[illegible]

DISCLAIMER

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

FEB 15 1995

21

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT

600154

2. To: (Receiving Organization) Distribution		3. From: (Originating Organization) TWRS Safety Special Projects		4. Related EDT No.: N/A	
5. Proj./Prog./Dept./Div.: SY-101 Mitigation		6. Cog. Engr.: M. Gimera/71140		7. Purchase Order No.: N/A	
8. Originator Remarks: Transmittal of WHC-SD-WM-CSDD-015 for approval and release.				9. Equip./Component No.: N/A	
				10. System/Bldg./Facility: 241-SY-101	
11. Receiver Remarks:				12. Major Assm. Dwg. No.: N/A	
				13. Permit/Permit Application No.: N/A	
				14. Required Response Date: 2/95	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Impact Level	Reason for Trans- mittal	Origi- nator Dispo- sition	Receiv- er Dispo- sition
1	WHC-SD-WM-CSDD-015		0	Void Fraction System Computer Software Design Description	Q	1,2	1	

16. KEY					
Impact Level (F)		Reason for Transmittal (G)		Disposition (H) & (I)	
1, 2, 3, or 4 (see MRP 5.43)		1. Approval	4. Review	1. Approved	4. Reviewed no/comment
		2. Release	5. Post-Review	2. Approved w/comment	5. Reviewed w/comment
		3. Information	6. Dist. (Receipt Acknow. Required)	3. Disapproved w/comment	6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)											
(G)	(H)	(J) Name (K) Signature (L) Date (M) MSIN				(J) Name (K) Signature (L) Date (M) MSIN				(G)	(H)
Reason	Disp.									Reason	Disp.
1	/	Cog. Eng.	M. Gimera	<i>Michael Gimera</i>	2/8/95	L7-05					
1	/	Cog. Mgr.	R. E. Bauer	<i>R. E. Bauer</i>	2/9/95	L6-37					
1	/	QA	M. L. McElroy	<i>M. L. McElroy</i>	2/9/95	S1-57					
1	/	Safety	L. S. Krogsrud	<i>L. S. Krogsrud</i>	2/9/95	R3-08					
		Env.									
1	/		T. I. Stokes			H5-09					

18. Signature of EDT Originator <i>Michael Gimera</i> 2/8/95		19. Authorized Representative for Receiving Organization _____ Date _____		20. Cognizant/Project Engineer's Manager <i>R. E. Bauer</i> 2/9/95		21. DOE APPROVAL (if required) Ltr. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
--	--	---	--	--	--	--	--

RELEASE AUTHORIZATION

Document Number: WHC-SD-WM-CSDD-015, REV. 0

Document Title: VOID FRACTION SYSTEM COMPUTER SOFTWARE DESIGN DESCRIPTION

Release Date: 2/14/95

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

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Chris Willingham
C. Willingham

2/14/95

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 143
2. Title Void Fraction System Computer Software Design Description	3. Number WHC-SD-WM-CSDD-015	4. Rev No. 0
5. Key Words Void Fraction 101-SY Instrumentation	6. Author Name: M. Gimera <i>Michael Gimera</i> Signature Organization/Charge Code 71140/N2BH3	
7. Abstract Provides the description of Version 1.1 of void fraction software. The void fraction instrument measures gas by volume in waste storage tanks.		
		8. RELEASE STAMP <div style="border: 1px solid black; padding: 5px; width: fit-content;"> OFFICIAL RELEASE (21) BY WAC DATE FEB 15 1995 <i>Jim. 21</i> </div>

VOID FRACTION SYSTEM COMPUTER SOFTWARE DESIGN DESCRIPTION

APPROVAL LEVEL QS

Issued by
TWRS Safety Special Projects
January 1995

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

Westinghouse Hanford Company

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

TABLE OF CONTENTS

SECTION	PAGE
1. INTRODUCTION	4
1.1. Background.....	4
1.2. Document Overview	4
2. HARDWARE DESCRIPTION	5
2.1. Computer	5
2.2. Third Party Software	6
3. VOID FRACTION SOFTWARE.....	6
3.1. Introduction to LabVIEW.....	6
3.2. Front Panel.....	8
3.3. Main Program	8
3.3.1. Front Panel Indicator Update	9
3.3.2. SG-300 Pressure Update	10
3.3.3. Check Loop	12
3.3.4. Operations Loop	16
3.4. Sub Programs.....	57
3.4.1. Acromag.vi	58
3.4.2. Calculate Elevation.vi	62
3.4.3. Calculate Void Fraction.vi	63
3.4.4. Check for Stability.vi	64
3.4.5. Check Pressures.vi	68
3.4.6. Check Temperatures.vi	70
3.4.7. Check Water Level.vi	71
3.4.8. Clear All Buffers.vi	72
3.4.9. Clear Device Buffers.vi	74
3.4.10. Compute Checksum.vi	78
3.4.11. Configuration Info.vi.....	79
3.4.12. Convert to Value.vi	88
3.4.13. Create File.vi	89
3.4.14. Date String.vi	91
3.4.15. Deselect Devices.vi	92
3.4.16. Elevation Zero Global.vi	95
3.4.17. Error Reporting.vi	96
3.4.18. Get Error Number.vi	97
3.4.19. Get Error String.vi.....	98
3.4.20. Get Path.vi	100
3.4.21. Init Serial Port 2.vi	105
3.4.22. Path/Date String.vi	106
3.4.23. Pressure Stabilized.vi	107

3.4.24.	PT3 Stabilized.vi	108
3.4.25.	Read Acromag.vi	109
3.4.26.	Read All Stations.vi	111
3.4.27.	Read Flowmeter.vi	113
3.4.28.	Read Station.vi	120
3.4.29.	Switch Globals.vi	124
3.4.30.	Temperature Stabilized.vi	125
3.4.31.	Verify Checksum.vi	126
3.4.32.	Void Calculation Globals.vi	127
3.4.33.	Void Fraction Globals.vi	128
3.4.34.	Write Message.vi	129
3.4.35.	Write Test Data.vi	130
3.4.36.	Write to Acromag.vi	137
3.4.37.	Write to Config File.vi	140
4.	REFERENCES	142

VOID FRACTION SYSTEM COMPUTER SOFTWARE DESIGN DESCRIPTION

1. INTRODUCTION

1.1. BACKGROUND

Waste Tank SY-101 has been the focus of extensive characterization work over the past few years. The waste continuously generates gases, most notably hydrogen, which are periodically released from the waste. In the past, some of these releases were sufficiently large to overwhelm the tank ventilation system and cause the dome space to reach flammable hydrogen concentrations.

Since the introduction of the mixer pump, these gas releases are more frequent and of smaller magnitude. There is still a fundamental lack of knowledge (proof) regarding how much gas is contained in the tank at any given point in time. Mixer pump tests to date provide indications of gas volumes and types released but have not accurately determined where the gas comes from and the gas retention mechanism(s) that is (are) prevalent in the waste.

Gas can be trapped in tank waste in three forms: void gas (bubbles), dissolved gas, or adsorbed gas. Void fraction is the volume percentage of a given sample that is comprised of void gas. The void fraction instrument (VFI) acquires the data necessary to calculate void fraction.

A team comprised of Westinghouse Hanford Company (WHC), ICF Kaiser Hanford (ICF KH), Battelle Pacific Northwest Laboratories (PNL), Los Alamos National Laboratory (LANL), and Science Applications International Corporation (SAIC) personnel was formed to develop the necessary measurement system.

1.2. DOCUMENT OVERVIEW

This document describes the software that controls the void fraction instrument. The format of the document may differ from typical Software Design Reports because it was created with a graphical programming language.

Hardware is described in Section 2. The purpose of this document is describe the software, so the hardware description is brief.

Software is described in Section 3. LabVIEW^{®1} was used to develop the viscometer software, so Section 3 begins with an introduction to LabVIEW[®]. This is followed by a description of the main program. Finally each Westinghouse developed subVI (sub program) is discussed.

¹LabVIEW is a registered trademark of National Instruments, Corp., Austin, TX.

2. HARDWARE DESCRIPTION

The void fraction instrument (VFI) is approximately a 19.8 meter (65 feet) piece of 7.62 cm (3-inch) schedule 80 pipe, with an arm at the bottom that is pneumatically actuated and swings out at 90 degrees from the main pipe (commonly referred to as the mast). At the end of this arm is a sample chamber. A second pneumatically controlled cylinder opens and closes the cover of this chamber. Sampling at different elevations is accomplished by lifting the VFI with a crane and lowering into the tank through a riser. The VFI is then lowered to the desired sampling level and a sample is obtained in the sample chamber. Once a sample is captured, it is pressurized with a fixed volume of nitrogen gas. Then pressure and temperature is measured at pressurization chamber (fixed volume gas source), along the connecting tubing, and at the sample chamber.

2.1. COMPUTER

The VFI is controlled by an integrated personal computer, and operator interface with the system is through point-and-click on the computer monitor screen using the system mouse and the keyboard for alphanumeric input. Each front panel control accessible to the operator is represented by an icon on the computer monitor display. These icons can be accessed and manipulated with the computer mouse. Using the computer monitor screen, mouse, and keyboard, the operator can select the operating mode and input necessary parameter values. The computer then automatically controls the cable drum drive motors, and acquires, displays, and stores ball position, speed, and cable tension data consistent with the selected operating mode.

The data acquisition and control computer is an IBM² compatible, AST³ system. It includes the following features:

- 66 MHz CPU Clock Speed
- 16 MBytes Random Access Memory
- 200 MByte Hard Disk Drive
- 3.5 inch, 1.4 MByte Floppy Disk Drive
- Five EISA Bus Slots
- Two Serial Ports and One Parallel Port
- Microsoft Compatible Mouse
- 101 Key Keyboard
- 13-Inch VGA Monitor

²IBM is a registered trademark of the International Business Machines, Corp., Boca Raton, FL.

³AST is a registered trademark of AST Research, Inc., Irvine, CA.

The computer is mounted inside an rack mountable industrial enclosure with a cooling fan. Access is from the front of the control console and the computer enclosure doors. The keyboard is a rack mountable, AT type, spill proof, dust resistant unit.

2.2. THIRD PARTY SOFTWARE

Software is required to support Westinghouse Hanford developed viscometer software. This other software consists of MS-DOS⁴ version 6.0 and Windows⁵ version 3.1 from Microsoft and LabVIEW[®] Run-Time for Windows version 3.0 from National Instruments[®].

Development was done with LabVIEW[®] for Windows full development system version 3.0.1 from National Instruments^{®6}.

3. VOID FRACTION SOFTWARE

This section provides the descriptions of the void fraction software.

3.1. INTRODUCTION TO LABVIEW

LabVIEW[®] is a program development application, much like C, Pascal or FORTRAN. However, LabVIEW[®] is different from those applications in one important respect. Other programming systems use text-based languages to create lines of code, while LabVIEW[®] uses a graphical programming language, G, to create programs in block diagram form.

LabVIEW[®] is a general-purpose programming system, but it also includes libraries of functions and development tools designed specifically for data acquisition and instrument control. LabVIEW[®] programs are called virtual instruments (VIs) because their appearance and operation imitate actual instruments. However, they are identical to functions from conventional programs. VIs have an interactive user interface, a source code equivalent, and accept parameters from higher level VIs. These three VI features are discussed below.

- The interactive user interface of a VI is called the front panel, because it stimulates the panel of a physical instrument. The front panel can contain knobs, push buttons, graphs, and other controls and indicators. You input data using a mouse and keyboard, and then view the results on the computer screen.

⁴MS_DOS is a registered trademark of Microsoft Corp., Redmond, WA.

⁵Windows is a registered trademark of Microsoft Corp., Redmond, WA.

⁶National Instruments is a registered trademark of National Instruments Corp., Austin, TX.

- The VI receives instructions from a block diagram, which you construct in G. The block diagram is a pictorial solution to a programming problem. The block diagram is also the source code for the VI.
- VIs are hierarchical and modular. You can use them as top-level programs, or as subprograms within other programs or subprograms. A VI within another VI is called a subVI. The icon and connector of a VI work like a graphical parameter list so that other VIs can pass data to a subVI.

With these features, LabVIEW® promotes and adheres to the concept of modular programming. An application can be divided into a series of tasks, which can again be divided until a complicated application becomes a series of simple subtasks.

The block diagram is the graphical source code of a LabVIEW® VI. A block diagram is constructed by wiring together objects that send or receive data, perform specific functions, and control the flow of execution.

Nodes are program execution elements. They are analogous to statements, operators, functions, and subroutines in conventional programming languages. The Add or Subtract functions are one type of node. LabVIEW® has an extensive library of functions for math, comparison, conversion, I/O, and more. Another type of node is a structure. Structures, similar to loops and case statements in traditional programming languages, repeatedly or conditionally execute code. LabVIEW® also has special nodes for linking to external text-based code and for evaluating text-based formulas.

Wires are data paths between source and sink terminals. A source terminal cannot be wired to another source terminal or wire a sink terminal to another sink, but a source can be wired to several sinks. Each wire has a different style or color depending on the data type that flows through the wire.

The principle that governs LabVIEW® program execution is called data flow. Stated simply, a node executes only when data arrives at all its input terminals; the node supplies data to all of its output terminals when it finishes executing; and the data passes immediately from source to sink (or destination) terminals. Data flow contrasts with the control flow method of executing a conventional program, in which instructions are executed in the sequence in which they are written. Control flow execution is instruction driven. Data flow execution is data driven or data dependent.

When a VI operates as a subVI (the LabVIEW® analog of a subroutine) inside another VI, the controls and indicators receive data from and return data to the calling VI.

The icon represents a VI in the block diagram of another VI. The connector is a set of terminals that correspond to the subVI controls and indicators. The icon can be the pictorial representation of the purpose of the VI, or it can be a textual description of the VI or its terminals.

The connector is much like a parameter list of function call; the connector terminals act like parameters. Each terminal corresponds to a particular control or indicator on the front panel. A connector receives data at its input terminals and passes data to the subVI code via the subVI controls, or receives the results at its output terminals from the subVI indicators.

3.2. FRONT PANEL

The user interfaces with the software through the front panel (Figure 1). The front panel is an abbreviated piping and instrumentation diagram. Each valve icon can be clicked on to change the state of the valve (open or closed). Indicators such as, pressure and temperature, are updated at a rate of once per second at all times that the software is running. The 1st Void and 2nd Void are updated only when running a test sequence.

Figure 1 Front Panel

3.3. MAIN PROGRAM

The void fraction software consists of four separate parts. One part is a loop that continually updates the indicators on the front panel.

The second part is a loop that reads the SG-300 pressure sensors. If the start/stop switch is in the on position, this loop updates the front panel controls with the values of the global variables preventing the user from changing these values.

The third part, the check loop, waits until start-up is completed, then continually checks pressures, temperatures and the water level.

The last part is the operations loop. This loop responds to each of the five switches located at the bottom of the front panel. If none of the switches are activated, it reads the values in the Acromags^{®7} and updates the global variables.

3.3.1. Front Panel Indicator Update

The front panel indicator update loop is depicted in Figure 2. The values stored in global variables are updated on the front panel. Global variables are used because values are read in subVIs which cannot directly update the front panel of this VI. Note: VI is LabVIEW term that stands for virtual instrument.

⁷ Acromag is a trademark of Acromag Incorporated, Wixom, MI.

Figure 2 Front Panel Indicator Loop

3.3.2. SG-300 Pressure Update

This loop provides the interface to the SG-300 pressure sensors. It begins by initializing the serial port that will be used for communications with these sensors (Figure 3).

Figure 3 SG-300 Initialization

The next step is to clear the buffers in the SG-300s. This assures that we will be getting fresh data.

Figure 4 Clear SG-300 Buffers

The final step is a loop that continually reads pressures from the SG-300s and stores the values in global variables. This loop reads new values every 1.4 seconds, allowing adequate time for the SG-300s to update their values.

Figure 5 SG-300 Update

3.3.3. Check Loop

The check loop continually check pressures, temperatures and the water level. If one of these values are found to be out of the acceptable range a dialog box is presented to the operator.

The check loop begins by waiting for two minutes for start-up to complete. This wait is depicted in Figure 6.

Figure 6 Wait for Start-up to Finish

The nitrogen supply is the first pressure to be checked. This check is performed only once to provide assurance that the operations are starting with a full tank of nitrogen. Nitrogen tanks are normally pressurized to 2,200 psi. If the pressure is below 2,000 psi the nitrogen supply is considered to be not full.

Figure 7 Check Nitrogen Supply

The loop begins by checking pressures as shown in Figure 8. The pressures are checked continually.

Figure 8 Pressure Check

Temperatures are checked in Figure 9, below:

Figure 9 Temperature Check

Figure 10 Water Level Check

The final check is the level of the water tank (Figure 10).

The loop waits for 30 seconds before repeating the checks (Figure 11). This wait is imposed to allow tasks outside the loop processing time.

Figure 11 30 Second Wait

3.3.4. Operations Loop

The operations loop responds to the four switches located at the bottom of the front panel. If none of the sequence switches are activated, the global variables are updated by reading the Acromags®.

3.3.4.1. Global Variable Update

The global variable update starts by storing the values for the solenoid valve switches from the front panel to global variables. In the case of the four 3-way valves an interlock must be performed. If YV2 is asserted, YV3 must not be asserted, and vice versa. The same interlocking is performed between YV4 and YV5.

Figure 12 shows the case statements that are executed if the value of YV2, YV3, YV4 or YV5 changes. This change is detected by comparing the value from the front panel to the global variable. If this is the case the global variable, Check Flow, is set to true. This global variable is used by the update loop to prevent the loop from change front panel controls until the flow has been checked (takes about one minute).

Figure 12 Begin Checking Flow

Figure 13, below, shows how the global variable values for YV2, YV3, YV4 and YV5 are updated. This update provides the interlocking function.

Figure 13 Set Global Variable Values

Figure 14 Write Switch Values to Acromags®

The next step is to write these switch values to the Acromags® (Figure 14).

Figure 15 shows that the next step is to check the flowmeter. This takes about a minute. The anchor icon that is the input to the Check Flow subVI is an empty path. When an empty path is provided as an input no data recording to file takes place while the flowmeter is being read.

Figure 16 Turn Off Checking Flow Global Variable

The last step is to turn off the global variable Checking Flow. This allows the update loop to resume updating information from the front panel controls.

The global variable update is completed by writing the values to the Acromags[®] as shown in Figure 17.

Figure 17 Write Values to Acromag[®]

3.3.4.2. Zero Level Gauge

One of the controls on the front panel allows the operator to zero the level gauge. When the control is asserted, the operator is presented with a dialog box that confirms that this is what the operator wants to do. If the operator responds no, the front panel control is reset (Figure 18).

Figure 18 Do Not Zero Level Gauge

Figure 19 Zero Gauge

If the operator confirms that the level gauge should be zeroed, the diagram in Figure 19 is performed.

Finally the front panel control is reset (Figure 20).

The record data sequence records all values from the front panel to a configuration file. The sequence consists of two steps. The first (Figure 21) writes the data to the file at ten second intervals until the record data switch is set to the off position, and the second (Figure 22) reads new values from the acromag for the next write to file.

Figure 21 Write Data to File

Figure 22 Update Values

3.3.4.4. Wash and Dry Sequence

The wash and dry sequence cleans the line between the pressurization chamber and the sample chamber. This is accomplished by pushing water through the line at 200 psi. The line is then dried with nitrogen at 500 psi. In order to assure that the line is dried, several pressurizations are required.

Figure 23 Close Valve YV11

Figures 23 and 24 depict the first step, which is to close valve YV11. YV11 is the valve between the pressurization chamber and the sample chamber.

Figure 24 Write to Acromag®

Figure 25 Open Valves YV1, YV7 and YV10

Figures 25 and 26 open valves YV1, YV7 and YV10. YV1 is the valve to the nitrogen supply. Valve YV7 is the inlet to the water tank. YV10 is the inlet to the pressurization chamber. Opening these valves pressurizes the water tank and the pressurization chamber.

Figure 26 Write to Acromag®

Figure 27 Open Valve YV9

Figures 27 and 28 open the solenoid valve YV9. YV9 is the water tank outlet. Opening this valve allows water to flow through the line and out the sample chamber.

Figure 28 Write to Acromag®

Figure 29 Wait 25 Seconds

Figure 29 shows a wait, or delay, of 25 seconds. This is how long the water is allowed to flow through line.

Figure 30 Close Solenoid Valve YV9

Figures 30 and 31 shows what is required to close solenoid valve YV9. This stops the water flow through the line.

Figure 31 Write to Acromag®

Figure 32 Open valve YV11

Figures 32 and 33 open solenoid valve YV11. This valve is the outlet for the pressurization chamber. Opening the valve allows nitrogen to flow through the line.

Figure 33 Write to Acromag®

Figure 34 Wait for 15 Seconds

Figure 34 is a 15 seconds delay. This is the length of time that the nitrogen is allowed to flow through the line. Notice that this is part of a loop that is executed eight times. Each time the air flows for 15 seconds.

Figure 35 Close Valve YV11

Figures 35 and 36 close valve YV11. This stops the flow of nitrogen.

Figure 36 Write to Acromag®

Figure 37 imposes a 20 second wait. This is the time between pressurizations.

Figures 38 and 39 close valves YV10 and YV11. These valves are the inlet and outlet of the pressurization chamber.

Figure 39 Write to Acromag®

Figure 40 Reset Front Panel Control

The wash and dry sequence concludes by resetting the front panel control (Figure 40).

3.3.4.5. Test Sequence

The test sequence provides the sequence of steps that obtains void fraction data and writes it to file.

Figure 41 Create the Data File

Figure 41 is the first step. It creates a data file and assigns initial values to the solenoid valve relays.

Figure 42 Close Sample Chamber Cover

Figures 42, 43 and 44 close the sample chamber cover, trapping a sample in the sample chamber. Figure 42 sets the solenoid relay values.

Figure 43 Write to Acromag®

Figure 43 writes the new solenoid values to the Acromags®.

Figure 44 Read Flowmeter

Figure 44 reads the flowmeter to provide a verification that the sample chamber did close.

Figure 45 Write a Set of Data to a Disk File

After the sample chamber cover is closed, a set of data is written to the file (Figure 45). This establishes initial conditions.

Test Sequence

TF

1

2

1

Open Pressurization Chamber Inlet Valve

Acro mag

Figure 47 Write to Acromag®

Figure 48 Wait for Pressures to Stabilize

The inlet valve remains open until the pressure in the chamber stabilizes (Figure 48). Pressure sensors PIT1 and PIT2 are located in the chamber and both sensors must become stable before this step is complete. The anchor in Figure 48 shows that data is not recorded to the file during this time.

Figure 49 Close Solenoid Valve YV10

After stabilization is reached, the inlet valve to the pressurization chamber is closed (Figures 49 and 50).

Figure 50 Write to Acromag®

Figure 51 Wait for Temperatures to Stabilize

With the inlet to pressurization chamber closed and the chamber pressurized, the next step is to wait for the chamber pressures to stabilize (Figure 51). This is necessary because the expanding gas changes temperature.

Figure 52 Write Message to File

A message is written to the file to show when the temperatures stabilized (Figure 52).

Figure 53 Record Data - Read Acromag®

After the temperatures in the pressurization chamber have stabilized, data is recorded to the file at two second intervals for four minutes (Figures 53 and 54).

Figure 54 Record Data - Write to File

Figure 55 Store Initial Pressure Values

Figures 55 and 56 show the storing of initial pressure and temperature values to global variables to be used in the calculation of void fraction.

Figure 56 Store Initial Temperature Values

Figure 57 Open Solenoid Valve YV11

After data is written to the file, the pressurization chamber outlet valve is opened (Figures 57 and 58). A message reflecting this is written to the file.

Opening the outlet valve allows the nitrogen to flow to the sample chamber.

Figure 58 Write to Acromag®

Figure 59 Wait for Pressures to Stabilize

With the pressurization chamber outlet valve open, the chamber pressures are monitored and recorded to file until they stabilize (Figure 59). The pressurization chamber and sample chamber are now in equilibrium.

Figure 60 Close Solenoid Valve YV11

Solenoid valve YV11 is then closed (Figures 60 and 61) to isolate the pressurization chamber from the sample chamber.

Figure 61 Write to Acromag®

Figure 62 Wait for Line Pressure to Stabilize

With the sample chamber isolated, the sample chamber pressure is monitored and recorded to file until it stabilizes (Figure 62).

Figure 63 Message Written to File

A message reflecting that the line pressure (sample chamber pressure) stabilized is written to file (Figure 63).

Figure 64 Store Final Pressure Value

Figure 65 Store Final Temperature Values

Figure 66 Calculate Void Fraction

Figures 64 and 65 show the storage of final values to be used in the void fraction calculation (Figure 66).

Figure 67 Dialog Box

One pressurization of the sample chamber has just been completed. A dialog box is presented to the operator asking if a repressurization of the sample chamber is to be performed (Figure 67). If the operator responds yes, the chamber is repressurized (Figure 63). Repressurizing the chamber is a repeat of Figures 45 through 66. If the operator responds no Figure 68 is skipped.

Figure 68 Repressurize Sample Chamber

Figure 69 Open Sample Chamber Cover

The test sequence concludes by opening the sample chamber cover (Figures 69, 70 and 71).

Figure 70 Write to Acromag®

Figure 71 Record Flow

Figure 71 shows that as the flow is monitored after opening the sample chamber, data is recorded to the file.

Figure 72 Test Sequence Conclusion

As the test sequence concludes (Figure 72), the front panel control is reset.

Figure 73 Adjust Level Gauge

Figure 73 shows a loop that continues until the Adjust Level Gauge switch is no longer asserted. The loop begins by subtracting the initial elevation readings from a continually updated elevation reading. When the loop stops the loop returns the difference in elevation readings (the amount the string pot weight was moved).

Figure 74 takes this difference and adjusts the elevation zero value by this amount.

Figure 74 Complete Level Gauge Adjustment

3.4. SUB PROGRAMS

The following pages contain descriptions of the Westinghouse developed subVIs that were created to support the void fraction instrument program. Each description shows the hierarchy of lower order subVIs. A connector pane shows the information that is passed to and from the subVI. Finally the block diagram shows the logic used to implement the subVI.

Acro
mag

3.4.1. Acromag.vi

Position in Hierarchy

Connector Pane

Acro
mag

Acromag.vi

Reads values of the two Acromag® stations and sends digital values to station1 to set relays.

Block Diagram

mA #

3.4.2. Calculate Elevation.vi

Position in Hierarchy

Connector Pane

Calculate Elevation.vi

Calculates the current elevation from the 4-20 mA current loop and the zero that is set with the Zero Elevation switch.

Block Diagram

calc
void**3.4.3. Calculate Void Fraction.vi**

Position in Hierarchy

calc
voidCalc
global

Connector Pane

calc
void

Void Percentage

Calculate Void Fraction.vi

Calculates the void fraction from global variables stored in Void Calculation Globals.vi.

Block Diagram

stable ?

3.4.4. Check for Stability.vi

Connector Pane

Filename ~~~~~ stable
Items to Monitor — ?

Check for Stability.vi

This subVI checks the indicated item(s) for stability. The check is made every two seconds (and records the data to a file if the filename is not empty. If the items are stable for 30 seconds, the subVI exits.

Block Diagram

Press
?

3.4.5. Check Pressures.vi

Position in Hierarchy

Connector Pane

Press
?

Check Pressures.vi

Checks pressures to verify that they have not gone out of range. PE2 is located downstream of a 600 psi regulator and PE3 is downstream of a 200 psi regulator. PE9 is downstream of a 500 psi regulator. These pressures are allowed a 10% variance.

The line pressure is indicated by PE4, PE5, PE6 and PE7. This line pressure must not drop below 35 psi per the LANL safety assessment.

Block Diagram

Temp
?**3.4.6. Check Temperatures.vi**

Position in Hierarchy

Connector Pane

Temp
?**Check Temperatures.vi**

Checks the pressures in the three cabinets and displays an alert box if they are out of range. The temperature values are in Celsius.

Block Diagram

Water
?

3.4.7. Check Water Level.vi

Position in Hierarchy

Water
?

VF
global

Connector Pane

Water
?

Check Water Level.vi

Displays an alert box if water level in tank is too low.

Block Diagram

clear
all

3.4.8. Clear All Buffers.vi

Position in Hierarchy

Connector Pane

clear
all

Clear All Buffers.vi

This VI clears the buffers of all three Black Box Smartnode-485s.

Block Diagram

clear
buffer

3.4.9. Clear Device Buffers.vi

Position in Hierarchy

Connector Pane

Clear Device Buffers.vi

This VI reads all data in the buffer of a given station. In effect clearing the buffer. The information read is not used, or saved. The station is one of the Black Box Smartnode - 485s.

Block Diagram

cs

3.4.10. Compute Checksum.vi

Position in Hierarchy

cs

Connector Pane

Compute Checksum.vi

Computes the checksum of a string and returns the value as a hexadecimal string.

Block Diagram

config
info

3.4.11. Configuration Info.vi

Position in Hierarchy

Connector Pane

Configuration Info.vi

Builds header strings to be incorporated into a data file. The string consists of, in order: filename, current data and time, solenoid valve states, pressures, temperatures and elevation.

Block Diagram

str	ch
	#

3.4.12. Convert to Value.vi

Position in Hierarchy

str	ch
	#

Connector Pane

Convert to Value.vi

Takes an Acromag® string and returns the value transmitted and channel number.

Block Diagram

file

3.4.13. Create File.vi**Position in Hierarchy** **Connector Pane** **Create File.vi**

Creates a new file and writes the filename and version of the program to the file.
Returns the path to this file for future updating.

[illegible]

Date
Str**3.4.14. Date String.vi**

Position in Hierarchy

Date
Str

Connector Pane

Date
Str

Current Date String

Date String.vi

Gets today's date and returns a string in the form "01-01-94"

Block Diagram

de
select**3.4.15. Deselect Devices.vi****Position in Hierarchy** **Connector Pane**de
select**Deselect Devices.vi**

Writes a deselect command to the Black Box Smart Node -485s. This command cannot address stations separately, but deselects all stations.

Block Diagram

elev.
global

3.4.16. Elevation Zero Global.vi

Connector Pane

elev.
global

Elevation Zero Global.vi

This variable is the reference elevation that is used as the "zero".

Front Panel

3.4.17. Error Reporting.vi

Connector Pane

Error Reporting.vi

This global variable activates/deactivates error reporting associated with the Acromag® devices.

Front Panel

str ch
er

Position in Hierarchy

str	ch
	err

String ~~~~~ str

ch	Channel
err	Error Number

Returns the error number and channel for an Acromag® string.

Position in Hierarchy

```
get
error
str
```

Connector Pane

Converts an error number to the associated string.

Block Diagram

◀40▶

Data Conversion Error:

Station:

◀41▶

Data Not Valid Yet:

Station:

◀43▶

Excitation Voltage Too Low:

Station:

◀44▶

Excitation Voltage Too High:

Station:

Get Path

3.4.20. Get Path.vi

Position in Hierarchy

Connector Pane

Get Path.vi

Creates a filename with the current date embedded.

Example: "01-01-94.XXX"

Where the three digit suffix is a sequential file number or letters "cfg".

Block Diagram

INIT
COM2

3.4.21. Init Serial Port 2.vi

Position in Hierarchy

Connector Pane

INIT
COM2

Init Serial Port 2.vi

Initializes the computers COM2 port. This port is used to talk to the Black Box devices.

Block Diagram

Date Path

3.4.22. Path/Date String.vi

Position in Hierarchy

Connector Pane

Path/Date String.vi

Takes a relative path and converts it to an absolute path. It does this by preceding the path with "C:\WF_DATA\", so it is specific to this application.

Block Diagram

PSI
?

3.4.23. Pressure Stabilized.vi

Position in Hierarchy

Connector Pane

Pressure Stabilized.vi

Compares the pressures of PIT1 and PIT2 with reference pressures. If the difference is less than 10 psi, the pressures are considered stabilized.

Block Diagram

PT3
?

3.4.24. PT3 Stabilized.vi

Position in Hierarchy

PT3
?

VF
global

Connector Pane

PT3 Stabilized.vi

Compares pressure PT3 with a reference pressure. If the difference is less than 10 psi, the pressure is considered stabilized.

Block Diagram

AM

3.4.25. Read Acromag.vi

Position in Hierarchy

Connector Pane

ReadAcromag.vi

Reads all channels of one Acromag® station.

Block Diagram

read
all

3.4.26. Read All Stations.vi

Position in Hierarchy

Connector Pane

Read All Stations.vi

Reads the pressure values from each of the three Black Box/Sensotec devices. The pressures are PIT1, PIT2 and PIT3.

Block Diagram

Flow

3.4.27. Read Flowmeter.vi**Position in Hierarchy** **Connector Pane** **Read Flowmeter.vi**

Reads the flowmeter. This is accomplished by sending a command to start averaging flowmeter reading, then waiting 60 seconds for the averaging to conclude. Finally, the average is retrieved. During the 60 second wait no other transmission to the Acromags® occurs.

Block Diagram

read
PIT

3.4.28. Read Station.vi

Position in Hierarchy

Connector Pane

Read Station.vi

Reads a specified Black Box Smart Node - 485 station).

Block Diagram

3.4.29. Switch Globals.vi

Connector Pane

Switch Globals.vi

A global variable that contains the states of all eleven relays that control the solenoid valves.

Front Panel

TE3,4
stable

3.4.30. Temperature Stabilized.vi

Position in Hierarchy

Connector Pane

Temperature Stabilized.vi

This VI takes the two pressurization chamber temperatures and compares them with reference values. If the temperatures are within 3 degrees Celsius, the temperature is considered stable.

Block Diagram

str ?

3.4.31. Verify Checksum.vi

Position in Hierarchy

Connector Pane

Verify Checksum.vi

Takes a string and verifies that the checksum is good.

Block Diagram

Calc
global**3.4.32. Void Calculation Globals.vi**

Connector Pane

Calc
global**Void Calculation Globals.vi**

Stores the variables that are used to calculate the void fraction.

Front Panel

VF
global**3.4.33. Void Fraction Globals.vi**

Connector Pane

VF
global**Void Fraction Globals.vi**

Stores global variables for void fraction.

Front Panel

PE1	TE1	FE1	PIT1
0.00	0.00	0.00	0.00
PE2	TE2	LT1	PIT2
0.00	0.00	0.00	0.00
PE3	TE3	ZT1	PIT3
0.00	0.00	0.00	0.00
PE4	TE4		
0.00	0.00		
PE5	TE5		Checking Flow
0.00	0.00
PE6	TE6		
0.00	0.00		
PE7	TE7		Error Reporting
0.00	0.00
PE8	TE8		
0.00	0.00		
PE9	TE9		
0.00	0.00		
	TE10		Elevation Zero
	0.00		0.00

3.4.34. Write Message.vi

Filename MSG
String to Write

Appends a string to a specified file.

String to Write

abc

Filename

D:\

3

Append

Write Characters To File.vi

T

3.4.35. Write Test Data.vi

Position in Hierarchy

Connector Pane

Write Test Data.vi

Writes pertinent values to a file. These values are appended to an existing file.

Block Diagram

Filename

Write Characters To File.vi

write
AM**3.4.36. Write to Acromag.vi**

Position in Hierarchy

Connector Pane

Write to Acromag.vi

Writes digital values to Acromag® station 1.

Block Diagram

**config
File****3.4.37. Write to Config File.vi**

Position in Hierarchy

Connector Pane

Write to Config File.vi

This VI creates/appends a file in a directory encoded with the current data (creates the directory, if necessary). The VI then writes data from the front panel to the file.

4. REFERENCES

1. WHC-CM-6-1, "Standard Engineering Practices".
2. ANSI/IEEE Standard 829-1983, "IEEE Standard for Software Test Documentation".