DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	TWRS Safety Special Projects	Date 10/20/94
Project Title/Work Order		EDT No. N/A
The Family of Standard Hydrogen Monitoring Systems Computer Software Design Description		ECN No. 198622

Name	MSIN	Text With All Attach.	Text Only	Attach./Appendix Only	EDT/ECN Only
R. E. Bauer	L6-37	X			
R. M. Bender	L7-04	X			
L. S. Krogsrud	R3-08	X			
M. L. McElroy	S1-57	X			
T. C. Schneider	L7-04	X			
Central Files (orig + 2)	L8-04	X			
OSTI (2)	L8-07	X			

RECEIVED
DEC 08 1994
OSTI

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 198622

Proj.
ECN

WED310

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedure ☐ Cancel/Void ☐		3. Originator's Name, Organization, MSIN, and Telephone No. R. M. Bender, TWRS, L7-04, 376-0307		4. Date 10/20/94	
		5. Project Title/No./Work Order No. SHMS/N244B N2D4D	6. Bldg./Sys./Fac. No. 200 area-General	7. Approval Designator SQ	
		8. Document Numbers Changed by this ECN (includes sheet no. and rev.) (See below.) -N/A-	9. Related ECN No(s). N/A	10. Related PO No. N/A	
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)		11b. Work Package No. N/A	11c. Modification Work Complete N/A _____ Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A _____ Cog. Engineer Signature & Date	
12. Description of Change Revise the CSDD to include the SHMS-B and SHMS-C modifications. Blk. 8 (Cont'd.) WHC-SD-WM-CSDD-004, Rev. 1					
13a. Justification (mark one) Criteria Change ☐ Design Improvement ☒ Environmental ☐ As-Found ☐ Facilitate Const. ☐ Const. Error/Omission ☐ Design Error/Omission ☐					
13b. Justification Details Add grab sampler and gas chromatograph to the SHMS system.					
14. Distribution (include name, MSIN, and no. of copies) See distribution list.				RELEASE STAMP OFFICIAL RELEASE BY WHO DATE NOV 16 1994 Sta. 21	

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

RELEASE AUTHORIZATION

Document Number: WHC-SD-WM-CSDD-004, Revision 2

Document Title: The Family of Standard Hydrogen Monitoring System
Computer Software Design Description

Release Date: November 15, 1994

**This document was reviewed following the
procedures described in WHC-CM-3-4 and is:**

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

M. Boston

M.N. Boston

11/15/94

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy. Available in paper copy and microfiche. Printed in the United States of America. Available to the U.S. Department of Energy and its contractors from:

U.S. Department of Energy
Office of Scientific and Technical Information (OSTI)
P.O. Box 62
Oak Ridge, TN 37831
Telephone: (615) 576-8401

Available to the public from:

U.S. Department of Commerce
National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 487-4650

SUPPORTING DOCUMENT

1. Total Pages **59**

2. Title

The Family of Standard Hydrogen Monitoring System
Computer Software Design Description

3. Number

WHC-SD-WM-CSDD-004

4. Rev No.

2

5. Key Words

SHMS
SHMS-B
SHMS-C

6. Author

Name: **R. M. Bender**

R M Bender

Signature

8D210/N2D4D

Organization/Charge Code **71140/N244M**

7. Abstract

A computer software design description for the SHMS family of hydrogen monitoring systems.

8. RELEASE STAMP

OFFICIAL RELEASE	(20)
BY WHO	
DATE	NOV 16 1994
<i>Sta. 21</i>	

[illegible]

**THE FAMILY OF STANDARD HYDROGEN MONITORING SYSTEMS
COMPUTER SOFTWARE DESIGN DESCRIPTION**

Impact Level 2S0

Issued by:

TWRS Safety Special Projects
October 1994

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

ff

CONTENTS

1.0	Introduction	3
1.1	Background	3
1.2	Purpose	3
1.3	Definitions	3
1.4	Overview	4
2.0	Requirements	4
2.1	Product Perspective	4
2.2	Product Functions	5
2.3	Specific Requirements	10
3.0	Design	15
3.1	Decomposition Description	15
3.2	Detailed Design	19
4.0	Installation	19
4.1	Overview	19
4.2	Loading the Logic Using a Master Chip	20
4.3	Programming the Programmable Logic Controller	22
5.0	Verification and Validation	23
5.1	Independent Review	23
5.2	Test Plan	24
6.0	References	24

Tables

1	Family of SHMS Inputs and Outputs	6
2	SHMS Specific Inputs and Outputs	6
3	SHMS-B Specific Inputs and Outputs	7
4	SHMS-B and SHMS-C Specific Inputs and Outputs	8
5	SHMS-C Specific Inputs and Outputs	9

Appendixes

A	SHMS Software Source Code Listing	25
B	SHMS-B Software Source Code Listing	31
C	SHMS-C Software Source Code Listing	38
D	PROM Writer Unit Description	46
E	Programmer Unit Description	49
F	Printer Interface Unit Description	55

THE FAMILY OF STANDARD HYDROGEN MONITORING SYSTEMS COMPUTER SOFTWARE DESIGN DESCRIPTION

1.0 INTRODUCTION

1.1 BACKGROUND

In March 1990, 23 waste tanks at the Hanford Nuclear Reservation were identified as having the potential for the buildup of gas to a flammable or explosive level. As a result of the potential for hydrogen gas buildup, a project was initiated to design a standard hydrogen monitoring system (SHMS) for use at any waste tank to analyze gas samples for hydrogen content. Since it was originally deployed three years ago, two variations of the original system have been developed: the SHMS-B and SHMS-C. All three are currently in operation at the tank farms and will be discussed in this document. To avoid confusion in this document, when a feature is common to all three of the SHMS variants, it will be referred to as "The family of SHMS." When it is specific to only one or two, they will be identified.

1.2 PURPOSE

The purpose of this computer software design document is to provide the following:

- The computer software requirements specification that documents the essential requirements of the computer software and its external interfaces.
- The computer software design description.
- The computer software user documentation for using and maintaining the computer software and any dedicated hardware.
- The requirements for computer software design verification and validation.

1.3 DEFINITIONS

- Computer Software A set of computer codes, procedures, rules, and associated documentation and data pertaining to the operation of computer systems. This includes user-provided instructions and data that implement preprogrammed algorithm control

systems, computer codes and data that will reside in firmware, and (when specified by the cognizant manager) user-provided instruction and data used by commercial computer software such as spreadsheet and database packages (Reference 1). In relation to the SHMS, computer software refers to the programmable logic controller's (PLC) programming language.

1.4 OVERVIEW

This computer software design description (CSDD) is divided into four sections. Each section documents the SHMS software as described in Section 1.2. Section 2.0, "Requirements," documents the essential requirements of the computer software and its external interfaces. Section 3.0, "Design," documents the design process used to accommodate the requirements specified. Section 4.0, "Installation," serves as the computer software user documentation for using and maintaining the computer software and any dedicated hardware. Each section also provides an overview paragraph in an attempt to justify the inclusion/exclusion of sections recommended by WHC-CM-6-1, EP-5.8 (Reference 3).

2.0 REQUIREMENTS

This section is divided into three parts: Product Perspective, Product Functions, and Specific Requirements. Product Perspective describes the functions of the SHMS and the computer hardware to be used. Product Functions provide a summary of the SHMS alarm inputs and alarm outputs. The Specific Requirements contain all the details needed to develop the program listing. The remaining sections detailed in EP-5.8 (External Interface Requirements, Performance Requirements, Design Constraints, etc.) are not applicable to this system due to the basic, simplistic nature of the software.

2.1 PRODUCT PERSPECTIVE

The primary function of the family of standard hydrogen monitoring systems is to monitor specifically for hydrogen in the waste tank atmosphere which may also contain (but not be limited to) unknown quantities of air, nitrous oxide, ammonia, water vapor, carbon dioxide, carbon monoxide, and other gaseous constituents.

The original SHMS will consist of hydrogen-specific monitors, a grab sampler composed of manually operated valves to collect samples for laboratory analysis, and the gas sample collection system necessary to support the

operation of the instrumentation. This system will be located in a cabinet placed at the tank of interest.

The SHMS-B will have all the capabilities of the original SHMS, but the manually operated valves used to obtain a grab sample will be replaced with electrically-operated solenoid valves. This feature allows for unattended automatic grab sampling during high hydrogen events. A pushbutton control will also be included for operator initiation of a grab sample.

The SHMS-C will have all of the capabilities of the SHMS-B plus a dual column gas chromatograph (GC) for analyzing the tank atmosphere for hydrogen and other selected gas species.

The basic purpose of the software is to provide alarm annunciation and control. A PLC, the GE Fanuc Automation Series One Junior, was selected to perform these functions.

2.2 PRODUCT FUNCTIONS

The design of the family of standard hydrogen monitoring systems provides system outputs based on system inputs. Tables 1 through 5 list the system inputs and their respective outputs. An output can be a control function, alarm, or information light.

Table 1. Family of SHMS Inputs and Outputs

SYSTEM INPUTS	SYSTEM OUTPUTS
Horn acknowledge	Silences horn (Indicating lamps showing the cause of the alarm condition are not affected)
Low sample flow	Trouble beacon Trouble remote alarm Horn Low sample flow lamp
Hi/Lo cabinet temp.	Trouble beacon Trouble remote alarm Horn Hi/Lo cabinet temp. lamp

Table 2. SHMS Specific Inputs and Outputs

SYSTEM INPUTS	SYSTEM OUTPUTS
Alarm test	Trouble beacon Trouble remote alarm High hydrogen beacon High hydrogen remote alarm Horn (All indicating lamps)
Alarm reset	Allows resetting of indicating lamps if the alarm condition has previously cleared
Low range high hydrogen	High hydrogen beacon High hydrogen remote alarm Horn High hydrogen lamp
High range high hydrogen	High hydrogen beacon High hydrogen remote alarm Horn High hydrogen lamp
Low calibration gas temp.	Trouble beacon Trouble remote alarm Horn Low calibration gas temp. lamp
Low sample gas temp.	Trouble beacon Trouble remote alarm Horn Low sample gas temp. lamp

Table 3. SHMS-B Specific Inputs and Outputs

SYSTEM INPUTS	SYSTEM OUTPUTS
Alarm test	Trouble beacon Trouble remote alarm High hydrogen beacon High hydrogen remote alarm Horn (All indicating lamps with the exception of reset sampler and grab sample lamp)
Alarm reset	Allows resetting of indicating lamps if the alarm condition has previously cleared; (dose will not effect reset sampler and grab sample lamps)

Table 4. SHMS-B and SHMS-C Specific Inputs and Outputs

SYSTEM INPUTS	SYSTEM OUTPUTS
High range high hydrogen	High hydrogen beacon high hydrogen remote alarm Horn High hydrogen lamp Grab sample solenoid Grab sample lamp Reset sampler lamp
Low range high hydrogen	High hydrogen beacon high hydrogen remote alarm Horn High hydrogen lamp Grab sample solenoid Grab sample lamp Reset sampler lamp
Low calibration gas temp.	Trouble beacon Trouble remote alarm Horn Low gas temp. lamp
Low sample gas temp.	Trouble beacon Trouble remote alarm Horn Low gas temp. lamp
Reset sampler	Grab sample solenoid valves Grab sample lamp Reset sampler lamp
Grab sample	High hydrogen beacon High hydrogen remote alarm Horn (These outputs only occur while the grab sample button is depressed) High hydrogen lamp (This output is locked in until reset) Grab sample solenoid valves Grab sample lamp Reset sampler lamp

Table 5. SHMS-C Specific Inputs and Outputs

SYSTEM INPUTS	SYSTEM OUTPUTS
Alarm test	Trouble beacon Trouble remote alarm High hydrogen beacon High hydrogen remote alarm Horn (All indicating lamps with the exception of reset sampler, grab sampler, and GC calibration lamp)
Alarm reset	Allows resetting of indicating lamps if the alarm condition has previously cleared; (dose will not effect reset sampler, grab sampler, and GC calibration lamps)
GC calibrate	GC calibration gas solenoid valves control GC calibration lamp

2.3 SPECIFIC REQUIREMENTS

Each input must be able to trigger multiple outputs. The intent of the device inputs is to activate the outputs on loss of power (fail safe condition). The remote alarms must also be designed for fail safe operation. Furthermore, the alarm beacons, remote alarms, and horn must be able to automatically reset on loss of alarm condition. However, the remaining outputs must be able to retain their alarm state on loss of alarm condition until manually reset. During alarm conditions, the system shall be designed so an operator may disable the horn without disabling the ability for another system input to activate the horn. Also, means shall be provided to test the alarm outputs.

Refer to Tables 1 through 5 for the specific alarms and control functions associated with the individual versions that compose the SHMS family.

The specific requirements for each function are now detailed as a list of steps from measurement to alarm. Detailed technical specifications are found in WHC-SD-WM-SDD-001 (Reference 2).

2.3.1 High Hydrogen

There are two identical electrochemical sensor cells and indicating transmitters in the SHMS-B and SHMS-C cabinets that signal a high hydrogen concentration. The original SHMS cabinet has one electrochemical sensor cell and associated indicating transmitter and one MOS solid-state high hydrogen sensor and signal conditioner.

- The sensor instruments generate an electrical signal proportional to the percent concentration of hydrogen by volume.
- The electrical signal generated by the hydrogen sensors are processed by indicating transmitters into 4-20mADC signals.
- These signals are fed into two channels of a 120VAC strip chart recorder.
- Each recording channel is programmed to activate an alarm relay on high hydrogen concentration. The activation of the relay opens a normally closed contact.

On contact opening, four alarms are initiated:

- High hydrogen beacon: A 120V heavy-duty, shatter-resistant, weatherproof, 65 flashes per minute beacon with a red lens.

- Horn: The 120V solid-state signal horn has a sound output at 2 feet of 80 to 95dB.
- High hydrogen indicating lamp: A 120V neon pilot light is supplied with an amber color cap.
- Remote high hydrogen alarm: A 120V relay contact opens on alarm.

2.3.2 Low Sample Flow

- The gas flow monitor consists of a laminar flow element and a differential pressure transmitter.
- As the laminar flow element senses the sample flow through the sample gas line, the dp transmitter generates a 4-20mA DC signal proportional to the gas flow rate.
- The flow signal is interfaced to a DC input limit alarm (120V).
- If the flow rate drops below a preset value, the limit alarm deenergizes a relay to open a normally open contact.

On contact opening, four alarms are initiated:

- Trouble beacon: A 120V heavy-duty, shatter-resistant, weatherproof, 65 flashes per minute beacon with an amber lens.
- Horn: The 120V solid-state signal horn has a sound output at 2 feet of 80 to 95dB.
- Low flow indicating lamp: A 120V neon pilot light is supplied with an amber color cap.
- Remote trouble alarm: A 120V relay contact opens on alarm.

2.3.3 High/Low Cabinet Temperature

- A thermocouple monitors the cabinet temperature and provides an electrical signal to a 120V indicating controller.
- On high/low cabinet temperature, one of the controller output relay deenergizes to open one of a set of two normally open series contact.

On contact opening, four alarms are initiated:

- Trouble beacon: A 120V heavy-duty, shatter-resistant, weatherproof, 65 flashes per minute beacon with an amber lens.
- Horn: The 120V solid-state signal horn has a sound output at 2 feet of 80 to 95dB.
- High/low cabinet temperature indicating lamp: A 120V neon pilot light supplied with an amber color cap.
- Remote trouble alarm: A 120V relay contact opens on alarm.

2.3.4 Low Calibration Gas Temperature

- A thermocouple measures the calibration gas line temperature and provides an electrical signal to a 120V indicating controller.
- On low temperature, the controller output relay deenergizes to open a normally open contact.

On contact opening, four alarms are initiated:

- Trouble beacon: A 120V heavy-duty, shatter-resistant, weatherproof, 65 flashes per minute beacon with an amber lens.
- Horn: The 120V solid-state signal horn has a sound output at 2 feet of 80 to 95dB.
- Low gas temp. indicating lamp: A 120V neon pilot light supplied with an amber color cap.
- Remote trouble alarm: A 120V relay contact opens on alarm.

2.3.5 Low Sample Gas Temperature

- A thermocouple monitors the sample gas line temperature and provides an electrical signal to a 120V indicating controller.
- On low temperature, the controller output relay is deenergized to open a normally open contact.

On contact opening, four alarms are initiated:

- Trouble beacon: A 120V heavy-duty, shatter-resistant, weatherproof, 65 flashes per minute beacon with an amber lens.

- Horn: The 120V solid-state signal horn has a sound output at 2 feet of 80 to 95dB.
- Low gas temp. indicating lamp: A 120V neon pilot light supplied with an amber color cap.
- Remote trouble alarm: A 120V relay contact opens on alarm.

2.3.6 Gas Temperature Low

- A thermocouple monitors the calibration gas line temperature and provides an electrical signal to a 120V indicating controller.
- On low temperature from either thermocouple, the respective controller output relay is deenergized to open a normally open contact.

On contact opening, four alarms are initiated:

- Trouble beacon: A 120V heavy-duty, shatter-resistant, weatherproof, 65 flashes per minute beacon with an amber lens.
- Horn: The 120V solid-state signal horn has a sound output at 2 feet of 80 to 95dB.
- Gas temp. low indicating lamp: A 120V neon pilot light supplied with an amber color cap.
- Remote trouble alarm: A 120V relay contact opens on alarm.

2.3.7 Grab Sample

- Each recording channel is programmed to activate its own alarm relay on high hydrogen concentration. The activation of the relay opens a normally closed contact feeding the PLC.
- A normally closed grab sample pushbutton is in series with the low range high hydrogen recording channel. When the button is pressed, it opens a normally closed contact feeding the PLC.

On contact opening, the following occurs:

- Both grab sample solenoid valves open.
- The grab sample light and two reset sampler lights illuminate.
- The 5-minute timer is initiated.

At the end of 5 minutes, the following occurs:

- Both grab sample solenoid valves close.
- The grab sample light goes out, but both reset sampler lights remain on.
- Operator-initiated and automatic grab sampling are both prevented until the grab sample is reset.

2.3.8 Reset Sampler

- The grab sampler has completed a 5-minute grab sample cycle.
- The reset sampler button is depressed.

On contact opening, the following occurs:

- The 5-minute timer is reset.
- Both reset sampler lights extinguish.
- The sampler will again respond to automatic or operator-initiated sampling.

2.3.9 GC Calibrate

- The GC calibrate button is depressed.

On contact opening, the following occurs:

- The 15-minute and 24-hour timers are both initiated.
- The GC calibrate solenoid valves open.

After 15 minutes:

- The GC calibrate solenoid valves close.

At 24 hours, the following occurs:

- The 15-minute and 24-hour timers are initiated.
- The calibration process repeats by opening the GC calibrate solenoid valves for 15 minutes.

3.0 DESIGN

This section is broken down into two parts: Decomposition Description and Detailed Design. The Decomposition Description describes the way the system has been structured assuming the use of electromechanical relays. The Detailed Design contains the source code listing of the PLC program. The remaining detailed sections recommended by EP-5.8 (process, module, data entity descriptions, etc.) are not applicable to this design.

3.1 DECOMPOSITION DESCRIPTION

The respective PLC ladder diagram as referenced in Section 6.0 presents the detailed relay logic diagrams needed to fulfill the requirements defined in Tables 1 through 5. The high hydrogen beacon and remote high hydrogen alarms will be driven by a single relay coil. The trouble beacon and remote trouble alarms will also be driven by a single relay coil. An alarm condition will open the OLC output contacts feeding the relays, resulting in a loss of power to the coils. Physical wiring of the relay contacts will then permit the beacons and remote alarms to energize. Since all inputs are closed during normal operation, an alarm condition opens the input contact--resulting in deenergized input coils.

3.1.1 High Hydrogen

Most alarm conditions follow this basic alarm sequence. In the case of a high hydrogen condition on the high range instrument, the following sequence takes place. The low range instrument is similar.

- On alarm condition, the normally closed chart recorder high range high hydrogen input contact (NASH-*-6-1) opens. This is input 000 to the PLC. When this input opens, Coil 300, the Whittaker high hydrogen coil, deenergizes.
- A 300 NOT contact closes energizing the high hydrogen Relay 311. Contact 311 in turn activates Output 022 of the PLC, which in turn activates the high hydrogen indicating light.
- Another 300 contact opens causing PLC Output 017 to deenergize. This causes the high hydrogen relay (BY-*-10-1) to deenergize.
- When Relay BY-*-10-1 deenergizes, one set of its contacts close and another opens. The set that closes activates the high hydrogen beacon and the set that opens activates an external circuit, indicating that a high hydrogen condition exists.

- Another 300 NOT contact closes, energizing the high hydrogen horn Coil 324. This in turn activates PLC Output 021 which energizes horn Relay BY-*9-1. A normally open contact in the horn relay closes, activating the horn.

3.1.2 Cabinet Trouble Alarms

The remaining alarm conditions are very similar to the high hydrogen alarms:

- A horn circuit is activated
- The trouble relay is deactivated
- The trouble relay contacts energize the trouble beacon and deenergize the remote trouble alarm contact
- A latched relay is energized which turns on an indicating lamp

3.1.3 Trouble Lamps

The "low flow," "high/low cabinet temperature," "low calibration gas temperature," "low sample gas temperature," and "gas temperature low" alarms activate the low flow, high/low cabinet temperature, low calibration gas temperature, low sample gas temperature, and gas temperature low indicating lamps, respectively.

3.1.4 Information Lamps

The "grab sample," "reset sampler," and "GC calibrate" lamps provide the following information:

- Grab sample: An automatic or operator-initiated sample is in progress.
- Reset sampler: An automatic or operator-initiated sample is in progress or has previously occurred. The sampler will not respond to subsequent sampling events until reset.
- GC calibrate: The GC is in the calibrate mode.

3.1.5 Alarm Test

On initiation of the alarm test function, the 306 coil and its associated contacts deenergize the high hydrogen and trouble relays and

energize all other outputs (the horn and indicating lamps). This will provide a means of testing the alarm devices as required in Table 1.

3.1.6 Horn Acknowledge

The purpose of the horn acknowledge function is to enable an operator to disable the horn by disabling the alarm signal that energized the horn circuit. Furthermore, disabling the horn does not effect the other alarm conditions' abilities to activate the horn. For instance, in the low sample gas temperature condition, the following sequence will take place:

- The horn sounds.
- The trouble relay deenergizes.
- The low sample gas temperature indicating lamp turns on.
- An operator is sent to investigate the problem.
- The operator acknowledges the horn and proceeds with troubleshooting.
- An instant later, a low flow condition is met.
- In a low flow condition, the horn sounds, the trouble relay remains deenergized, and the low flow indicating lamp turns on.

The ability to acknowledge the horn is achieved by using a series of latched relays. On alarm condition:

- The input relay alarm contact (000-013) completes circuits to the horn and to their respective latched relay (311-315).
- If horn acknowledge is not initiated, the latched relay is not set and the horn blares loudly.
- Initiating horn acknowledge sets the latched relay and opens the latched relay contact, turning off the horn.

3.1.7 Alarm Reset

The alarm reset relay, 310, simply resets all latched alarm relays, 311-323.

3.1.8 Grab Sample

The grab sample pushbutton allows for operator initiation of the grab sampler. While the button is depressed, a high hydrogen event is simulated by opening the hydrogen recorder's channel two-alarm contact input to the PLC. All of the events associated with a high hydrogen event, as covered in Section 3.1.1, occur while the button is depressed. The following additional events also occur and are independent of how long the button is depressed or the duration of the high hydrogen event.

- A high hydrogen event on hydrogen recorder Channel One or Two occurs or the grab sampler pushbutton is depressed.
- Set relay Coil 331 is asserted and remains on until reset. A set/reset type relay was used to ensure that the valves stay open for 5 minutes and to facilitate the lock out until reset feature.
- A 331 NOT contact activates Counter 601, a 300-second counter.
- Another 331 contact closes causing Output 026 to energize. This causes the grab sample solenoid valves to energize.
- After 5 minutes, Counter 601 reaches 300 and changes state. When this occurs, power is removed from Output 26 causing the grab sample solenoid coils to deenergize and the counter to stop counting.
- Set Coil 331 remains asserted and prevents subsequent alarms from asserting the grab sample solenoid valves because the Counter 601 has not been reset.

3.1.9 Reset Sampler

The reset sampler pushbutton restores the capability of operator-initiated or automatic grab sampling after it has been locked out due to a prior grab sampling event. When the pushbutton is depressed, the following occurs:

- Input 006 is reset, which in turn resets Coil 332.
- A 332 NOT contact causes Counter 601 to reset to 0. This sets the counter up for a new 5-minute count.
- Another 332 NOT contact closes causing Coil 331 to reset. This sets up the input circuit for triggering the counter.

3.1.10 GC Calibrate

The GC calibrate pushbutton initiates an automatic periodic calibration of the GC. When the button is pressed, the PLC starts a 15-minute calibration cycle that will repeat itself on a 24-hour basis. When in the calibrate mode, the PLC activates the GC calibration gas solenoid valves, allowing calibration gas to the GC. The GC calibrate pushbutton is a normally closed pushbutton. When it is depressed, the following occurs:

- Input 007 is reset, which in turn resets Coil 333.
- A 333 NOT contact sets Coil 334, which in turn causes Output 027 to energize. This causes the GC solenoid valves to open.
- Another 333 NOT contact resets Counter 602, a 15-count counter incremented by a 1-minute timer.
- A 334 contact enables Counter 602, causing it to commence counting.
- Another 333 NOT contact resets and starts Counter 603, a 1440-count counter incremented by a 1-minute timer.
- When Counter 602 reaches Count 15 in 15 minutes, it asserts--resetting itself to 0 and causing Coil 334 to reset. This in turn shuts the GC solenoid valves.
- When Counter 603 reaches Count 1440 in 24 hours, it asserts, resetting itself to 0 and causing Coil 334 to set. Setting Coil 334 causes the GC calibration process to repeat itself.

3.2 DETAILED DESIGN

The basic programming language for the Series One Junior is a simple relay ladder representation based on standard Boolean (mnemonic) functions (AND, OR, and NOT). Appendixes A, B, and C contain a listing of the source code needed to convert the design to the Series One Junior programming language.

4.0 INSTALLATION

4.1 OVERVIEW

This section serves as the computer software user documentation for using and maintaining the PLC. The PLC can be described as a black box that, based on the state of its inputs, triggers selected outputs. The "box" or

basic unit contains a fixed size of complimentary metal-oxide semiconductor (CMOS), random access memory (RAM). The programmer unit allows a user to load commands into the CMOS memory. However, CMOS memory is volatile and can lose its content if power is removed. The basic unit is provided with a battery to maintain its content when power fails. Another type of memory, programmable read only memory (PROM), retains its contents upon loss of power. A typical PROM memory device is the Intel 2732A-2 memory chip. The PROM writer unit allows the user to transfer memory from CMOS to PROM and from PROM to CMOS.

Once the logic is programmed into the PLC, the PLC then becomes part of the SHMS and all procedures relating to scheduled maintenance, corrective maintenance, troubleshooting, operation, configuration management, and quality assurance are covered by the appropriate SHMS documents.

The internal logic needed to program the PLC and the hardwiring setup is documented in the engineering drawings referenced in Section 6.0.

There are two methods available for configuring the PLC:

- 1) A master chip containing the programmed relay logic is located within tank farms engineering. Copies of the master chip and ladder logic printout will be distributed to each hydrogen monitoring system for PLC setup.
- 2) A programmer unit may be used to key enter the relay logic.

The following sections detail each method of PLC configuration.

4.2 LOADING THE LOGIC USING A MASTER CHIP

4.2.1 Equipment Needed

The equipment needed for this option include the PROM writer unit, the programmer unit, and the SHMS master chip.

4.2.2 Loading Logic Procedure

The sequence of operation for transferring the contents of PROM memory to CMOS memory (i.e., from the SHMS master chip to the PLC) is as follows:

- 4.2.2.1 With PLC power off, attach the programmer onto the PLC by placing the mating connector on the rear of the programmer over the 26-pin connector and gently pushing down on the programmer until the programmer snaps into place.

- 4.2.2.2 Turn PLC power on and select the PROG mode.
- 4.2.2.3 Clear existing RAM by entering the following function:
-- CLR, SHF, 348, ENT, DEL, NXT
- 4.2.2.4 Turn PLC power off and remove programmer by squeezing the top and bottom programmer tabs and gently pulling the unit from the PLC.
- 4.2.2.5 Insert the SHMS master PROM into the PROM writer unit socket. Attach the PROM writer unit to the PLC. Use the same method as described in 4.2.2.1.
- 4.2.2.6 Turn power on.
- 4.2.2.7 Depress the WRITE and CMPR pushbuttons simultaneously. The WRITE light and CMPR light will turn on.
- 4.2.2.8 When the contents of PROM and RAM memory are compared, the WRITE light turns off.
- 4.2.2.9 If the compare was good, the CMPR light turns off and the load sequence is complete.
- 4.2.2.10 If an error is detected during the compare operation, the CMPR light will remain on and the ERR light will turn on. The error can be cleared by depressing the ERR pushbutton. When this is done, the ERR and CMPR lights will turn off. If an error is indicated, turn off power to the units and repeat Steps 4.2.2.6 through 4.2.2.10.
- 4.2.2.11 Turn off PLC power and remove the PROM writer unit from PLC.
- 4.2.2.12 With PLC power off, attach the programmer onto the PLC. Use the same method as described in 4.2.2.1.
- 4.2.2.13 Turn PLC power on and select the run mode on the programmer. The run light on the PLC will illuminate.
- 4.2.2.14 Remove the programmer from the PLC. It is not necessary to secure power while removing or adding the programmer.

4.3 PROGRAMMING THE PROGRAMMABLE LOGIC CONTROLLER

4.3.1 Equipment Needed

Equipment needed for this operation includes the programmer unit, the printer interface unit, a printer interface cable, and an Epson MX-100 or equivalent printer.

4.3.2 Programming Logic Procedure

The programming steps necessary to program the PLC are as follows:

4.3.2.1 With PLC power turned off, attach the programmer to the PLC.

4.3.2.2 Energize PLC and select PROG mode.

4.3.2.3 Clear existing RAM by entering the following function:

-- CLR, SHF, 348, ENT, DEL, NXT

4.3.2.4 Proceed with line-by-line entry of the source code listed in Section 3.2, "Detailed Design."

Note: Reference numbers are entered by depressing the SHF key.
Depressing the ENT key completes the reference number input.

4.3.2.5 Select RUN mode. PLC programming is now complete.

4.3.2.6 Turn off PLC and remove programmer.

4.3.2.7 Attach printer interface unit.

4.3.2.8 Connect printer interface cable to printer interface unit and printer.

4.3.2.9 Select appropriate power supply setting for printer interface unit.

Note: If the programmable logic controller is programmed in the field, then it will be necessary to physically locate the printer at the hydrogen monitor location to obtain a hard copy of the ladder logic manually programmed.

4.3.2.10 Energize PLC, printer interface unit, and printer.

4.3.2.11 Program transfer from PLC to printer interface unit will occur.
This transfer will take about 2 minutes.

- 4.3.2.12 When the program has been successfully transferred, the FORM and PROD LED indicators will turn on GREEN. If the program transfer is not successful, the LED indicators will either flicker on and off RED or neither LED will illuminate.
- 4.3.2.13 If after 2 minutes neither LED turns on, repeat Steps 4.3.2.10 through 4.3.2.12.
- 4.3.2.14 Depress the FORM key such that the FORM LED lights GREEN.
- 4.3.2.15 Depress the PROD key such that the PROD LED lights RED.
- 4.3.2.16 Depress the PRNT pushbutton. The ladder diagram listing will begin to print and continue printing until the complete program has been listed or has been stopped by the operator.
- 4.3.2.17 Deenergize the PLC, printer interface unit, and printer.
- 4.3.2.18 Remove the printer interface unit from the PLC.
- 4.3.2.19 Energize the PLC.

5.0 VERIFICATION AND VALIDATION

Listed below are two options available for verification and validation of the PLC setup.

5.1 INDEPENDENT REVIEW

The first option is to compare the respective PLC ladder logic printout with the defined ladder logic diagram of the respective engineering drawing. This is readily accomplished if the SHMS PLC setup was performed using the master chip method or the manually programmed method. In both setup schemes, a PLC ladder logic printout was generated for comparison against the respective engineering drawing. A designated independent reviewer may initial the label upon satisfactory inspection of the software installation.

Upon satisfactory installation of the SHMS system logic into the programmable logic controller, a label will be affixed on the PLC with the following information displayed:

- Drawing number of logic installed
- Revision number of drawing

- Date installed
- Initials of verifier/validator

5.2 TEST PLAN

A second method of testing is also available by comparing the system performance against the system requirements. An acceptance test procedure, unique for each of the family of SHMS, is performed to verify that the system requirements have been met.

6.0 REFERENCES

1. WHC-CM-6-1, EP-2.1, Rev. 2, "Computer Software Configuration Management," March 31, 1989.
2. WHC-SD-WM-SDD-001, Rev. 0, "System Design Description, Standard Hydrogen Monitoring System," December 20, 1991.
3. WHC-CM-6-1, EP-5.8, "Engineering Document Content Guidelines."
4. H-2-81830, "Standard Hydrogen Monitoring System PLC Ladder Diagram."
5. H-2-87278, "Standard Hydrogen Monitoring System 1 Line & Elementary Diagrams."
6. H-2-87282, "Standard Hydrogen Monitoring Cabinet Wiring Diagram."
7. H-2-818213, "Standard-B Hydrogen Monitoring System PLC Ladder Diagram."
8. H-2-817852, "Standard-B Hydrogen Monitoring System 1 Line & Elementary Diagrams."
9. H-2-817854, "Standard-B Hydrogen Monitoring System Wiring Diagram."
10. H-2-822781, "Standard-C Hydrogen Monitoring System PLC Ladder Diagram."
11. H-2-822774, "Standard-C Hydrogen Monitoring System 1 Line & Elementary Diagrams."
12. H-2-822776, "Standard-C Hydrogen Monitoring System Wiring Diagram."

APPENDIX A

SHMS SOFTWARE SOURCE CODE LISTING

SHMS SOFTWARE SOURCE CODE LISTING

Explanation of headings for software source code listings.

<u>Heading</u>	<u>Explanation</u>
Address	Instruction address that is automatically generated by the PLC as the program is entered. It is included as an aid to programming/troubleshooting and is not required to be entered by the programmer.
Function 1	The first instruction set entered into the PLC.
Function 2	The second instruction set entered into the PLC. It can only modify function 1. It is usually used to NOT the function 1.
Reference	Coil or contact designation. All coils are denoted by a # symbol; the contacts are not. The # sign is automatically generated by the PLC as the program is entered. It is included as an aid to programming/troubleshooting and is not required to be entered by the programmer.
Comments	Explanatory information to aid the programmer/troubleshooter.

SHMS SOFTWARE SOURCE CODE LISTING				
Address	Function 1	Function 2	Reference	Comments
0000	SET		373#	Enables activation of latched relays
0001	STR		000	High range hydrogen
0002	OUT		300#	
0003	STR		001	Low range hydrogen
0004	OUT		301#	
0005	STR		002	Low flow
0006	OUT		302#	
0007	STR		003	Cabinet temperature

SHMS SOFTWARE SOURCE CODE LISTING				
Address	Function 1	Function 2	Reference	Comments
0008	OUT		303#	
0009	STR		004	Calibration gas temperature
0010	OUT		304#	
0011	STR		005	Sample gas temperature
0012	OUT		305#	
0013	STR		011	Alarm test
0014	OUT		306#	
0015	STR		012	Horn acknowledge
0016	OUT		307#	
0017	STR		013	Alarm reset
0018	OUT		310#	
0019	STR	NOT	300	
0020	OR	NOT	301	
0021	SET		311#	
0022	STR	NOT	302	
0023	SET		312#	
0024	STR	NOT	303	
0025	SET		313#	
0026	STR	NOT	304	
0027	SET		314#	
0028	STR	NOT	305	
0029	SET		315#	
0030	STR	NOT	307	
0031	MCS			
0032	STR	NOT	300	

SHMS SOFTWARE SOURCE CODE LISTING				
Address	Function 1	Function 2	Reference	Comments
0033	SET		316#	
0034	STR	NOT	301	
0035	SET		317#	
0036	STR	NOT	302	
0037	SET		320#	
0038	STR	NOT	303	
0039	SET		321#	
0040	STR	NOT	304	
0041	SET		322#	
0042	STR	NOT	305	
0043	SET		323#	
0044	MCR			
0045	STR	NOT	300	
0046	AND	NOT	316	
0047	STR	NOT	301	
0048	AND	NOT	317	
0049	OR	NOT		
0050	OUT		324#	
0051	STR	NOT	302	
0052	AND	NOT	320	
0053	OUT		325#	
0054	STR	NOT	303	
0055	AND	NOT	321	
0056	OUT		326#	
0057	STR	NOT	304	
0058	AND	NOT	322	

SHMS SOFTWARE SOURCE CODE LISTING				
Address	Function 1	Function 2	Reference	Comments
0059	OUT		327#	
0060	STR	NOT	305	
0061	AND	NOT	323	
0062	OUT		330#	
0063	STR	NOT	310	
0064	MCS			
0065	RST		311#	
0066	RST		312#	
0067	RST		313#	
0068	RST		314#	
0069	RST		315#	
0070	RST		316#	
0071	RST		317#	
0072	RST		320#	
0073	RST		321#	
0074	RST		322#	
0075	RST		323#	
0076	MCR			
0077	STR		300	
0078	AND		301	
0079	AND		306	
0080	OUT		017#	High hydrogen relay
0081	STR		302	
0082	AND		303	
0083	AND		304	
0084	AND		305	

SHMS SOFTWARE SOURCE CODE LISTING				
Address	Function 1	Function 2	Reference	Comments
0085	AND		306	
0086	OUT		020#	Trouble relay
0087	STR	NOT	306	
0088	OR		324	
0089	OR		325	
0090	OR		326	
0091	OR		327	
0092	OR		330	
0093	OUT		021#	Horn
0094	STR	NOT	306	
0095	OR		311	
0096	OUT		022#	High hydrogen light
0097	STR	NOT	306	
0098	OR		312	
0099	OUT		023#	Low flow light
0100	STR	NOT	306	
0101	OR		313	
0102	OUT		024#	Cabinet temperature light
0103	STR	NOT	306	
0104	OR		314	
0105	OUT		025#	Calibration gas light
0106	STR	NOT	306	
0107	OR		315	
0108	OUT		026#	Sample gas light

APPENDIX B

SHMS-B SOFTWARE SOURCE CODE LISTING

SHMS-B SOFTWARE SOURCE CODE LISTING

Explanation of headings for software source code listings.

<u>Heading</u>	<u>Explanation</u>
Address	Instruction address that is automatically generated by the PLC as the program is entered. It is included as an aid to programming/troubleshooting and is not required to be entered by the programmer.
Function 1	The first instruction set entered into the PLC.
Function 2	The second instruction set entered into the PLC. It can only modify function 1. It is usually used to NOT the function 1.
Reference	Coil or contact designation. All coils are denoted by a # symbol; the contacts are not. The # sign is automatically generated by the PLC as the program is entered. It is included as an aid to programming/troubleshooting and is not required to be entered by the programmer.
Comments	Explanatory information to aid the programmer/troubleshooter.

SHMS-B SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0000	SET		373#	Enables activation of latched relays
0001	STR		000	High range hydrogen
0002	OUT		300#	
0003	STR		001	Low range hydrogen
0004	OUT		301#	

SHMS-B SOFTWARE SOURCE CODE LISTING

ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0005	STR		002	Low flow
0006	OUT		302#	
0007	STR		003	Cabinet temperature
0008	OUT		303#	
0009	STR		004	Calibration gas temperature
0010	OUT		304#	
0011	STR		005	Sample gas temperature
0012	OUT		305#	
0013	STR		006	Reset sampler
0014	OUT		332#	
0015	STR		011	Alarm test
0016	OUT		306#	
0017	STR		012	Horn acknowledge
0018	OUT		307#	
0019	STR		013	Alarm reset
0020	OUT		310#	
0021	STR	NOT	300	
0022	OR	NOT	301	
0023	SET		311#	
0024	STR	NOT	302	
0025	SET		312#	
0026	STR	NOT	303	
0027	SET		313#	
0028	STR	NOT	304	
0029	SET		314#	

SHMS-B SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0030	STR	NOT	305	
0031	SET		315#	
0032	STR	NOT	307	
0033	MCS			
0034	STR	NOT	300	
0035	SET		316#	
0036	STR	NOT	301	
0037	SET		317#	
0038	STR	NOT	302	
0039	SET		320#	
0040	STR	NOT	303	
0041	SET		321#	
0042	STR	NOT	304	
0043	SET		322#	
0044	STR	NOT	305	
0045	SET		323#	
0046	MCR			
0047	STR	NOT	300	
0048	AND	NOT	316	
0049	STR	NOT	301	
0050	AND	NOT	317	
0051	OR	NOT		
0052	OUT		324#	
0053	STR	NOT	302	
0054	AND	NOT	320	
0055	OUT		325#	

SHMS-B SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0056	STR	NOT	303	
0057	AND	NOT	321	
0058	OUT		326#	
0059	STR	NOT	304	
0060	AND	NOT	322	
0061	OUT		327#	
0062	STR	NOT	305	
0063	AND	NOT	323	
0064	OUT		330#	
0065	STR	NOT	310	
0066	MCS			
0067	RST		311#	
0068	RST		312#	
0069	RST		313#	
0070	RST		314#	
0071	RST		315#	
0072	RST		316#	
0073	RST		317#	
0074	RST		320#	
0075	RST		321#	
0076	RST		322#	
0077	RST		323#	
0078	MCR			
0079	STR		300	
0080	AND		301	
0081	AND		306	

SHMS-B SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0082	OUT		017#	High hydrogen relay
0083	STR		302	
0084	AND		303	
0085	AND		304	
0086	AND		305	
0087	AND		306	
0088	OUT		020#	Trouble relay
0089	STR	NOT	306	
0090	OR		324	
0091	OR		325	
0092	OR		326	
0093	OR		327	
0094	OR		330	
0095	OUT		021#	Horn
0096	STR	NOT	306	
0097	OR		311	
0098	OUT		022#	High hydrogen light
0099	STR	NOT	306	
0100	OR		312	
0101	OUT		023#	Low flow light
0102	STR	NOT	306	
0103	OR		313	
0104	OUT		024#	Cabinet temperature light
0105	STR	NOT	306	
0106	OR		314	

SHMS-B SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0107	OR	NOT	315	
0108	OUT		025#	Gas temp low
0109	STR	NOT	600	
0110	TMR		600	Timer
0111			*001.0	1 second timer
0112	STR	NOT	300	
0113	OR	NOT	301	
0114	SET		331	
0115	STR	NOT	332	
0116	RST		331	
0117	STR		331	
0118	AND		604	
0119	AND	NOT	601	
0120	CNT		601	300 count counter
0121			*300	
0122	STR	NOT	332	Reset counter
0123	STR		331	
0124	AND	NOT	601	
0125	OUT		026	Grab sample solenoid

APPENDIX C

SHMS-C SOFTWARE SOURCE CODE LISTING

SHMS-C SOFTWARE SOURCE CODE LISTING

Explanation of headings for software source code listings.

<u>Heading</u>	<u>Explanation</u>
Address	Instruction address that is automatically generated by the PLC as the program is entered. It is included as an aid to programming/troubleshooting and is not required to be entered by the programmer.
Function 1	The first instruction set entered into the PLC.
Function 2	The second instruction set entered into the PLC. It can only modify function 1. It is usually used to NOT the function 1.
Reference	Coil or contact designation. All coils are denoted by a # symbol; the contacts are not. The # sign is automatically generated by the PLC as the program is entered. It is included as an aid to programming/troubleshooting and is not required to be entered by the programmer.
Comments	Explanatory information to aid the programmer/troubleshooter.

SHMS-C SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0000	SET		373#	Enables activation of latched relays
0001	STR		000	High range hydrogen
0002	OUT		300#	
0003	STR		001	Low range hydrogen
0004	OUT		301#	

SHMS-C SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0005	STR		002	Low flow
0006	OUT		302#	
0007	STR		003	Cabinet temperature
0008	OUT		303#	
0009	STR		004	Calibration gas temperature
0010	OUT		304#	
0011	STR		005	Sample gas temperature
0012	OUT		305#	
0013	STR		006	Reset sampler
0014	OUT		332#	
0015	STR		007	GC cal
0016	OUT		333#	
0017	STR		011	Alarm test
0018	OUT		306#	
0019	STR		012	Horn acknowledge
0020	OUT		307#	
0021	STR		013	Alarm reset
0022	OUT		310#	
0023	STR	NOT	300	
0024	OR	NOT	301	
0025	SET		311#	
0026	STR	NOT	302	
0027	SET		312#	
0028	STR	NOT	303	
0029	SET		313#	

SHMS-C SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0030	STR	NOT	304	
0031	SET		314#	
0032	STR	NOT	305	
0033	SET		315#	
0034	STR	NOT	307	
0035	MCS			
0036	STR	NOT	300	
0037	SET		316#	
0038	STR	NOT	301	
0039	SET		317#	
0040	STR	NOT	302	
0041	SET		320#	
0042	STR	NOT	303	
0043	SET		321#	
0044	STR	NOT	304	
0045	SET		322#	
0046	STR	NOT	305	
0047	SET		323#	
0048	MCR			
0049	STR	NOT	300	
0050	AND	NOT	316	
0051	STR	NOT	301	
0052	AND	NOT	317	
0053	OR	NOT		
0054	OUT		324#	
0055	STR	NOT	302	

SHMS-C SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0056	AND	NOT	320	
0057	OUT		325#	
0058	STR	NOT	303	
0059	AND	NOT	321	
0060	OUT		326#	
0061	STR	NOT	304	
0062	AND	NOT	322	
0063	OUT		327#	
0064	STR	NOT	305	
0065	AND	NOT	323	
0066	OUT		330#	
0067	STR	NOT	310	
0068	MCS			
0069	RST		311#	
0070	RST		312#	
0071	RST		313#	
0072	RST		314#	
0073	RST		315#	
0074	RST		316#	
0075	RST		317#	
0076	RST		320#	
0077	RST		321#	
0078	RST		322#	
0079	RST		323#	
0080	MCR			
0081	STR		300	

SHMS-C SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0082	AND		301	
0083	AND		306	
0084	OUT		017#	High hydrogen relay
0085	STR		302	
0086	AND		303	
0087	AND		304	
0088	AND		305	
0089	AND		306	
0090	OUT		020#	Trouble relay
0091	STR	NOT	306	
0092	OR		324	
0093	OR		325	
0094	OR		326	
0095	OR		327	
0096	OR		330	
0097	OUT		021#	Horn
0098	STR	NOT	306	
0099	OR		311	
0100	OUT		022#	High hydrogen light
0101	STR	NOT	306	
0102	OR		312	
0103	OUT		023#	Low flow light
0104	STR	NOT	306	
0105	OR		313	
0106	OUT		024#	Cabinet temperature light

SHMS-C SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0107	STR	NOT	306	
0108	OR		314	
0109	OR	NOT	315	
0110	OUT		025#	Gas temp low
0111	STR	NOT	600	
0112	TMR		600	Timer
0113			*60.0	60 second timer
0114	STR	NOT	604	
0115	TMR		604	Timer
0116			*001.0	1 second timer
0117	STR	NOT	300	
0118	OR	NOT	301	
0119	SET		331	
0120	STR	NOT	332	
0121	RST		331	
0122	STR		331	
0123	AND		604	
0124	AND	NOT	601	
0125	CNT		601	300 count counter
0126			*300	
0127	STR	NOT	332	Reset counter
0128	STR		331	
0129	AND	NOT	601	
0130	OUT		026#	Grab sample solenoid
0131	STR	NOT	333	
0132	OR		603	

SHMS-C SOFTWARE SOURCE CODE LISTING				
ADDRESS	FUNCTION 1	FUNCTION 2	REFERENCE	COMMENTS
0133	SET		334	
0134	STR		334	
0135	OUT		027#	GC cal gas
0136	STR		334	
0137	AND		600	
0138	CNT		602	
0139			*0015	15 count counter
0140	STR	NOT	333	
0141	OR		602	
0142	STR		602	
0143	RST		334	
0144	STR		600	
0145	CNT		603	
0146			*1440	1440 count counter
0147	STR	NOT	333	
0148	OR		603	

APPENDIX D

PROM WRITER UNIT DESCRIPTION

PROM WRITER UNIT DESCRIPTION

The PROM writer unit physically mounts on the lower left of the front panel of the Series One Junior. A connector on the lower left rear of the PROM writer unit attaches to the connector on the lower left of the front panel on a Series One Junior. When used with the Series One Junior, the PROM writer unit **must** be powered by an external power supply. The source of power for the PROM writer unit is switch selectable.

WARNING:

When a program is downloaded into the PLC using the PROM writer unit, the PLC is left in the program mode and will not execute the loaded program until it is placed in the run mode. To place the PLC in the run mode requires the operator to connect the programmer unit to the PLC and select run on the key switch. When this is done, the PLC's run light will illuminate and it will then execute the loaded program.

Front Panel Features

The front panel has two LEDs in the upper right corner which are visual indicators of system status. The purpose of each indicator is described below:

- **PWR:** The green PWR LED monitors the status of DC power being supplied to the PROM writer unit.
 - ON If power is being supplied by the CPU rack, this indicates that +5 volts DC is being produced by the supply. If the PROM writer unit is being powered from an external source, the +5VDC being supplied is within the specified tolerance.
 - OFF 5VDC not being supplied or not in tolerance.
- **CPU:** The red CPU LED monitors the operating status of the CPU module. Identical to the CPU LED on the Series One Junior or a Series One CPU module.
 - ON CPU failure has been detected.
 - OFF CPU operation is normal.

The socket on the lower right of the panel is used to contain the PROM being written to. The socket is a zero insertion force socket. To insert a PROM into the socket, push the locking handle up, insert the PROM, then lock the PROM in place by moving the handle down to the horizontal position. The PROM should be placed in the socket with the notch towards the end of the

socket closest to the PWR LED as indicated by the figure on the panel next to the socket. Even though the spacing of the slots in the socket allows easy insertion of a PROM, care should be taken to ensure that leads on the PROM are not damaged.

Immediately to the left of the socket are four pushbuttons and their associated LED indicators. These pushbuttons are used to initiate operation of the PROM writer unit and the LEDs are indicators for each part of the operation.

- **BLANK** When depressed, initiates checking of the PROM inserted in the socket for verification that the PROM does not have any information written into it. To initiate a blank check, the pushbutton is depressed. The light will turn on, then off, indicating a successful blank check. If the light remains on and the ERR light turns on, the PROM needs to be erased. The BLANK light will also turn on, then off during the normal operation of writing to a PROM as indicated by the instructions printed on the lower left of the unit.
- **WRITE** When depressed, the WRITE pushbutton initiates the sequence of events that causes the user program in the Series One Junior CMOS memory to be written to the PROM. When the WRITE pushbutton is depressed, the BLANK light will turn on, then off. Next, the WRITE light turns on, program entry is executed, then the WRITE light turns off. A blank check and verify are performed automatically when the WRITE pushbutton is depressed.
- **CMPR** During the sequence for writing to a PROM, this light will turn on while the contents of the PROM are being compared to the contents of user memory in RAM. The CMPR light turns off when the compare is completed and is good. If the compare is not good, the CMPR light will remain on and the ERR light will turn on. In addition, the contents of a PROM inserted in the PROM writer unit socket can be compared to the contents of user memory whenever the CMPR pushbutton is depressed.
- **ERR** This light is a visual indication that the PROM writing operation has not been successful. If the light turns on during any portion of the operation, an error has occurred. If this does happen, depress the ERR pushbutton and repeat the procedure.

WHC-SD-WM-CSDD-004

Rev. 2

Page 49

APPENDIX E

PROGRAMMER UNIT DESCRIPTION

PROGRAMMER UNIT DESCRIPTION

Programming the Series One Junior

The basic programming language for the Series One Junior is a simple relay ladder representation based on standard Boolean functions.

Programming References

Whenever programs are entered into any PLC, they must contain reference numbers. These references help to tell the CPU what exact function is desired. Reference numbers are a vital part of programming. In the Series One Junior, the reference numbers are octal based. They start at 0 and go up to 7, then jump to 10; after 77, the next value is 1000. They look like traditional decimal numbers except the digits 8 and 9 are not used.

Input/Output References

References assigned to inputs and outputs for the basic Series One Junior PLCs are fixed for each unit. Those are the only valid references and are marked on the unit adjacent to each field wiring terminal. There are a total of 15 inputs and 9 outputs for each basic unit.

Use of Internal Coils

The internal coils are control relays used to control logic in the user program in the Series One Junior PLC; however, their status cannot be provided directly to the I/O section. Retentive relays are specialized internal coils that have their ON and OFF status retained during time periods that the PLC is not operating such as during loss of AC power. They use dual operations (set or reset) similar to hardwired latching relays.

Use of Special Purpose Coils

Reference 373 must be programmed into user memory address 0000 using a "SET 373" or an "OUT 373" instruction in order to specify internal Coils 300-372 as retentive coils. If this is not done, the internal Coils 300-373 will be nonretentive.

Programmer Features

The features of the programmer are described in this section.

- Mode Switch This is a 3-position keyswitch used for selecting the operating mode of the PLC. This switch can be repositioned at any time as necessary without disrupting AC power. The left position (RUN) allows

program execution with outputs enabled. The CPU scans its stored logic and allows timer/counter and relay contacts to be displayed. However in the RUN mode, changes to the logic are not allowed. In the center (PROG) position, new programs can be entered and previously entered logic can be altered; however, no solving of the logic is performed. The right (LOAD) position connects the programmer to an external device such as a tape recorder through the adjacent tape port. Logic is not solved while in the LOAD position.

- Address/Data Display

This is a 4-digit display used to indicate either the address, in decimal format of where the display is in the user program stored in the PLC's memory, or reference data used as part of the logic. To indicate that addresses are being displayed, periods appear near the bottom and to the right of each digit (e.g., 0.1.2.3.). The LED to the top right behind ADR will also be lit.

- Status Display

These five LEDs are energized to indicate the following functions or status of the Series One:

ON/OFF	When in the RUN mode, this LED indicates the status of discrete references (I/O and internal coils). It is ON when a reference is energized and OFF when deenergized.
RUN	ON when in the RUN mode and CPU is solving logic.
BATT	ON when the voltage of the internal lithium battery, which is used for maintaining the program stored in CMOS memory during no-power conditions, is at a low level and should be replaced within 10 days. This LED is OFF when battery voltage is OK or battery is disconnected.
PWR	ON when the internal power supply is producing DC power. If OFF, the Series One Junior's power supply should be checked.
CPU	ON when internal error checking has detected a fault in internal hardware.

The above four LEDs (RUN, BATT, PWR, and CPU) duplicate the operation of the indicators on the CPU when the programmer is installed. The four CPU indicators on the Series One Junior are located in the lower left section of the front panel directly above the 26-pin connector.

- **Logic Display** These 16 LEDs are used to indicate the type of logic entered into memory. While being programmed, they reflect the logic selected by the user prior to actual entry into CPU memory. For definition of the first 12 LED's functions, see key definitions in "Logic Keys" below. The two LEDs to the upper right have special functions as follows:

ADR ON when display is indicating an address value. The address is displayed in decimal notation, beginning at 0000 and ending at the last address in the user program or a maximum of 07000 (maximum number of 16-bit words in memory).

SHF ON when operator has selected the shift key and is an indication that future key selections will be based on the upper key labels. Shift function will remain in effect until either the ENTER or CLEAR key is selected.

- **Logic Keys** The keyboard has both uppercase and lowercase functions similar to a typewriter. The numerical keys are accessed by first selecting the SHF (shift) key located in the upper right. Once depressed, the SHF LED is lit (display center right) and then the appropriate numerical digit(s) can be selected. The shift function is latched and will be released only by selection of an ENT (enter) or CLR (clear) key. The SHF key does not have to be held. The display window in the upper left reflects either address or data information (not both) as the operation progresses. Typically as keys are selected, their respective LEDs will light to display the function selected.

KEYS	FUNCTION
AND	Place referenced status in series (AND) with previously entered logic.
OR	Place referenced status in parallel (OR) with previously entered logic.
STR	Start new rung of a ladder diagram.
NOT	NOT or invert (make normally closed) the referenced contact.
OUT	Output logic status to a coil, either real-world output or internal coil.
TMR	Selects a timer function.
CNT	Selects a counter function.
SET	Set latching relay or shift register status.
MCS	Master control start--begin control of master control relay.
MCR	Master control reset--end control of master control relay.
SR	Shift register--selects a shift register function.
RST	Reset a latching relay or shift register status.

- **Editing Keys** These eight keys select the action required to modify either the stored logic within the CPU or the logic address being displayed. Those keys that can modify previously entered logic (this is, delete and insert) require a confirming key operation to ensure that the operation is to be executed. Thus if they are accidentally depressed, the error can be corrected by depressing the CLR (clear) key without affecting any entered logic. A description of each editing key is as follows:

KEYS	FUNCTION
DEL	When logic is being displayed, this key when included as the first keystroke of a two-key sequence will cause that single function to be removed from the CPU memory.
INS	This key allows logic functions to be inserted between existing logic functions.
ENT	The enter key is used to complete the entry of logic when initially building the CPU program or to replace an entire single work function.
CLR	The clear key clears the programmer of previously entered commands.
SHF	This key locks all other keys to their shifted (upper label) functions and causes the SHF LED to be lit in the display area.
SCH	This key allows the entire program to be searched for specific logic functions.
PRV	When displaying logic or monitoring I/O state, selecting the PRV key causes the previous logic function or I/O status to be displayed.
NXT	When displaying logic or monitoring I/O state, selecting the NXT key causes the next logic function or I/O status to be displayed.

APPENDIX F

PRINTER INTERFACE UNIT DESCRIPTION

PRINTER INTERFACE UNIT DESCRIPTION

The printer interface unit is attached to the PLC by placing its 26-pin connector directly over the mating connector on the PLC and gently pushing down on the unit until it is securely in place. Connection from the printer interface unit to the selected printer is made through the printer interface cable to a 24-pin connector on the front of the unit. Power to the unit can be supplied directly through the rear panel connector from the CPU power supply or from an external power source capable of supplying +5VDC @ 300mA. The power source, either internal (INT) or external (EXT) is selected by a two-position switch located on the rear panel. Connection to an external power source is made through a 3-wire cable supplied with the printer interface unit.

The printer interface unit front panel has two LEDs located in the upper right corner used for visual indication of system status. The purpose of the indicators is described below:

- CPU: The red CPU LED is an indication of the status of the CPU in the PLC. This is identical to the CPU LED on the Series One Junior.
 - ON CPU failure has been detected.
 - OFF CPU operation is normal.
- PWR: The green PWR LED is an indication of the status of DC power being supplied to the printer interface unit.
 - ON If power is being supplied by the Series One Junior's internal power supply, this indicates that +5VDC is being produced by the supply. If the printer interface unit is being powered from an external source, the +5VDC being supplied is within the specified tolerance.
 - OFF 5VDC not being supplied or not in tolerance.

The 24-pin connector located on the lower right of the front panel provides a connection from the printer interface unit to the selected printer through the printer interface cable. Immediately to the left of the connector are four pushbuttons used to initiate operation of the printer interface unit to get a hard-copy printout. There are also 2 LEDs used as status indicators during the setup procedure.

- FORM This pushbutton is used to select the format of the printout, either a ladder diagram or Boolean listing of the user program. The pushbutton is an alternate function switch. Each time it is depressed, the selected printout

format will change. As the pushbutton is depressed, the color of the LED will alternate between green and red. The LED when GREEN indicates a ladder diagram printout; when RED, it indicates a Boolean listing printout.

- **PROD** This pushbutton is also an alternate function switch. Each time it is depressed, either a Series One Junior or Series One PLC is alternately selected as the program listing source. The selection must agree with the PLC to which the printer interface unit is attached. As this pushbutton is depressed, the color of the LED will alternate between green and red. The LED when RED indicates selection of Series One Junior; when GREEN, it indicates selection of Series One PLC.
- **PRNT** When depressed, this pushbutton causes the printer to begin printing the user program in the selected formats.
- **STOP** When depressed, this pushbutton causes the printing operation to stop.