand chosen was picked because of its proven reliability and availability of assorted types of I/O modules.

3.6.5 Scheduling

The PLC system requires no scheduled maintenance other than the replacement of a lithium battery in the CPU module every 4-5 years. This battery keeps the critical timer/counters active in the event of a power failure.

3.6.6 Reliability and Recovery

The PLC performs self checking of its internal operation both during power-up and operation to ensure reliable operation. If an error is detected, it shuts both itself and the truck down. Qualified personnel can then trouble shoot the PLC and replace the failed module.

3.6.7 Audit

This section is not applicable to this application.

3.6.8 Priorities

This section is not applicable to this application.

3.6.9 Transferability

Multiple installations of the same firmware are present in CST 2, 3 and 4. Multiple installations can be done by copying the logic onto a PROM. This firmware can then be installed into the PLC. The PLC must be of the same make and model as on CST 2, 3 and 4. The make and model information is listed on the Instrument Enclosure drawings listed in section 4.0 REFERENCES. There are no special requirements for the installations.

3.6.10 Conversion

There are no software conversion requirements for this system. The logic, but not the software, used in the PLC can be implemented on most any other commercially available PLC.

3.6.11 Testing and Acceptance Criteria

The PLC system functions, as well as many other RMCST functions, are tested during the Rotary Mode Core Sample Truck ATP listed in section 4.0 REFERENCES of this document.

3.6.12 Documentation

This is no requirement for user documentation because the operation of the system (PLC) is transparent to the user (operator). The maintenance documentation consists of the vendor supplied manuals and the logic diagrams documented on the H-2 drawings listed in section 4.0 REFERENCES of this document.

3.6.13 Training

The operators (users) are trained on how to operate the CST. The operation of the PLC is transparent to the operator and no specific training is required to operate the PLC.

3.6.14 Security and Privacy

While the PLC does not have security features in the conventional sense (i.e., passwords) casual unauthorized changes to the control logic in the EPROM are deterred as outlined in the following two scenarios:

1. Changing the existing EPROM in the field. First another EPROM must be programmed elsewhere before it could be changed in the field. This requires at least TWO vendor specific peripherals: the EPROM programmer and the hand-held programmer (with special keypad and interface). In addition another blank EPROM or an EPROM eraser, an external 5 volt dc power supply and another CPU base (to use its RAM prior to loading it into the EPROM) is also required.
2. Remove the EPROM and install the RAM into the field CPU; then the RAM can be changed in the field using the (vendor specific) hand-held programmer.

Then a vendor specific peripheral (the hand-held programmer) must be used to change the RAM. However this is not a quick matter: first the right type of RAM must be acquired, then experience has shown to manually load all the logic into the RAM requires the a minimum of 2 hours by an experienced user. If the RAM were to be changed enmasse by downloading an EPROM, that effort would require all the equipment in scenario 1 (above); then the EPROM programmer would need to be in the field with the PLC.

4.0 REFERENCES

4.1 Drawings

Truck # 2 Drawings (partial list)

- H-2-83111, INSTRUMENT ENCLOSURE ASSEMBLY TRUCK #2
- H-2-81840, CONTROL CONSOLE ASSEMBLY (TRUCK #2)
- H-2-140300, CORE SAMPLER TRUCK #2 ASSEMBLY
- H-2-89459, ALARM AND CONTROL DIAGRAMS (TRUCK #2)

Truck # 3 and 4 Drawings (partial list)

- H-2-690000, CORE SAMPLER TRUCK ASSEMBLY RMCST
- H-2-690068, INSTRUMENT ENCLOSURE ASSEMBLY
- H-2-690069, ALARM AND CONTROL DIAGRAMS
- H-2-690090, CONTROL CONSOLE ASSEMBLY

NOTE: All H-2-69XXXX series drawings are for RMCST #3 and 4.

4.2 Documents

ANSI/ISA-S18.1-1979 (R1992) Annunciator Sequences and Specifications

WHC-CM-6-1, Standard Engineering Practices

WHC-SD-WM-ATP-119, Rotary Mode Core Sample Truck ATP

WHC-SD-WM-CSCM-032, COMPUTER SOFTWARE CONFIGURATION MANAGEMENT PLAN FOR CORE SAMPLE TRUCKS #2, 3 AND 4 PROGRAMMABLE LOGIC CONTROLLER

Corbett, J.E., 1993, Rotary Mode Core Sampling Safety Equipment List, WHC-SD-WM-SEL-032, Westinghouse Hanford Company, Richland, Washington

WHC-SD-WM-SARR-031, SAFETY ANALYSIS FOR PUSH-MODE AND ROTARY MODE CORE SAMPLING

4.3 Vendor Information

SERIES ONE (tm) JUNIOR PROGRAMMABLE CONTROLLER Users Manual by GE Fanuc
Automation (part number GEK-90503A, March 1987)