ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Siemens / Controlotron System 990MN* at our website: *Click HERE*

MANUAL ADDENDUM

For Uniflow Field Manual 990NFM-2-1926

This addendum explains the changes to our standard 990N operating system made under the Engineering Work Order (EWO) number: 1926. The flow computer model number is 994MN2BS-3-1926. This application uses special aerospace transducers that have the part numbers: 991CNPS-EO.875 & 991CNPS-E1.000. This addendum presents the changes that affect the current 990NFM-2L field manual. The following sections detail the changes that affect the current field manual.

1. Site Setup - Pipe Data Menu

- ☐ The revised default Pipe OD is: 0.875 inches. This should be correct for the application. However, this value can be edited if necessary.
- ☐ The standard default Pipe Material is: *Titanium*. This should be correct for the application. However, this value can be edited if necessary.
- ☐ The default Estimated Vps is: 250000. This should be correct for the application. However, this value should be changed can be edited if necessary.
- ☐ The revised default Wall Thickness is: 0.025 inches. This should be correct for the application. However, if it is not, please edit it to reflect the exact wall thickness of the tube on which the transducers will be installed.

- *All other standard Site Setup defaults are left in place. You may modify these as necesary.*

2. Installation - Xdcr Mount Menu

- ☐ The default entry for Xdcr Size is: 991CNPS-E.O.875. This is a selectable entry. Select 991CNPS when installing on a 0.875" OD tube. Select 991CNPS-E 1.000 when installing on a 1.000" OD tube.

- *All other standard Installation defaults are left in place. You may modify these as necessary.*

3. Engineering drawings for EWO-1926

994MN-7 . . . . . Installation Drawing, 994MN NEMA 4X Flow Computer, Four Channel
994MN-8 . . . . . Outline Drawing, 994MN NEMA 4X Flow Computer, Four Channel
991CNPS-8. . . . . Installation/Outline Drawing, Condenser Tube Transducer
995T-7. . . . . Installation/Outline Drawing, 995T Control & Display Unit (CDU)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

990NFM-2L
December 1994

FIELD MANUAL

SYSTEM 990 UNIFLOW™

UNIVERSAL CLAMP-ON

NEMA FLOWMETER

MULTIPULSE,™ TRANSIT-TIME SYSTEM

CONTROLOTRON
155 PLANT AVENUE
HAUPPAUGE, NEW YORK 11788

Copyright © 1994 Controlotron
All Rights Reserved

Made in USA

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

ABOUT THIS MANUAL

This field manual presents detailed information about the installation, set-up and operation of Controlotron's System 990N Dedicated, NEMA, Clamp-On, Transit-Time Ultrasonic Flowmeter.

You do not need any special experience or training to operate our Uniflow System 990N. This field manual contains all the information and instructions that you require. If you connect an external device to System 990N, then you will need that device's instruction manual.

Keep this field manual in a convenient place at all times so it will be always available when needed.

SECTION 1 **INTRODUCTION TO UNIFLOW**
Introduction to the Uniflow flowmeter.

SECTION 2 **UNIFLOW FUNCTIONS & FEATURES**
Uniflow functions, features & typical applications.

SECTION 3 **DESCRIPTION OF UNIFLOW EQUIPMENT**
Description of Uniflow system components.

SECTION 4 **UNIFLOW APPLICATION & INSTALLATION GUIDELINES**
Application and installation guidelines for pipes, liquids and transducer positioning.

SECTION 5 **HOW TO INSTALL & OPERATE UNIFLOW**
How to perform the Installation programming steps and operate a Uniflow flowmeter properly.

SECTION 6 **MENU LISTS**
Menu Lists that show selectable parameters. You will choose functions and features from these lists during the Site programming procedure.

SECTION 7 **HOW TO DIAGNOSE & SOLVE UNIFLOW APPLICATION PROBLEMS**
Presents advice on locating and resolving common application problems.

APPENDIX A **AVOIDING ELECTROSTATIC DISCHARGE (ESD) DAMAGE WHEN HANDLING EQUIPMENT**
Advice on the proper handling of Controlotron circuit boards.

APPENDIX B **DRAWINGS**
Engineering Drawings for the Uniflow flowmeter that show outline dimensions for all system components and how to install the hardware correctly.

NOTICE:This equipment contains components that are susceptible to electrostatic discharge (ESD). Please refer to Appendix A for correct handling procedures.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

TABLE OF CONTENTS

SECTION 1	**INTRODUCTION TO UNIFLOW**	1
1.1	General	1
1.2	Construction Features	2
1.3	990N Installation Features	2
1.4	Functional Features & Options	2
1.5	Performance Features (standard conditions)	2
1.6	Easy Use Features	3
1.7	Drawings	3
1.8	Customer Services	3
SECTION 2	**FUNCTIONS & FEATURES**	4
2.1	General	4
2.2	Uniflow Data Categories	4
2.3	Graphics Display Option	4
2.4	LCD Digital Display Option (CDU programmable)	5
2.5	Data Outputs & Inputs (field-programmable for each channel)	5
SECTION 3	**EQUIPMENT DESCRIPTION**	8
3.1	General	8
3.2	Transducer Assemblies	8
3.3	Flow Display Computer (FDC)	8
3.4	995T Control & Display Unit (CDU)	9
SECTION 4	**APPLICATION & INSTALLATION GUIDELINES**	10
4.1	General	10
4.1.1	Considerations For Critical Applications	10
4.2	Liquid Guidelines	10
4.3	Pipe Guidelines	10
4.3.1	Pipe Dimensions	11
4.4	Transducer Selection Guidelines	11
4.5	Mounting Track Guidelines	11
4.6	Transducer Location	13
4.7	Flow Velocity Range	13
4.8	Flow Data Scatter & Damping	13
4.9	High Temperature Applications	13
SECTION 5	**HOW TO INSTALL & OPERATE UNIFLOW**	14
5.1	Uniflow Installation Menu	14
5.1.1	Installation Menu Notes	16
5.2	Powering The 994 Flow Display Computer	16
5.3	How To Perform Site Setup	19
5.3.1	Site Load	19
5.3.1.1	Channel Select (multi-channel systems only)	20
5.3.1.2	Channel Disable	20
5.3.1.3	Create Site	21
5.3.1.4	Save Site	22
5.3.1.5	Recall/Use Site	22
5.3.1.6	Find/Delete Site	23
5.3.2	Pipe Data	23
5.3.2.1	Units	23
5.3.2.2	Pipe OD	23
5.3.2.3	Pipe Material	24
5.3.2.4	Estimate Vps (i/s)	24
5.3.2.5	Wall Thickness	24
5.3.2.6	Liner Material	27

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.2.7	Liner Thickness	27
5.3.3	Liquid Data	27
5.3.3.1	Liquid Type	27
5.3.3.2	Estimated Vs (m/s)	28
5.3.3.3	Viscosity	29
5.3.3.4	Density (SG)	29
5.3.4	Flow Rate Units	30
5.3.4.1	Units (Vol/Mass)	30
5.3.4.2	Time Units	30
5.3.4.3	Display Range	30
5.3.4.4	Display Scaling	30
5.3.5	Flow Total Setup	31
5.3.5.1	Units (Vol/Mass)	32
5.3.5.2	Resolution (Totalizer Capacity)	32
5.3.5.3	Totalizer Mode	32
5.3.5.4	Batch/Sample Tot	33
5.3.5.5	Display Scaling (Totalizer)	33
5.3.6	Analog Span	33
5.3.6.1	Max Flow Rate	34
5.3.6.2	Min Flow Rate	34
5.3.6.3	Max Vs	34
5.3.6.4	Min Vs	34
5.3.7	Alarm Set	35
5.3.7.1	High Flow Alarm	35
5.3.7.2	Low Flow Alarm	35
5.3.7.3	Interface Vs	35
5.3.7.4	Aeration Alarm	35
5.3.8	Stripchart Setup	36
5.3.8.1	Data Selected (Stripchart & Barchart)	36
5.3.8.2	Scale Units	36
5.3.8.3	Time Interval	37
5.3.9	Datalogger Setup (Level 2 & 3 Systems)	37
5.3.9.1	Datalogger Mode	37
5.3.9.2	Data Selected (Datalogger)	37
5.3.9.3	Event Selected	38
5.3.9.4	Log Interval Set	38
5.3.10	Analog Inputs	39
5.3.10.1	Auxiliary 1 (2, 3 or 4) Input	39
5.3.11	Analog Outputs	40
5.3.11.1	V1 (V3 & V4)	40
5.3.11.2	Io/V2 (Io/V1, Four Channel Systems)	40
5.3.12	Relay Setup	41
5.3.12.1	Channel Relay 1 (2, 3 & 4)	41
5.4	How To Enter Installation Data	42
5.4.1	Xdcr (Transducer) Mount	42
5.4.1.1	Xdcr (Transducer Size)	43
5.4.1.2	Track Type	43
5.4.1.3	Track Size	44
5.4.1.4	Letter Index	44
5.4.1.5	Number Index	45
5.4.1.6	Initial Makeup	45
5.4.1.6.1	Successful Initial Makeup	45
5.4.1.7	Measured Vs	47
5.4.1.8	Alternate Initial Makeup Results	47
5.4.1.9	In-Process Makeup	48

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.4.1.9.1 Re-Registration . . . 49
5.4.2 Site Adjustment . . . 49
5.4.2.1 Empty Set . . . 49
5.4.2.1.1 Actual Empty Procedure . . . 49
5.4.2.1.2 MTYmatic Procedure . . . 50
5.4.2.2 Zero Flow Set . . . 50
5.4.2.3 SmartSlew . . . 51
5.4.2.3.1 Damping Set . . . 51
5.4.2.3.2 Slew Rate (F/S/S) . . . 52
5.4.2.4 Deadband Set . . . 52
5.4.2.5 Memory or Fault . . . 52
5.4.3 Flow Calibration . . . 53
5.4.3.1 Calibration Type . . . 53
5.4.3.2 Calibrate Kc . . . 53
5.4.4 Diagnostics . . . 54
5.4.4.1 Data Mode . . . 54
5.4.4.2 Test/Control Mode . . . 55
5.5 Operation Setup . . . 56
5.5.1 Operation Mode . . . 56
5.5.1.1 Security . . . 56
5.5.1.2 Makeup Alarm Latch . . . 57
5.5.1.3 LCD Digital Display Option . . . 57
5.5.2 Display Select (Level 3 Only) . . . 59
5.5.2.1 Viewing the Datalogger Display (Levels 2 & 3 Systems only) . . . 62
5.5.3 Data Memory (Levels 2 & 3 Only) . . . 62
5.5.3.1 Print Memory . . . 62
5.5.3.1.1 Printing the Stripchart . . . 63
5.5.3.2 Data Memory Open . . . 63
5.5.3.3 Data Memory Clear . . . 64
5.5.3.4 Circular Memory . . . 64
5.5.4 RS-232 Setup (Levels 2 & 3 Only) . . . 64
5.5.4.1 Baud Rate . . . 64
5.5.4.2 Parity . . . 65
5.5.4.3 Line Feed . . . 65
5.5.4.4 Network I.D. . . . 65
5.5.5 Clock Set . . . 66
5.5.5.1 Date . . . 66
5.5.5.2 Time . . . 66

SECTION 6 MENU LISTS . . . 67
6.1 Opening Screen . . . 67
6.2 Site Setup Menu Lists . . . 67
6.3 Installation Data Menu Lists . . . 70
6.4 Operation Setup Menu Lists . . . 71

SECTION 7 HOW TO DIAGNOSE & SOLVE UNIFLOW APPLICATION PROBLEMS . . . 72
7.1 General . . . 72
7.2 Equipment Failure Diagnosis Using The Pipe Simulator . . . 72
7.3 Unacceptable Application Conditions . . . 74
7.3.1 Liquid Conditions . . . 74
7.3.1.1 Aeration . . . 74
7.3.1.2 Liquid Slurries . . . 74
7.3.1.3 Two-Phase Liquids . . . 75
7.3.1.4 Viscous Liquids . . . 75
7.3.2 Pipe Conditions . . . 75
7.3.2.1 Pipe Liners . . . 75

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

7.3.2.2	Pipe Outside Diameter-To-Wall Thickness Ratio	75
7.3.2.3	Transducer-to-Pipe Coupling	75
7.3.3	Flow Conditions	76
7.3.3.1	Flow Fluctuation	76
7.3.3.2	Low Flow Rates	76
7.3.3.3	Flow Profile Consideration	76
7.4	Improper Site Setup Or Installation	77
7.4.1	Erroneous Pipe Specification	77
7.4.2	Erroneous Liquid Specification	77
7.4.3	Improper Transducer Mounting	77
7.5	Loss Of Zero Adjustment	78
7.5.1	Re-Registration Procedure	78
7.6	Diagnostic Display Commands	79
7.7	Messages	80
7.8	General Performance Deficiency	82
7.8.1	Accuracy	82
7.8.2	Data Stability	82
7.8.2.1	Data Scatter	82
7.8.2.2	Drift	83
7.8.3	Repeatability	83

FIGURES

Figure 2-1:	Typical NEMA 4X Flow Display Computer	6
Figure 2-2:	Versions of the Uniflow Dedicated NEMA Flow Display Computer	7
Figure 3-1:	995T Control & Display Unit (CDU)	9
Figure 4-1:	Reflect & Direct Mounting Track Configurations	12
Figure 5-1:	Uniflow NEMA Installation Menu (Sheet 1)	17
Figure 5-1:	Uniflow NEMA Installation Menu (Sheet 2)	18
Figure 5-2:	Optional LCD Digital Display Screen	58
Figure 5-3a:	Single Channel Digital Display	59
Figure 5-3b:	Dual Channel Digital Display	60
Figure 5-3c:	Four Channel Digital Display	60
Figure 5-3d:	Datalogger Display Screen	60
Figure 5-3e:	Single Channel Stripchart Screen	61
Figure 5-3f:	Dual Channel Stripchart Screen	61
Figure 5-3g:	Typical Stripchart Printout (996P Printer)	61
Figure 7-1:	Setting up the Pipe Simulator	73

TABLES

Table 5-1:	Vps Values (inches/second) For Some Common Metals	25
Table 5-2:	Pipe Data	26
Table 5-3:	Vs Values (meters/second) for Common Liquids	28
Table 5-3a:	Sonic Velocity of Pure Water	29
Table 5-4:	Recommended Sonic Coupling Compounds	46
Table 7-1:	Pipe Simulator Chart	73

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

MENU LISTS

List 1:	Channel Select (Multi-Channel Systems)	67
List 2:	Channel Enable; Circular Memory; Data Memory Clr; Line Feed	67
List 3:	Site Name	67
List 4:	Units	67
List 5:	Pipe Material	67
List 6:	Liner Material	68
List 7:	Liquid Type	68
List 8:	Units (Vol/Mass)	68
List 9:	Flow Rate Time Units	68
List 10:	Flow Rate Display Range	68
List 11:	Totalizer Resolution/Capacity	68
List 12:	Totalizer Display Mode	68
List 13:	Data Selected	69
List 14:	Stripchart Scale Units (Level 3)	69
List 15:	Stripchart Pixel Time Interval (Level 3)	69
List 16:	Datalogger Mode (Levels 2 & 3)	69
List 17:	Datalogger Data Selected (Levels 2 & 3)	69
List 18:	Datalogger Event Selected (Levels 2 & 3)	69
List 19:	Log Interval Set (Levels 2 & 3)	69
List 20:	Analog Outputs	69
List 21:	Relay Setup	69
List 22:	Xdcr Size	70
List 23:	Mounting Track Type	70
List 24:	Mounting Track Size	70
List 25:	Letter Spacing Index	70
List 26:	Empty Pipe Set	70
List 27:	Zero Flow Set	70
List 28:	Fault Mode	70
List 29:	Calibration Select	70
List 30:	Diagnostics & Test Routines	70
List 31:	Site Security; Makeup Latch	71
List 32:	Display Select	71
List 34:	RS-232 Baud Rate	71
List 33:	Print Memory (Levels 2 & 3)	71
List 35:	RS-232 Parity	71

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

DRAWING LIST

994N-7 . . . . . Installation Drawing, 994N NEMA 4X Flow Computer

994N-8 . . . . . Outline Dimensions, 994N NEMA 4X Flow Computer

994DN-7 . . . . . Installation Drawing, 994N NEMA 4X Flow Computer, Dual Channel

994DN-8 . . . . . Outline Dimensions, 994N NEMA 4X Flow Computer, Dual Channel

994MN-7 . . . . . Installation Drawing, 994N NEMA 4X Flow Computer, Four Channel

994MN-8 . . . . . Outline Dimensions, 994N NEMA 4X Flow Computer, Four Channel

994X-7 . . . . . Installation Drawing, 994N NEMA 7 Flow Computer

994X-8 . . . . . Outline Dimensions, 994N NEMA 7 Flow Computer

994DX-7 . . . . . Installation Drawing, 994N NEMA 7 Flow Computer, Dual Channel

994DX-8 . . . . . Outline Dimensions, 994N NEMA 7 Flow Computer, Dual Channel

993-7 . . . . . Installation, Adaptive Function & Control Module (AFAC)

994-7-7 . . . . . Installation, Analog Output Module

994-7V-7 . . . . . Installation, Analog Voltage Output Module

994-11D-7 . . . . . Insatallation, Digital Display Computer Module

994-12-7 . . . . . Installation, Serial Output Module

990TNDM-7B . . . . . Installation Drawing, 990 Series Transducer, Direct Mode, NEMA 4, Std. Temp.

994TNRM-7B . . . . . Installation Drawing, 990 Series Transducer, Reflect Mode, NEMA 4, Std. Temp.

990TNHM-8 . . . . . Outline Dimensions, 990 Series Transducer & Tracks, Dedicated, Hybrid Style

992-60-7 . . . . . Installation, Adjustable Mounting Strap Assembly

994-8M-7 . . . . . Installation, Voltage-to-Current Convertor Module

995T-7 . . . . . Installation/Outline Drawing, 995T CDU, Hand-Held Terminal

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SECTION 1
INTRODUCTION TO UNIFLOW

1.1 GENERAL

Welcome to the Uniflow System 990N, Controlotron's Universal, Dedicated, NEMA Clamp-On, Transit-Time Flowmeter. This manual presents a detailed description of System 990N functions, installation and operation. The Uniflow 990N is a full-featured, easy to use, high precision instrument that will provide accurate flow data for most applications.

The Uniflow series is the latest in the long line of Clamp-On Ultrasonic Flowmeters designed and produced by Controlotron. Controlotron pioneered clamp-on ultrasonic flowmetering, introducing the world's first instrument of this type in 1972. Since that time, Controlotron maintains its leadership, holding more original patents and producing more ultrasonic flowmeters than any other company. Winners of the prestigious IR-100, Vaaler, Putman, and Plant Engineering and Maintenance Show awards, Controlotron manufactured flowmeters are used in essentially every industry and every industrialized country in the world.

Uniflow flowmeters offer more features than any type of flowmeter produced previously, conventional or ultrasonic, intrusive or non-intrusive. Uniflow is actually three instruments in one!

...Flowmeter ...Stripchart Recorder ...Datalogger!

To get to know about these features and functions so that you may realize all the benefits System 990N offers, we recommend that you invest the time to read this manual. You can obtain further assistance by calling Controlotron Application Engineering or Technical Service.

We offer our dedicated 990N systems in single, dual or four channel configurations, with standard NEMA 4X or optional NEMA 7 enclosures. Opening these enclosures provides access to the system's function modules. This "building block" construction allows you to maintain a stock of basic 990N models, and add only those function modules that are required for a particular application.

Our Dedicated 990N and Portable 990P systems are entirely equivalent in operation. However, we equip our Portable systems with all available options (except Analog Inputs). You can evaluate a Dedicated 990N System's applicability by first trying a 990P Portable model at the prospective site.

The following sections will introduce you to some of the functions and features available. However, the best way to learn what the system can do, and how to use it, is to review each programming step listed on the Installation Menu Chart (see Figure 5-1). The Installation Menu Chart includes paragraph references for each Menu procedure. These explanatory paragraphs can be found in Section 5 of this manual.

TYPICAL APPLICATIONS INCLUDE:

- ☐ Mass Flow Measurement
- ☐ Aircraft Ground Support
- ☐ Custody Transfer (Irrigation & Oil Pipeline Delivery)
- ☐ Thermal Energy (BTU) Metering (System 990E)
- ☐ Pump & Valve Capacity & Condition Testing
- ☐ Preventative Maintenance
- ☐ Leak Detection (System 990LD & 990LDV)
- ☐ Custody Transfer Certification
- ☐ Water Injection (Oil Recovery)
- ☐ Boiler Feed Flow - Heating Oil
- ☐ Waste Water - Effluent Flow
- ☐ Flow Tracing & Sampling
- ☐ Flow Balancing (System 990MN)
- ☐ Portable Flow Survey (990P)

TYPICAL INDUSTRIES SERVICED INCLUDE:

- ☐ Water & Waste
- ☐ Power Plants (Nuclear, Fossil, & Hydro)
- ☐ Chemical & Petrochemical Processing
- ☐ Oil Production & Transportation
- ☐ Shipboard Operations & Maintenance
- ☐ Energy (HVAC)
- ☐ Food & Pharmaceutical
- ☐ Paper & Pulp
- ☐ Aircraft Avionics & Ground Support
- ☐ Automotive

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

1.2 CONSTRUCTION FEATURES

- ☐ Lightweight & Rugged NEMA 4X or NEMA 7 flow computer suitable for all industrial environments
- ☐ Universal Transducers clamp to pipe in minutes using patented mounting tracks that eliminate "ruler" spacing measurements
- ☐ A Few Transducer Assemblies measure most pipes:
  - A total of 3 sizes needed for 1/4 to 8 inch pipes
  - A total of 4 sizes needed for 1/2 to 48 inch pipes
  - A total of 3 sizes needed for 1/2 to 24 inch pipes
  - A total of 5 sizes needed for up to 360 inch pipes
- ☐ Single channel flow survey and multi channel flow balance and flow trace units available
- ☐ High precision 990DB dual-path systems available for non-intrusive replacement of Wetted Transducer 4-Path and 8-Path Chordal Systems

1.3 990N INSTALLATION FEATURES

Installing the 990N system is far simpler, quicker and less expensive than intrusive flowmeters. Our clamp-on flow transducers are more reliable and require much less maintenance than measurement systems that require contact with the flow stream. These intrusive systems routinely deteriorate from the continuous liquid immersion.

Our Dedicated 991N transducers use stainless steel mounting straps to secure the transducers on the mounting track. They install easily in minutes. You may use also the magnetic track mounts supplied with our portable version. Using portable tracks may be more convenient with large diameter pipes.

1.4 FUNCTIONAL FEATURES & OPTIONS

- ☐ Displays flow rate, flow total & status/alarms on easy to read LCD Digital or LCD Graphic Screens with selectable display units
- ☐ Internal real-time Diagnostic function keeps track of application & equipment conditions and displays data on CDU screen
- ☐ Internal programmable Datalogger option records selected data or alarms during unattended operation
- ☐ Internal programmable Stripchart option for real-time printout of selected flow or diagnostic data
- ☐ Comprehensive status/alarm indicators
- ☐ RS-232 compatible serial I/O port option allows remote programming, permits system networking and transmits real-time stripchart data or memorized datalogger data
- ☐ Internal multiple site memory option allows you to re-install the system at previous sites without needing to re-enter Site Data
- ☐ Analog input option allows the flow computer to receive data from external direct-sensing instruments

NOTE: Section 5.5 includes illustrations of the LCD Digital Display Screen and typical Graphic Display Screens.

1.5 PERFORMANCE FEATURES *(standard conditions)*

Accuracy . . . . . 1% to 3% intrinsic Calibration; better than 1/2% of actual flow possible with flow calibration
Flow Sensitivity . . . . . 0.001 ft/sec even at zero flow
Zero Drift Stability . . . . . 0.003 ft/sec for most applications
Response Rate. . . . . . Programmable from 0.2 to 60 seconds, (10Hz bandwidth)
Flow Velocity Range . . . . . ±40 ft/sec (minimum), including zero flow
Linearity . . . . . 0.003 ft/sec
Automatic Flow Profile Compensation . . . . . Reynolds Number correction of reported flow rate

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

1.6 EASY USE FEATURES

- ☐ Simple menu-driven data entry for Site Setup, Installation & Operation Setup
- ☐ Hand-Held programming terminal (995T CDU) recommends appropriate Transducer size; Mounting Configuration & PinStop™ Mounting Track
- ☐ Mounting Track Indices ensure accurate transducer spacing (no measurement required)
- ☐ Instant Datalogger Command Key eliminates need to hand write data in the field

1.7 DRAWINGS

Appendix B of this field manual provides the engineering drawings for this equipment. These drawings include outline and installation schematics for mounting tracks, transducers, and flow display computer, as well as any drawings required for a specific application.

1.8 CUSTOMER SERVICES

Controlotron offers various in-plant and field customer training programs, as well as world-wide installation, application evaluation and maintenance services. To obtain assistance, simply call Controlotron and ask for Technical Service. Before calling for assistance, please have the serial numbers for the following equipment available: 991 Transducer; 994 Flow Display Computer.

ATTENTION: TECHNICAL SERVICE
CONTROLOTRON CORPORATION
155 PLANT AVENUE, HAUPPAUGE,
NEW YORK 11788, U.S.A.

- **HOTLINE: (800) 275-8480**
- **PHONE: (516) 231-3600**
- **FAX: (516) 231-3334**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SECTION 2
FUNCTIONS & FEATURES

2.1 GENERAL

System 990 provides comprehensive flow and application data. You can instruct the flow computer to memorize measured data for later review. Also, you can use our optional 996P 80-column portable printer to print selected data in the standard 8-1/2" by 11" format to ease report preparation. System 990 provides the following functions and features (depending on the model ordered).

2.2 UNIFLOW DATA CATEGORIES

- ☐ Volumetric & Mass Flow Rate Display in selected units
- ☐ Volumetric & Mass Flow Total Display in selected units
- ☐ Status & Alarm Indicators:
  - Flow (Hi/Lo)
  - Aeration
  - Interface
  - Totalizer Mode
  - Empty Pipe
  - Operation Fault
  - Makeup
  - Flow Direction
  - Xdcr Spacing Alert
- ☐ Liquid Sonic Properties:

Sonic Propagation Velocity (related to liquid density)

Sonic Conductivity or Turbidity (related to signal strength)

Degree of Cavitation or Aeration

2.3 GRAPHICS DISPLAY OPTION

(programmable single and multi-channel display screens)

- ☐ Digital Mass or Volumetric Flow Rate Display in selected units (4 digits)
- ☐ Digital Mass or Volumetric Flow Total Display in selected units (7 digits)
- ☐ Status/Alarm, Totalizer Mode, & Flow Direction Indicator
- ☐ Analog Bargraph - (53 segments, 0.1% numerical resolution)
- ☐ Analog Stripchart - selected data & report interval
- ☐ Digital Datalogger - selected data & report interval
- ☐ Diagnostic Display presents flow data, current operating conditions, test commands & recovery routines (CDU Screen)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

2.4 LCD DIGITAL DISPLAY OPTION *(CDU programmable)*

(Available for single & multi-channel NEMA 4X systems or single-channel NEMA 7 systems)

- ☐ Digital Mass or Volumetric Flow Rate Display in selected units (4 digits)
- ☐ Digital Mass or Volumetric Flow Total Display in selected units (6 digits)
- ☐ Flow Direction Indicator
- ☐ Analog Bargraph, (52 segments, 0.1% resolution)
- ☐ Eight Status/Alarm Symbols
- ☐ Diagnostic Display presents flow data, current operating conditions, test commands & recovery routines (CDU Screen)

2.5 DATA OUTPUTS & INPUTS *(field-programmable for each channel)*

Available with Analog Data Option:

- ☐ 0 to 10 Vdc - output proportional to spanned flow rate *(Vo)*
- ☐ 0 to 10 Vdc - output proportional to spanned flow velocity *(Vf)*
- ☐ 0 to 10 Vdc - output proportional to signal strength *(Valc)*
- ☐ 0 to 10 Vdc - output proportional to liquid sonic velocity *(Vs)*
- ☐ 0 to 10 Vdc - output proportional to degree of liquid aeration/cavitation or nonhomogeneity *(Vaer)*
- ☐ 4 to 20 mA (isolated) - output proportional to any of the functions listed above
- ☐ TTL Pulse (0 - 5000 Hz) - output proportional to any of the functions listed above

Available with Alarm Relay Option:

- ☐ Normally-open or normally-closed dry contact relay - output assignable to any alarm function
- ☐ Normally-open mercury wetted contact relay - output assignable to any status/alarm function

Available with RS-232 Serial I/O port option:

- ☐ Memorized Datalogger print-out to remote printer, computer or network
- ☐ Real-time Stripchart output to remote printer, computer or network
- ☐ Remote programmability via P.C. or modem

Available with Analog Input Board Option:

- ☐ Four 4-20mA or 0-10V analog inputs *(single-channel systems)*
- ☐ Two 4-20mA or 0-10V analog inputs per channel *(dual-channel systems)*
- ☐ One 4-20mA or 0-10V analog input per channel *(four-channel systems)*

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

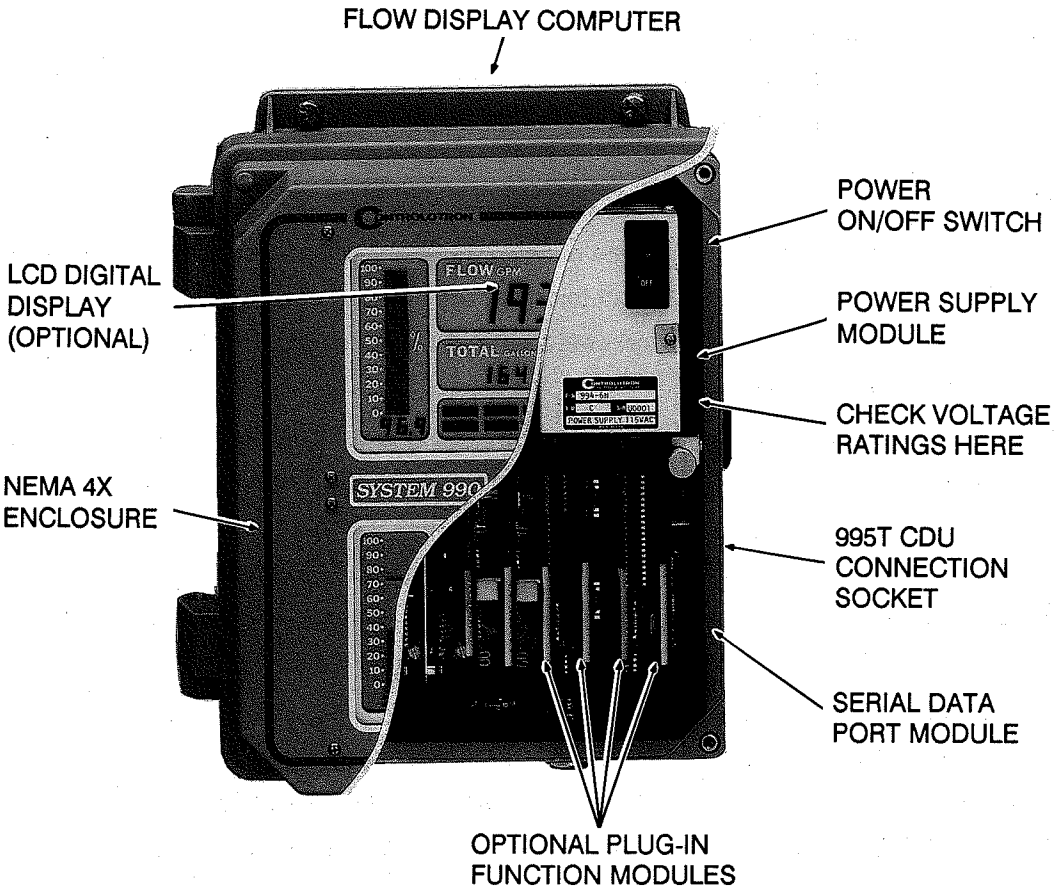
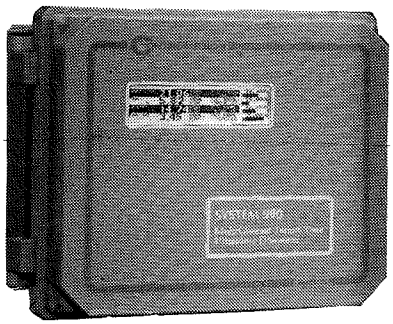


Figure 2-1: Typical NEMA 4X Flow Display Computer

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com



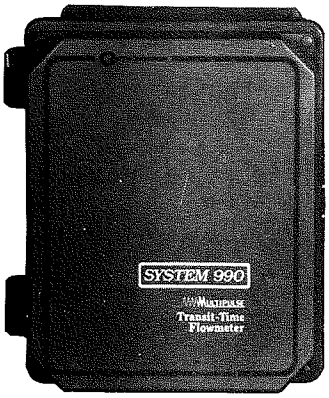
994MN4G-3
Multi-Channel NEMA 4
(Graphics Display)



994N3D-2
Single Channel NEMA 4
(LCD Digital Display)



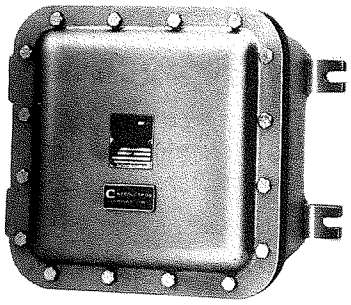
994DN3D-2
Dual Channel NEMA 4
(LCD Digital Display)



994N4B-2
Blind NEMA 4
(No Local Display)



994N5G-3
Single Channel NEMA 4
(Graphics Display)



994X3B-1
Single Channel NEMA 7
(Explosion Proof)

Figure 2-2: Versions of the Uniflow Dedicated NEMA Flow Display Computer

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SECTION 3
EQUIPMENT DESCRIPTION

3.1 GENERAL

System 990N includes:

☐ One to six 991N Transducer Assemblies as ordered (see Para. 3.2)

Size	Pipe OD Range (inches)
0	0.25 to 2
1	0.5 to 4
2	1.25 to 8
3	6 to 24 (reduced max. liquid Vs above 20)
4	20 to 48 (reduced max. liquid Vs above 42)
5	36 to 360

☐ One set of 992CN Transducer Cables (per channel)

☐ One 994N Flow Computer (single or multi-channel)

☐ One 995T Control & Display Unit (CDU) Hand-Held Terminal

☐ One 990NFM-2L field manual

3.2 TRANSDUCER ASSEMBLIES

As noted in Paragraph 3.1, System 990N uses six standard transducer assembly sizes. Each assembly size covers a specific range of pipe outer diameters. You select the transducer assembly size when purchasing the system. If necessary, you may purchase additional transducer assemblies that are within the diameter group range of your 994N flow computer.

System 990 mounting tracks feature PinStop™ transducer spacing to eliminate difficult and uncertain pipe measurement during transducer installation. Transducer and mounting track installation requires no tools. Our standard universal mounting tracks fit any pipe within their designated outside diameter range. We can supply shorter "A" or "B" ("S" for portable systems) mounting tracks for tight locations or short pipes.

You should use the optional Pipe Simulator to test the entire system (flow computer, cables, transducers) whenever you encounter an operating difficulty. This will almost always prove that an application condition (e.g. excessive liquid aeration or an unbonded pipe liner) and not defective equipment caused the problem.

3.3 FLOW DISPLAY COMPUTER (FDC)

The 994N flow computer comes in a NEMA 4X or NEMA 7 enclosure for permanent installations. The plastic NEMA 4X enclosure is lightweight, weatherproof, corrosion resistant and impact resistant to withstand the rigors of most industrial environments. The NEMA 7 enclosure is an aluminium case suitable for use in N.E.C. Class 1, Groups C and D hazardous areas.

System 990N uses plug-in modules (including Power Supply). This allows simple and rapid maintenance when required. You have the option of stocking basic 990N models, and adding only those function modules that are required for a particular application.

Number of Channels: . . . . . 1, 2 or 4

Power . . . . . 100 to 115 VAC (50-60 HZ); 200 to 240 VAC (50-60 HZ); 9-36 VDC

Display . . . . . 64 X 256 Pixel LCD Graphics Display (NEMA 4X only); Single or Multi-Channel LCD Digital Display (Single only for NEMA 7)

Pipe OD Ranges . . . . .

Group	Operates Transducer Size
2	0, 1, 2
3	1, 2, 3
4	1, 2, 3, 4
5	1, 2, 3, 4, 5 (for pipes up to 216" OD)
6	1, 2, 3, 4, 5 (for pipes up to 360" OD)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

3.4 995T CONTROL & DISPLAY UNIT (CDU)

The 995T Control & Display Unit (CDU) is a hand-held terminal for entering, reviewing or editing Site parameters. It connects to the flow computer via a cable and receptacle. It includes a 4 X 20 character alphanumeric LCD screen that shows the Installation Menu data entry cells and their stored parameters. The LCD screen serves also as a digital data display for systems purchased without a local display screen. You enter data via a 30-button array of numeric and function keys.

The Menu key activates the Installation Menu. For numeric entry, the keypad includes digits 0 through 9, a decimal point key, and a positive/negative number toggling key. The Up, Down, Right and Left Arrow keys scroll the Installation Menu in their respective directions (see Figure 5-1). The Enter key stores data, and the Clear key erases data. The mathematic operator keys allow the CDU to emulate a simple four-function calculator. The "F" keys select special operation and display functions. The Datalog key selects the on-screen data logging function.

Menu-driven site programming guarantees a simple and successful installation. The installation menu progresses sequentially through all installation steps. Apprpriate menu cells have per-programmed defaults. Accepting as many defaultsas possible will reduce the programming steps required to obtain operation.

The CDU has no alphabetic keys to eliminate possible spelling mistakes during data entry. The CDU accepts either numeric data (such as pipe dimensions) or items selected fromscrolling option lists presented on the CDU screen. The Up or Down Arrows scroll these lists in their respective directions.

The CDU provides a diagnostic screen that presents flow data, current operating conditions and system test/recovery routines. The flow computer's site memory stores up to 16 sets of Site Data (depending on installed options). You recall a Site Data set simply by selectinga Site Name froman option list.

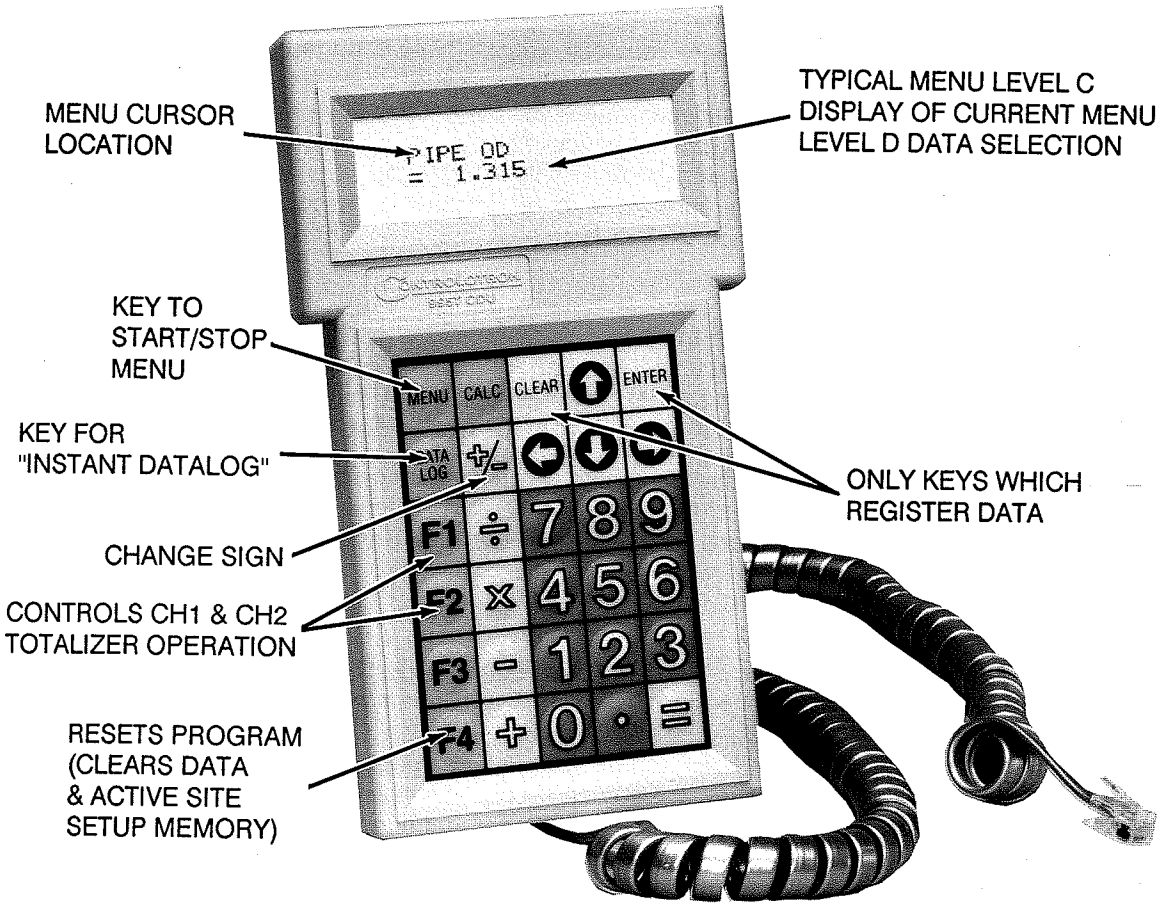


Figure 3-1: 995T Control & Display Unit (CDU)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SECTION 4
APPLICATION & INSTALLATION GUIDELINES

4.1 GENERAL

System 990 is an extremely versatile clamp-on, transit-time, ultrasonic flowmeter. To obtain the best possible service from this equipment, it is advisable to pay particular attention to the application guidelines presented in this section. The system must be told what you want it to do. You accomplish this by performing the menu-driven installation procedure. The flow computer verifies pipe and liquid conditions to optimize operation. However, satisfactory performance depends also on the accuracy of the information that you provide.

4.1.1 CONSIDERATIONS FOR CRITICAL APPLICATIONS

All flowmeters depend on site flow conditions and proper installation to achieve precise, critical flow measurement. Flow profile irregularities, flow stratification, aeration or cavitation, and the length of available straight run, can contribute to uncertainty and potential error. This reality applies to all flowmeters, regardless of their sophistication, expense, or published intrinsic accuracy. These conditions become critical when applications involve nuclear safety related flows, custody transfer and tenant billing situations.

Our 990 clamp-on transit-time meters offer the opportunity to minimize adverse flow conditions in order to achieve extremely high accuracy. This can be accomplished by following the instructions for proper equipment selection, use of the proper transducer configuration and by paying close attention to installation instructions. Such judicious use implies expert knowledge and experience with equipment and flow conditions.

If your application requires critical measurement accuracy, you will have to do more than just simply install our flowmeter and expect optimal precision. To achieve optimal performance, you must consider carefully your piping configuration and install the transducers correctly. Even if this system has been calibrated for optimum precision at a flow laboratory, it does not relieve you of the responsibility of paying particular attention to our programming instructions and installation guidelines. We recommend that if your application is critical, you participate in our customer training programs. Another alternative, is to commission our trained professionals to install the flowmeter for you.

4.2 LIQUID GUIDELINES

Successful flow measurement depends on the sonic transmit signal traveling through the liquid and arriving at the receive transducer without excessive attenuation. Most liquids are excellent sonic conductors, regardless of their electrical or optical properties. Although highly viscous liquids exhibit a greater degree of sonic attenuation, the vast majority of these liquids are acceptable applications.

The usual cause of low liquid sonic conductivity is sonic beam scattering due to liquid non-homogeneity. Thus, liquids that contain an excess of gas bubbles or mineral solids may yield unsatisfactory results. However, System 990 is more tolerant of these conditions than any other Ultrasonic Transit-Time Flowmeter. Dissolved gasses and dissolved organic solids are always acceptable.

4.3 PIPE GUIDELINES

System 990 operates on any round pipe that is sonically conductive. Suitable pipe materials include most metals, plastics, glass and mandrel wound FRP. Pipes with a fine grain structure (e.g. carbon and stainless steel) are usually more sonically conductive than cast iron, ductile iron or copper pipes. Nevertheless, all are usually acceptable. Unsuitable pipes include concrete or other non-homogeneous materials. Pipe liners are acceptable if they are sonically conductive and bonded solidly to the pipe's inner wall. The system operates successfully on pipes with cement liners that are "spun" onto the pipe interior to exclude any air bubbles. Pipes with smoothly applied bituminous and epoxy coatings are also acceptable. Plastic liners are universally acceptable, provided that they are in intimate contact with the inner wall (not merely slipped within the pipe).

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

4.3.1 PIPE DIMENSIONS

Depending on the transducers and mounting tracks purchased, Uniflow Systems can be used with pipes from 0.25" to 360" in outer diameter. During installation programming (see Section 5.4), the flow computer recommends transducer sizes based on the Site Setup data that you enter (see Section 5.3).

Pipes with OD-to-Wall thickness (OD/W) ratios greater than 10 to 1 are ideal applications. Operation on pipes with OD/W ratios of 7 to 1 (or less) are acceptable, but may exhibit reduced stability and linearity. Generally, higher OD/W ratios provide better stability. If a pipe has a low OD/W ratio, you should use the smaller of the recommended transducer sizes (if the CDU recommends two transducer sizes).

4.4 TRANSDUCER SELECTION GUIDELINES

The recommended transducer size is based on the pipe's outer diameter(see Para. 5.3.3.2). However it is possible to use the system with a pipe size outside of its nominal pipe OD range. During transducer installation, you specify the transducer size. The flow computer responds by recommending a 992MT Spacing Index number. The transducer size is acceptable if the flow computer allows installation at the recommended spacing index without issuing a Spacing Alert.

NOTE: The 991 Flow Transducers are sold in matched pairs. Before installing the transducers, make sure that their serial numbers match.

If using the nominal transducers (for the specified diameter group) does not provide satisfactory operation, try using our "A" series transducers. An "A" series transducer may be recommended for some combinations of pipe wall thickness and material. Consult Controlotron's Application Engineering Department for further information, or request the 991XA Bulletin for your pipe material.

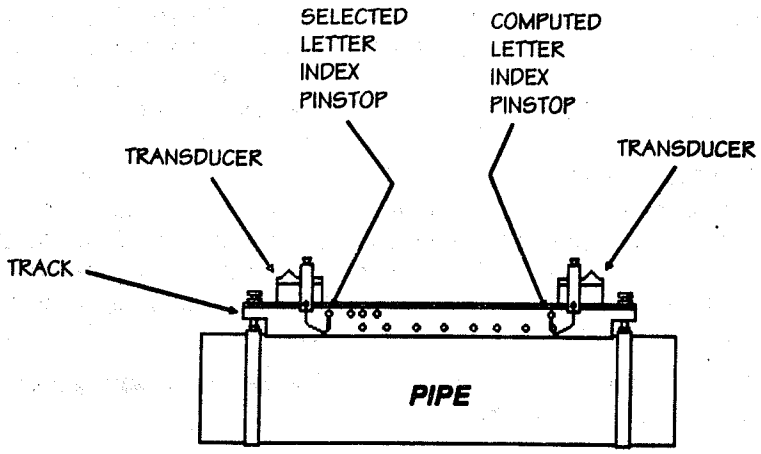
4.5 MOUNTING TRACK GUIDELINES

Controlotron transducer mounting tracks accommodate Direct or Reflect mounting configurations (see Figure 4-1). Based on data entered during Site programming, the flow computer may recommend either a Direct or Reflect mounting track. This recommendation can be overruled to use an available mounting track type. Note that Hybrid mounting tracks, that support both Direct and Reflect mounting modes, are available from the factory.

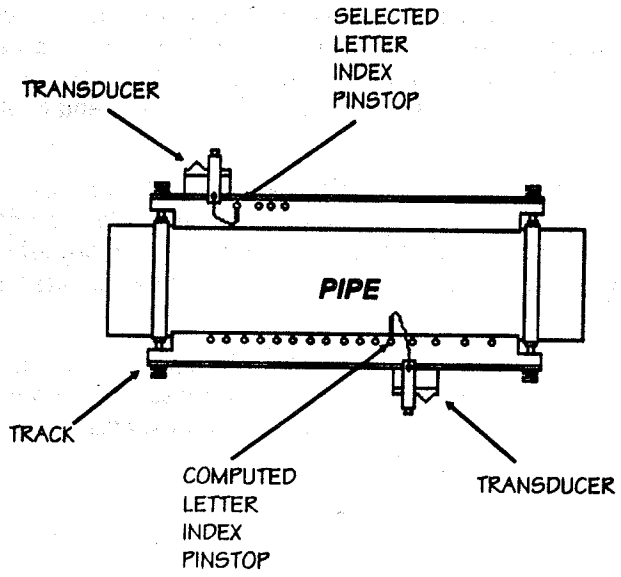
We usually recommend Reflect mounting because of its simple installation. Also, Reflect mounting provides improved resistance to skewed flow profile conditions that may produce crossflow within the flow stream. Reflect mounting may be required if site conditions disallow access to the opposite side of the pipe. Note that when compared to Direct mounting, Reflect mount tracks require almost double the amount of a straight pipe run.

Since Direct mounting provides a shorter sonic beam path, this configuration usually improves performance with sonically attenuative liquids. Also, Direct mounting may necessary to accommodate the mounting track if the only available pipe straight run is very short. In such cases, it may also be necessary to use the shorter special order *A* or *B* tracks (*S* for portable systems).

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com



REFLECT TRANSDUCER CONFIGURATION



DIRECT TRANSDUCER CONFIGURATION

Figure 4-1: Reflect & Direct Mounting Track Configurations

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

4.6 TRANSDUCER LOCATION

It is important to consider the following facts when you choose a transducer location:

1) For the best flow profile, try to locate the transducers slightly downstream from the center of the longest available straight run.

2) **DO NOT** (if possible), locate the transducers downstream from:
   - A throttling valve or any other cavitation source.
   - A mixing tank or other equipment that could potentially aerate the liquid.

3) **DO NOT** mount transducers on a pipe section that may empty during zero flow. If you cannot avoid this, then take into account that the system will not be able to measure flow until the pipe refills and the liquid flows for long enough to drive all the air from the pipe.

4) **DO NOT** mount the transducers on a pipe section that has internal scale. You should remove all external scale.

5) **DO NOT** mount the transducers on a pipe seam or other discontinuity. Transducers should be mounted so that any seam is midway between Direct Mount tracks, and not opposite Reflect Mount tracks.

6) **DO NOT** mount transducers from different 994 flow computers on the same pipe.

7) **DO NOT** run transducer cables in common bundles with cables from communication equipment or other Uniflow systems.

8) **DO NOT** mount transducers under water, unless you order submersible units and you install them in accordance with factory instructions.

9) Refer to Table 5-4 for a list of the sonic coupling compounds we recommend that you use when mounting the transducers on the pipe.

4.7 FLOW VELOCITY RANGE

System 990's flow velocity range is at least ±40 ft/sec regardless of the pipe's diameter. Depending on application conditions, this range can extend to over ±100 ft/sec. This measurement range is greater than needed for virtually any known application.

4.8 FLOW DATA SCATTER & DAMPING

System 990 features a much faster flow response and better detection sensitivity than any conventional flowmeter. Therefore, it can display slight flow fluctuations that are always present, though not detectable by typical flowmeters. This is a valuable asset if you need to track fast flow transients. However, you can adjust the Slew Rate and Damping Set controls (see Para. 5.4.2) to smooth the system's response.

4.9 HIGH TEMPERATURE APPLICATIONS

We rate our standard 991 transducers for operation to 250°F. We offer *High* (H) temperature flow transducers rated for operation at up to 375°F. You should purchase these if your pipe temperature exceeds 250°F. We also manufacture *Very High* (VH) temperature transducers for applications where the temperature exceeds 375°F, but is less than 450°F.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SECTION 5
HOW TO INSTALL & OPERATE UNIFLOW

5.1 UNIFLOW INSTALLATION MENU

System Installation is quick and simple. It can be accomplished by any user, whatever their experience. A sequential menu-driven procedure, presented on the hand-held 995T Control & Display Unit (CDU), guides you through all the steps necessary to bring the System on-line to perform any (or all) available data functions. An optional Site Storage facility allows operational parameters to be defined for a 'named' site, instead of a designated pipe size. This feature allows simple re-installation at a previous site.

Refer to the Installation Menu Chart (Figure 5-1). Note that it divides into four columns labeled Levels A, B, C and D (from left to right). The Level A column (on the left side of the chart) contains the three major Installation Menu categories. These are the three principal data entry activities:

- Site Setup
- Installation
- Operation Setup

Level B contains the major sub-categories nested within each Level A region. Level A and B can be considered the menu "express lanes". You can "express travel" between Level A and Level B categories. However, Level B limits "express" travel to menu categories associated with the related Level A activity. Level C shows data entry parameters. You perform data entry in adjacent Level D menu cells.

The Installation Menu Chart (Figure 5-1) shows the menu segments in the exact order in which they appear on the CDU Screen. Activating the Installation Menu (see Para. 5.3), selects automatically the Level A category, [Site Setup].

Normally, the CDU cursor moves through the Installation Menu in two ways:

- ☐ During programming, the cursor moves automatically to the next location after you enter data (by pressing ENTER key). However, if the data entered is not valid, the cursor may remain at the menu cell until the CDU detects an acceptable entry.
- ☐ You can move the cursor manually with the UP, DOWN, LEFT or RIGHT Arrow keys to avoid data entry. Arrow key cursor movement is entirely safe, because only the ENTER (or rarely, the CLEAR key) can affect memorized data. This allows you to review safely any data entered previously.

The flow computer uses two types of data:

- ☐ Numeric Data - typed on the CDU keypad
- ☐ "Named" Options - selected from scrollable option lists (this avoids the need to spell the selection).

Usually, the parameter stored in a Level D menu cell will be displayed in its adjacent Level C cell. A *greater than* symbol **[>]** precedes Level C parameters. When you move the CDU cursor to Level D, a *colon* - **[:]** precedes an option list item, and an *equal sign* **[=]** precedes numeric data.

You can only enter or clear option list items in Level D menu cells that display the notation [Enter:] or [Clear:]. The colon indicates active ENTER or CLEAR keys. You can use either the UP or the DOWN Arrow to scroll an option list. When you scroll through an option list, the currently active parameter flashes. When you scroll the option list to the required parameter, you press the ENTER key to activate it.

In Level D menu cells that store numeric data, you can either press the CLEAR key first to set the data to zero, or use the CDU Number keys to over-type the displayed data. After typing the correct numeric value, you press the ENTER key to store it. Note that in Level D, you can use the CDU Number keys for simple calculations (add, subtract, multiply, divide). You can change a number to negative by typing it, pressing the [+/-] key, followed by the ENTER key.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

For correct operation, Site Data must be present in the system's *Active Memory* (the operational Database). For an original installation, you begin programming the Site Data by invoking the CREATE SITE command (see Para. 5.3.1.2). For a re-installation, you use the RECALL/USE command (see Para. 5.3.1.4) to load previously stored Site Data into Active Memory.

CREATE SITE inserts system defaults in all menu cells with edit code **D** (see Installation Menu Chart). If necessary, you can edit these defaults. You only need to access optional menu cells (edit code **O**) if you intend to use or modify the function controlled by these cells. You must enter data in Menu cells with the edit code **R**. Menu cells with the Edit Code **V** are "view only" locations that show reference data during Site Setup.

NOTE: Data entry for a menu cell may be a prerequisite for access to a subsequent menu cell. Attempting to enter data in the subsequent menu cell without completing the prerequisite entry might not be permitted, or may trigger an INCOMPLETE DATA message.

Sections 5.3, 5.4 and 5.5 provide detailed instructions on how to use the Installation Menu to program the flow computer. The Installation Menu Chart includes paragraph references for every menu cell. This simplifies locating specific instructions in this field manual.

To summarize an original installation, after activating the Installation Menu (see Para. 5.3), the CDU guides you through the following steps:

1) You invoke the CREATE SITE command, then you enter pipe data and any other Site Setup parameters required for the application.

2) Site programming then proceeds to the Installation Menu, which:

   - Guides you through Transducer Installation:
     - Selecting a transducer size
     - Selecting a mounting track type & size
     - Identifying the Letter & Number mounting track spacing indices
     - Offers you the option of adjusting the Liquid sonic velocity (Vs)
   - Guides you through site adjustments (empty setting, zero setting, damping & slew rate settings)
   - Offers you the choice of intrinsic or external flow calibration
   - Offers you the option of viewing Diagnostic data and invoking optional test routines

3) Finally, Site programming proceeds to Operation Setup that (depending on the options installed):

   - Offers you a choice of data display formats for the LCD Graphics Screen
   - Provides you with data memory check, clear & print functions
   - Allows you to define RS-232 Setup parameters for the serial I/O port
   - Allows you to set the system real-time clock/calendar

NOTE: The CREATE SITE or RECALL/USE commands do not affect Operation Setup settings. These items are not Site attributes. They relate to the flow computer only.

☐ The system will be fully operational after completing the above steps.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.1.1 INSTALLATION MENU NOTES

a) If a power failure occurs while you are entering or editing data, the entered data may not be retained in Active Memory.

b) Once the system is operational, you should save the Site Data to preserve the settings. You can save the Site Data at any time before invoking the CREATE SITE or RECALL/USE command. CREATE SITE and RECALL/USE overwrites all current Site Data in a measurement channel's Active Memory. You should save all needed data before using these commands.

c) We do not recommend that you recall and edit Site Data of a previously installed site to develop a new set of site parameters. You should invoke the CREATE SITE command to eliminate unwanted parameters. You can only use previously saved Site Data if the data for the new site is identical (except for site name). Note that each site must have its own set of transducer and mounting parameters, even if transducer and mounting information is identical.

d) If you change pipe dimensions or the transducer spacing index after completing a Site Installation, you must repeat the Installation procedure.

5.2 POWERING THE 994 FLOW DISPLAY COMPUTER

Uniflow Systems use various power sources. The power requirement appears in the power source code within the 994 Flow Computer part number. For example, systems with power source codes "S" and "M" require 100/115 VAC or 230 VAC respectively.

CAUTION: Before connecting power, make sure the power source's voltage agrees with the voltage rating of the 994 Flow Display Computer. Refer to the identification label located on the bracket attached to the inside front cover. Refer to Figure 2-1 for the location of this label.

To begin System Installation:

1) Connect power to the Flow Computer (refer to the appropriate Installation Drawing to locate the power terminal strip).

2) Turn on Power using switch mounted on the 994-6 Power Supply Module (if so equipped).

3) Proceed to Section 5-3 for Site Setup instructions.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

	LEVEL A	LEVEL B	Edit Code	LEVEL C	LEVEL D *See List Details, Sec. 6*	*See Field Manual:*
1	Site Setup	Site Load	O	Channel Select*	Enter From List 1	Para. 5.3.1.1
2	(Para. 5.3)	(Para. 5.3.1)	O	Channel Disable	Enter From List 2	Para. 5.3.1.2
3			R	Create Site	Enter Site Name	Para. 5.3.1.3
4			O	Save Site**	Enter/Clear Site Name	Para. 5.3.1.4
5			R	Recall/Use**	Enter From List 3	Para. 5.3.1.5
6			O	Find/Delete**	Enter From List 3	Para. 5.3.1.6
7						
8		Pipe Data	D	Units	Enter From List 4	Para. 5.3.2.1
9		(Para. 5.3.2)	R	Pipe OD	Enter Pipe OD Data	Para. 5.3.2.2
10			D	Pipe Material	Enter From List 5	Para. 5.3.2.3
11			O	Estimate Vps i/s	Enter Estimate Vps i/s	Para. 5.3.2.4
12			R	Wall Thickness	Enter Pipe Wall Data	Para. 5.3.2.5
13			O	Liner Material	Enter From List 6	Para. 5.3.2.6
14			O	Liner Thickness***	Enter Liner Thk Data	Para. 5.3.2.7
15						
16		Liquid Data	S/D	Liquid Type	Enter From List 7	Para. 5.3.3.1
17		(Para. 5.3.3)	D	Estimated Vs m/s	Enter Vs Data	Para. 5.3.3.2
18			D	Viscosity (CS)	Viscosity Data	Para. 5.3.3.3
19			D	Density (SG)	Enter Specific Gravity	Para. 5.3.3.4
20						
21						
22		Flow Rate Units	D	Volume Units	Enter From List 8	Para. 5.3.4.1
23		(Para. 5.3.4)	D	Time Units	Enter From List 9	Para. 5.3.4.2
24			D	Display Range	Enter From List 10	Para. 5.3.4.3
25			V	Display Scaling	For Viewing Only	Para. 5.3.4.4
26						
27		Flow Total Setup	D	Volume Units	Enter From List 8	Para. 5.3.5.1
28		(Para. 5.3.5)	D	Resolution	Enter From List 11	Para. 5.3.5.2
29			D	Totalizer Mode	Enter From List 12	Para. 5.3.5.3
30			O	Batch/Sample Tot	Enter/Clear Total Set	Para. 5.3.5.4
31			V	Display Scaling	For Viewing Only	Para. 5.3.5.5
32						
33		Analog Span	D	Max Flow Rate	Enter Flow Rate Data	Para. 5.3.6.1
34		(Para. 5.3.6)	D	Min Flow Rate	Enter Flow Rate Data	Para. 5.3.6.2
35			D	Max Vs (m/s)	Enter Max Vs (m/s)	Para. 5.3.6.3
36			D	Min Vs (m/s)	Enter Min Vs (m/s)	Para. 5.3.6.4
37						
38		Alarm Set	O	High Flow Alarm	Enter Flow Rate Data	Para. 5.3.7.1
39		(Para. 5.3.7)	O	Low Flow Alarm	Enter Flow Rate Data	Para. 5.3.7.2
40			O	Interface Vs m/s	Enter Vs Data	Para. 5.3.7.3
41			O	Aeration Alarm	Enter Aeration Number	Para. 5.3.7.4
42						
43		Stripchart Setup	D	Data Selected	Enter From List 13	Para. 5.3.8.1
44		(Para. 5.3.8)	D	Scale Units	Enter From List 14	Para. 5.3.8.2
45			D	Time Interval	Enter From List 15	Para. 5.3.8.3
46						
47		Datalogger Setup	O	Datalogger Mode	Enter From List 16	Para. 5.3.9.1
48		(Para. 5.3.9)	D	Data Selected	Enter/Clear From List 17	Para. 5.3.9.2
49			D	Event Selected	Enter/Clear From List 18	Para. 5.3.9.3
50			D	Log Interval Set	Enter From List 19	Para. 5.3.9.4
51						
52		Analog Inputs	O	Aux 1 Enab	Enter From List 2	Para. 5.3.10.1
53		(Para. 5.3.10)	O	Aux 1 High	Enter Aux 1 High Value	Para. 5.3.10.1
54			O	Aux 1 Low	Enter Aux 1 Low Value	Para. 5.3.10.1
55			O	Aux 2 Enab	Enter From List 2	Para. 5.3.10.1
56			O	Aux 2 High	Enter Aux 2 High Value	Para. 5.3.10.1
57			O	Aux 2 Low	Enter Aux 2 Low Value	Para. 5.3.10.1
58			O	Aux 3 Enab	Enter From List 2	Para. 5.3.10.1
59			O	Aux 3 High	Enter Aux 3 High Value	Para. 5.3.10.1
60			O	Aux 3 Low	Enter Aux 3 Low Value	Para. 5.3.10.1
61			O	Aux 4 Enab	Enter From List 2	Para. 5.3.10.1
62			O	Aux 4 High	Enter Aux 4 High Value	Para. 5.3.10.1
63			O	Aux 4 Low	Enter Aux 4 Low Value	Para. 5.3.10.1

Figure 5-1: Uniflow NEMA Installation Menu (Sheet 1)

Artisan Scientific - Quality Instrumentation, Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

	LEVEL A	LEVEL B	Edit Code	LEVEL C	LEVEL D *See List Details, Sec. 6*	*See Field Manual:*
64	Site Setup (cont.)	Analog Outputs	D	V1	Enter From List 20	Para. 5.3.11.1
65		(Para. 5.3.11)	D	Io/V2†	Enter From List 20	Para. 5.3.11.2
66			D	V3	Enter From List 20	Para. 5.3.11.1
67			D	V4	Enter From List 20	Para. 5.3.11.1
68						
69		Relay Setup††	D	Channel Relay 1	Enter From List 21	Para. 5.3.12.1
70		(Para. 5.3.12)	D	Channel Relay 2	Enter From List 21	Para. 5.3.12.1
71			D	Channel Relay 3	Enter From List 21	Para. 5.3.12.1
72			D	Channel Relay 4	Enter From List 21	Para. 5.3.12.1
73						
74	Installation	Xdcr Mount	R	Xdcr[2,3]	Enter From List 22	Para. 5.4.1.1
75	(Para. 5.4)	(Para. 5.4.1)	R	Track Type [R]	Enter From List 23	Para. 5.4.1.2
76			D	Track Size†††	Enter From List 24	Para. 5.4.1.3
77			R	Letter Index	Enter From List 25	Para. 5.4.1.4
78			R	Number Index	Enter Xdcr Mounted	Para. 5.4.1.5
79			O	Measured Vs	Enter Known Vs m/s	Para. 5.4.1.7
80						
81		Site Adjustment	S/D	Empty Pipe Set	Enter From List 26	Para. 5.4.2.1
82		(Para. 5.4.2)	R	Zero Flow Set	Enter From List 27	Para. 5.4.2.2
83			D	Damping Set	Enter X Seconds	Para. 5.4.2.3.1
84			D	Slew Rate (F/S/S)	Enter X Ft. Sec^2	Para. 5.4.2.3.2
85			D	Deadband Set	Enter Deadband Data	Para. 5.4.2.4
86			D	Memory or Fault	Enter From List 28	Para. 5.4.2.5
87			D	Memory Interval††††	Enter X Seconds	Para. 5.4.2.5
88						
89		Flow Calibration	D	Calibration Type	Enter From List 29	Para. 5.4.3.1
90		(Para. 5.4.3)	O	Calibrate Kc	Enter Percent Change	Para. 5.4.3.2
91						
92		Diagnostics	V	Data Mode	Enter From List 30	Para. 5.4.4.1
93		(Para. 5.4.4)	O	Test/Control Mode	Enter From List 30	Para. 5.4.4.2
94						
95	Operation Setup	Operation Mode	O	Security	Enter Code, List 31	Para. 5.5.1.1
96	(Para. 5.5)	(Para. 5.5.1)	O	Makeup Latch	Enter Code, List 31	Para. 5.5.1.2
97						
98		Display Select	D	LCD Graphics Screens	Enter From List 32	Para. 5.5.2
99		(Para. 5.5.2)				
100						
101		Data Memory	O	Print Memory	Enter From List 33	Para. 5.5.3.1
102		(Para. 5.5.3)	O	Data Memory Open		Para. 5.5.3.2
103			O	Data Memory Clr		Para. 5.5.3.3
104			O	Circular Memory	Enter From List 2	Para. 5.5.3.4
105						
106		RS-232 Setup	D	Baud Rate	Enter From List 34	Para. 5.5.4.1
107		(Para. 5.5.4)	D	Parity	Enter From List 35	Para. 5.5.4.2
108			D	Line Feed	Enter From List 2	Para. 5.5.4.3
109			O	Network ID	Enter ID Data	Para. 5.5.4.4
110						
111		Clock Set	S	Date (MM.DD.YY)	Enter/Clear Date	Para. 5.5.5.1
112			S	Time (HH.MM)	Enter/Clear Time	Para. 5.5.5.2

PROGRAMMING NOTES

1. When the CDU Cursor is in a Data View Cell (usually Level C), a "greater than" symbol: **[>]** precedes the CDU legend.

2. When ENTER or CLEAR is active, a colon: **[:]** precedes a Scrolling List item, and an equal sign: **[=]** precedes a Numeric Entry.

FOOTNOTES

* —— *Multi-channel systems only*
** —— *Multi-site storage option only*
*** —— *Only appears on menu if you select a Liner Material*
† —— *Four-channel systems use Io/V1*
†† —— *Four-channel systems provide two relays per channel*
††† —— *Only appears on systems using size 5 transducers*
†††† —— *Only appears if you select Memory mode*

EDIT CODE DESCRIPTION

R . . . . REQUIRED ENTRY	S . . . . SUGGESTED ENTRY	O . . . . OPTIONAL ENTRY
D . . . . EDITABLE DEFAULT	S/D . . . SUGGESTED EDIT	V . . . . VIEW DATA ONLY

Figure 5-1: Uniflow NEMA Installation Menu (Sheet 2)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3 How To Perform Site Setup

The 995T CDU hand-held terminal provides the data entry interface for the flow computer. To use the CDU, simply insert its modular plug into the jack on the flow computer. You will find the CDU jack either on the front edge of the 994-12 RS-232 Serial Data Module, or this system may be equipped with an optional external CDU jack. When you connect the CDU to the gas flow computer, there will be a brief delay before it becomes active. A single beep indicates that it is ready. Pressing the MENU key selects Level A of Installation Menu, advancing the cursor to Site Setup (see Figure 5-1).

Pressing specific Numeric keys, before pressing the MENU key, instructs the CDU to show digital flow data. This allows the CDU to act as a digital display for flow computers purchased without a local display screen.

NOTE: The CDU cannot provide flow data until you complete the system installation.

The 4 X 20 character 995T CDU Screen displays the following data:

- Channel Number & Site Name
- Flow Rate & Flow Rate Units
- Flow Total & Flow Total Units
- Liquid Sonic Propagation Velocity (M/Sec)
- 8 Status/Alarm Symbols

For the 990N System, the CDU Numeric keys control the CDU digital display as follows:

Numeric Key	Function Selected
1	Selects Ch. 1 Data Display
'n'	Selects Ch. 'n' Data Display (multi-channel models)
0	Disables data display

Pressing the MENU key during the CDU digital display, selects the Installation Menu immediately. Pressing the MENU Key again (or the LEFT Arrow when in any Level A category) toggles the CDU back to the digital display function. Please unplug the CDU when it is not in use.

Site Setup defines the application data for a Site. For example, you enter information relating to pipe dimensions and liquid conditions. Also, you select display/data entry units, data functions, set the analog span and select analog inputs, outputs and relay functions.

You must invoke the CREATE command to begin an original installation. To re-install the system at a former site, you can use the RECALL/USE command to load memorized Site parameters (multi-site storage equipped systems). After you complete the Site programming, or you recall memorized Site parameters, flow measurement begins as soon as you enable a measurement channel (see Para. 5.3.1.2).

NOTE: Paragraphs printed in bold text and highlighted by hollow boxes describe programming steps. The Menu Lists referenced in these steps can be found in Section 6 of this manual.

5.3.1 SITE LOAD

The SITE LOAD Menu provides the CREATE command that begins user programming. SITE LOAD also allows you to enable or disable a measurement channel. Systems equipped with multi-site storage include the SAVE SITE, RECALL/USE and FIND/DELETE commands. The SAVE SITE command stores Site Data in the 993M AFAC memory module. The RECALL/USE command reloads previously stored Site Data. The FIND/DELETE command erases obsolete Site Data to make room for new Sites.

TO SELECT SITE LOAD:

☐ **Press the RIGHT Arrow to move the cursor from SITE SETUP to SITE LOAD**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.1.1 Channel Select *(multi-channel systems only)*
The CHANNEL SELECT option list (Menu List 1) applies to multi-channel systems only. It offers a choice of channels 1, 2, 3 or 4 (Menu List 1) for loading newly Created (or Recalled) Site Data into Active Memory. You cannot move site information from one channel to another. Each measurement channel requires the full installation procedure to become operational. You should consider Saving any Site Data currently in the selected channel's Active Memory before loading new Site Data.

You can operate a multi-channel system without installing all channels. However, when you install a new channel on an active flowmeter you will disable flowmeter operation during the new channel's Initial Makeup (see Para. 5.4.1.6). Therefore, you must take into account that any function you assigned to an operating channel will be temporarily suspended. This is especially important if you are using the operating channel to perform a critical function. The time to complete an Initial Makeup varies with application conditions. It can take from a few seconds to a few minutes.

TO SELECT A CHANNEL:

- ☐ **Press the RIGHT Arrow to move the cursor from SITE LOAD to CHANNEL SELECT**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 1)**
- ☐ **Use the UP or DOWN Arrow to scroll List 1 to the correct channel number**
- ☐ **Press <ENTER> to select the channel. This moves the cursor to CHANNEL DISABLE**

5.3.1.2 Channel Disable
CHANNEL DISABLE allows you to disable or invoke single-channel operation, or the operation of any channel of a multi-channel system. The flow computer disables measurement channels until you complete the required Site Setup entries and the transducer installation procedure. When operation is disabled, the Graphics Screen will only display an Opening Screen. You must complete all the required entries in the Installation Menu before attempting to enable a measurement channel. The CDU responds with [INCOMPLETE DATA] if you attempt to enable the system before completing all the required data entry procedures.

The flow computer enables a measurement channel automatically when you confirm the reported liquid sonic propagation velocity (Vs). This is the final step in transducer installation (see Para. 5.4.1.6.1). At that time the Graphic Display Opening Screen will be replaced by a selected flow display Screen.

The system does not require your presence for routine operation. If a fault condition (e.g. an empty pipe) disrupts operation, the system will recover automatically after the fault clears. However, if extreme conditions occur during recovery, the system might accumulate false data. If you know that the meter will encounter high aeration during a pipe refill, etc., then it would be prudent to disable flow measurement before departing.

If you are using a multi-channel system, you should disable all unused channels. This will enhance operation by limiting flow computation to operating channels only. This also makes it the full screen available for the selected channel's data display.

TO DISABLE A CHANNEL:

- ☐ **Press the RIGHT Arrow to move the cursor from SITE LOAD to CHANNEL DISABLE (single channel systems)**
- ☐ **Press the DOWN Arrow from CHANNEL SELECT to move the cursor to CHANNEL DISABLE (multi-channel systems)**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 2)**
- ☐ **Use the UP or DOWN Arrow to select [YES] (channel disabled)**
- ☐ **Press <ENTER> to register selection. This moves the cursor to CREATE SITE**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

TO ENABLE A CHANNEL:

- ☐ **Press the RIGHT Arrow to move the cursor from SITE LOAD to CHANNEL DISABLE (single channel systems)**
- ☐ **Press the DOWN Arrow from CHANNEL SELECT to move the cursor to CHANNEL DISABLE (multi-channel systems)**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 2)**
- ☐ **Use the UP or DOWN Arrow to select [NO] (channel enabled)**
- ☐ **Press <ENTER> to register selection. This moves the cursor to CREATE SITE**

5.3.1.3 Create Site

The CREATE SITE command prepares the system for site programming by clearing the selected channel's Active Memory and installing system defaults in the appropriate menu cells. This is the first step to install the flowmeter at a new site. If this system includes multi-site storage, before invoking CREATE SITE, you should consider saving any important data present in the Active Memory (see Para. 5.3.1.4).

If your system is equipped with multi-site storage, then we recommend that you create a *template* site to store custom defaults. This will avoid redundant data entry of common parameters. After you enter a set of custom parameters, SAVE the *template* site (see Para. 5.3.1.4) using a unique filename (e.g. TEMPLAT1). When you recall the template site parameters (see Para. 5.3.1.5), you load the custom defaults into Active Memory. First, edit the *template* data to add other site-specific parameters, then complete the installation procedure. Remember to save the completed site data using a NEW site name. This avoids over-writing your *template* data. All your *template* defaults will be incorporated into the new site.

TO SELECT CREATE SITE:

- ☐ **Press the DOWN Arrow to move the cursor from CHANNEL DISABLE to CREATE SITE**

NOTE: Do not to re-use an existing site name if you wish to avoid overwriting the associated Site Data.

TO ENTER A NEW SITE NAME *(optional)*:

NOTE: You can type Numeric or Decimal Point Characters directly from the CDU keypad.

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 3). A Site Name (or blank field) preceded by a [?] appears on the second line of the CDU Screen. The cursor will highlight the first character position**
- ☐ **Use the UP or DOWN Arrow to scroll an alphanumeric character list. When the correct first character appears, Press RIGHT Arrow to move the cursor to second character position**
- ☐ **Select the second character in the same manner. Repeat for all required characters (8 max.)**
- ☐ **Press <ENTER> to register Site Name. This moves the cursor to PIPE DATA (Level B)**

TO USE AN EXISTING SITE NAME *(multi-site storage option)*:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 3). A Site Name preceded by a [?] appears on the second line of the CDU Screen**
- ☐ **Press <ENTER> to use an existing Site Name. This moves the cursor to PIPE DATA (Level B)**

NOTE: If this system is not equipped with multi-site storage, you can proceed directly to Para. 5.3.2, Pipe Data.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.1.4 Save Site

The SAVE SITE command copies data from Active Memory to the 993M AFAC memory module for permanent storage. You can recall the saved data for future use (see Para. 5.3.1.5). You can save the Site Data before completing the data entry. However, you must recall and complete the Site Data before the Site can become active.

NOTE: Do not re-use a name unless you want to over-write the associated Site Data.

TO SAVE SITE DATA *(required for multi-site storage systems)*:

- ☐ **Press the DOWN Arrow to move the cursor from CREATE SITE to SAVE SITE**
- ☐ **Press the RIGHT Arrow to access Level D (Menu List 3). A Site Name preceded by a [?] appears on the second line of the CDU Screen**
- ☐ **Press <ENTER> to use the existing Site Name. This moves the cursor to PIPE DATA (Level B)**

TO ENTER A NEW SITE NAME:

NOTE: You can type Numeric or Decimal Point Characters directly from the CDU Keypad.

- ☐ **Use the UP or DOWN Arrow to scroll an alphanumeric character list. When the correct first character appears, press RIGHT Arrow to move the cursor to second character position**
- ☐ **Repeat this procedure for all required characters (8 max.)**
- ☐ **Press <ENTER> to save Site Data to 993M AFAC under the new Site Name. This moves the cursor to PIPE DATA (Level B)**

WHEN YOU COMPLETE THE SITE SETUP & INSTALLATION PROCEDURES:

- ☐ **Press the MENU key to leave the Installation Menu or proceed to the OPERATION SETUP Menu to select a Data Display screen**

5.3.1.5 Recall/Use Site

The RECALL/USE command reloads saved Site Data into Active Memory, overwriting any data in Active Memory at the time that you issue the command. Therefore, before you invoke RECALL/USE, consider saving any important data in Active Memory that is not already stored permanently.

RECALL/USE restores the Site Setup and Site Installation data. The system will be ready for operation if the transducer installation complies with the restored spacing data. This can be verified by reviewing the Installation Menu parameters. However, if the Site is unchanged, then you should not have to enter any additional data.

TO RECALL/USE A SITE:

- ☐ **Press the DOWN Arrow to move the cursor from SAVE SITE to RECALL/USE**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 3)**
- ☐ **Use the UP or DOWN Arrow to scroll through the names of Sites stored in the 993M AFAC**
- ☐ **When the required Site Name appears, Press <ENTER> to RECALL the Site Data. This moves the cursor to PIPE DATA (Level B)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.1.6 Find/Delete Site

The FIND/DELETE command erases obsolete Site Data stored in the 993M AFAC Memory Module. The system allocates a set amount of 993M AFAC memory space for Site Data storage. If you attempt to save Site Data when this memory space is full, [AFAC FULL!] appears on the CDU screen. A full memory can be revealed by counting the number of Site Names (Menu List 3). This system can store Site Data for up to sixteen separate Sites. If AFAC memory is full, you will have to delete unneeded Site Data before saving new Site Data.

TO FIND/DELETE SITE DATA:

- ☐ **Press the DOWN Arrow to move the cursor from RECALL/USE to FIND/DELETE**
- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 3)**
- ☐ **Use the UP or DOWN Arrow to scroll through the stored Site names**
- ☐ **When the correct Site name appears, Press <ENTER> to delete the Site Data. This moves the cursor to PIPE DATA (Level B)**

5.3.2 PIPE DATA

The PIPE DATA menu controls data entry for the Pipe outer diameter (OD), pipe material (or pipe sonic properties), pipe wall thickness and a pipe liner (if present). PIPE DATA parameters are required for operation. You must define these parameters, or the flow computer will deny access to the Installation Data Menu.

When the system is operational, you can still edit pipe parameters to correct errors. However, editing pipe parameters could invalidate other data for related categories. If this occurs, operation may be suspended until you make the necessary corrections. The flow computer will identify these menu locations.

TO SELECT PIPE DATA:

- ☐ **Press the DOWN Arrow to move the cursor from SITE LOAD to PIPE DATA**

5.3.2.1 Units

The UNITS option list offers inches or millimeters for pipe dimension data entry. The default unit is *inches*. If this suits the application, then you may bypass this menu cell by pressing the DOWN Arrow.

TO SELECT THE MEASUREMENT UNITS:

- ☐ **Press the RIGHT Arrow to move the cursor from PIPE DATA to UNITS**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 4)**
- ☐ **Use the UP or DOWN Arrow to scroll List 4 until the required UNITS appear on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to PIPE OD**

5.3.2.2 Pipe OD

The PIPE OD (outer diameter) is a required entry. You will not be able to access the Installation Data menu unless you enter this information. You must enter the pipe's exact outside diameter using the measurement units you selected. Be aware that an inaccurate entry will affect system performance.

NOTE: Do not use the ASA code to represent the pipe OD. You must enter the actual dimensions (see chart on page 24).

TO ENTER THE PIPE OD:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric keys to type the pipe outer diameter dimension (in selected units)**
- ☐ **Press <ENTER> to register data. This moves the cursor to PIPE MATERIAL**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.2.3 Pipe Material
The CREATE SITE command selects Steel for the default pipe material. If this suits the application, then you may bypass this menu cell by pressing the DOWN Arrow. The PIPE MATERIAL option list offers a selection of common pipe materials. Select [OTHER] then see Paragraph 5.3.2.4 if the application's pipe material does not appear on Menu List 5. Be aware that incorrect identification of the Pipe Material could reduce system accuracy.

TO SELECT PIPE MATERIAL:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 5)**
- ☐ **Use the UP or DOWN Arrow to scroll List 5 until the correct Pipe Material appears on the CDU Screen**
- ☐ **Press <ENTER> to select the Pipe Material. This moves the cursor ESTIMATE Vps**

5.3.2.4 Estimate Vps (i/s)
When the cursor moves to ESTIMATE Vps, Level C, the CDU shows an estimate of the pipe's shear mode sonic propagation velocity, Vps in inches-per-second (i/s). The flow computer bases this value on the Pipe Material selected from Menu List 5. If you selected [Other] from Menu List 5, or you are sure that the displayed value is not the pipe's true Vps, then you can edit the Vps by pressing the RIGHT Arrow to move the cursor to Level D. However, be aware that an incorrect Vps entry could reduce system accuracy.

The data you enter must be in inches-per-second. If you selected a pipe material from Menu List 5, then you should consider carefully the impact of replacing the displayed value. Table 5-1 lists Vps values for common pipe materials. If you cannot determine the Vps, then please call Controlotron Application Engineering or Technical Service for assistance.

TO ACCEPT THE DISPLAYED Vps:

- ☐ **Press the DOWN Arrow to move the cursor to WALL THICKNESS**

If you decide to edit the Estimated Vps, or you selected [OTHER] as the pipe material from List 5 (Para. 5.3.2.3), then you must enter a Vps value.

TO EDIT THE DISPLAYED Vps:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric keys to type the Vps value (in inches-per-second)**
- ☐ **Press <ENTER> to register data. This moves the cursor to WALL THICKNESS**

5.3.2.5 Wall Thickness
You must enter the pipe's WALL THICKNESS. The flow computer denies access the Installation Data Menu if it does not receive this parameter. Table 5-2 lists standard pipe wall dimensions for common pipe materials. You must enter the actual dimensions using the measurement units you selected (see Para. 5.3.2.1).

NOTE: Do not use ASA schedule code to specify the wall thickness. You must enter actual dimensions. If necessary, use an ultrasonic thickness gauge to obtain an accurate measurement of this dimension.

TO ENTER A WALL THICKNESS:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D. The CDU shows a residual wall thickness value**
- ☐ **Use the Numeric keys to type the Wall Thickness (in selected units)**
- ☐ **Press <ENTER> to register data. This moves the cursor to LINER MATERIAL**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table 5-1: Vps Values (inches/second) For Some Common Metals

Metal	Vps (in/sec)	Metal	Vps (in/sec)
Aluminium	120,000	Magnesium O-1	120,000
AL 1100 (2S)	121,000	Magnesium ZK-60A-TS	120,000
AL 1100-0 (2S0)	122,000	Monel	107,000
AL 2014 (14S)	121,000	Molybdenum	132,000
AL 2024-T4 (24ST)	124,000	Nickel	118,000
AL 2117-T4 (17ST)	123,000	Steel, 302 Cres.	123,000
Brass	89,400	Steel, 347 Cres.	122,000
Brass, Alpha	79,500	Steel, 1020	128,000
Brass, Half Hard	80,700	Steel, 1095	126,000
Brass, Naval	83,500	Steel, 4150, Rc14	110,000
Bronze, Phosphor	87,800	Steel, 4150, Rc18	125,000
Cadmium	59,100	Steel, 4150, Rc43	126,000
Carpenter 20 Steel	117,900	Steel, 4340	126,000
Columbium	82,700	Tantalum	114,000
Columbium (10W, 10TN)	74,800	Tin	65,700
Constantan	104,000	Titanium	122,000
Copper	89,400	Titanium, T1 150A	124,000
Iconel	119,000	Titanium Carbide	203,000
Iron	127,000	Tungsten	113,000
Iron, Cast	110,000	Vanadium	109,000
Magnesium AM-35	122,000	Zinc	94,900
Magnesium PS-1	119,000	Zirconium	88,600
Magnesium J-1	118,000		

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

CARBON STEEL & PVC□ PIPE

PIPE	SIZE	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	42
	Out. Dia.	.840	1.050	1.315	1.660	1.900	2.375	2.875	3.500	4.000	4.500	5.563	6.625	8.625	10.750	12.750	14.000	16.000	18.000	20.000	22.000	24.000	26.000	28.000	30.000	32.000	34.000	36.000	42.000
Standard	I.D	.622	.824	1.049	1.380	1.610	2.067	2.469	3.068	3.548	4.026	5.047	6.065	7.981	10.020	12.000	13.250	15.250	17.250	19.250	21.250	23.250	25.250	27.250	29.250	31.250	33.250	35.250	41.250
	Wall	.109	.113	.133	.140	.145	.154	.203	.216	.226	.237	.258	.280	.322	.365	.375	.375	.375	.375	.375	.375	.375	.375	.375	.375	.375	.375	.375	◆ .375
Extra Heavy	I.D	.546	.742	.957	1.278	1.500	1.939	2.323	2.900	3.364	3.826	4.813	5.761	7.625	9.750	11.750	13.000	15.000	17.000	19.000	21.000	23.000	25.000	27.000	29.000	31.000	33.000	35.000	41.000
	Wall	.147	.154	.179	.191	.200	.218	.276	.300	.318	.337	.375	.432	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	◆ .500
Double Extra Heavy	I.D.	.252	.434	.599	.896	1.100	1.503	1.771	2.300	2.728	3.152	4.063	4.897	6.875	8.750	10.750													
	Wall	.294	.308	.358	.382	.400	.436	.552	.600	.636	.674	.750	.864	.875	1.000	1.000													
Schedule 10	I.D.	NOTES ● Wall thickness identical with thickness of "Standard Weight" pipe. ▲ Wall thickness identical with thickness of "Extra-Heavy" pipe. ◆ These do not conform to American Standard B36.10. □ These materials are generally available in Schedules 40 and 80 only. (a) Wall thickness of Schedule 5S & 10S does not permit threading in accordance with the American Std. for Pipe Threads (ASA No. B2.1)															13.500	15.500	17.500	19.500	21.500	23.500	25.376	27.376	29.376	31.376	33.376	35.376		
	Wall																.250	.250	.250	.250	.250	.250	.312	.312	.312	.312	.312	.312	
Schedule 20	I.D.													8.125	10.250	12.250	13.376	15 376	17.376	19.250	21.250	23.250	25 000	27 000	29.000	31 000	33.000	35 000	41.000
	Wall													.250	.250	.250	.312	.312	.312	● .375	● .375	● .375	▲ .500	▲ .500	▲ .500	▲ .500	▲ .500	▲ .500	▲ .500
Schedule 30	I.D.													8.071	10.136	12.090	13.250	15 250	17 124	19.000	21 000	22.876		26 750	28 750	30 750	32 750	34.750	40.750
	Wall													.277	.307	.330	● .375	● .375	.438	▲ .500	▲ .500	.562		.625	.625	.625	.625	.625	◆ .625
Schedule 40	I.D	.622	.824	1.049	1.380	1.610	2.067	2.469	3.068	3.548	4.026	5.047	6.065	7.981	10.020	11.938	13 124	15.000	16.876	18.814		22.626							
	Wall	● 109	● 113	● 133	● 140	● 145	● 154	● 203	● 216	● 226	● 237	● 258	● 280	● 322	● 365	406	438	▲ 500	.562	593		.687							
Schedule 60	I.D.													7.813	9 750	11.626	12.814	14.688	16.500	18.376	20 250	22.064							
	Wall													.406	▲ .500	.562	.593	.656	750	.812	.875	.968							
Schedule 80	I.D	.546	.742	.957	1 278	1.500	1.939	2.323	2.900	3 364	3 826	4.813	5 761	7.625	9.564	11.376	12 500	14.314	16 126	17 938	19 750	21 564							
	Wall	▲ .147	▲ .154	▲ .179	▲ .191	▲ .200	▲ .218	▲ .276	▲ .300	▲ .318	▲ .337	▲ .375	▲ .432	▲ .500	.593	.687	750	.843	.937	1.031	1 125	1.218							
Schedule 100	I.D.													7 439	9.314	11.064	12.126	13 938	15.688	17.438	19 250	20.938							
	Wall													.593	.718	.843	.937	1.031	1 156	1.281	1 375	1.531							
Schedule 120	I.D										3.624	4.563	5.501	7 189	9.064	10 750	11.814	13.564	15 250	17 000	18 750	20.376							
	Wall										.438	.500	.562	.718	.843	1.000	1.093	1.218	1.375	1.500	1 625	1.812							
Schedule 140	I.D													7 001	8.750	10.500	11 500	13 124	14.876	16 500	18 250	19.876							
	Wall													.812	1.000	1.125	1.250	1 438	1.562	1.750	1.875	2.062							
Schedule 160	I.D.	.466	.614	.815	1.160	1.338	1.689	2.125	2.624		3.438	4.313	5.189	6.813	8.500	10.126	11 188	12 814	14 438	16.064	17.750	19.314							
	Wall	.187	.218	.250	.250	.281	.343	.375	.438		.531	.625	.718	.906	1.125	1 312	1 406	1 593	1.781	1.968	2 125	2.343							

NON-STANDARD CARBON STEEL PIPE

SIZE	10	20	24	24
Out. Dia.	10.750	20.000	24.000	24.000
I.D	10 192	19.375	23.375	22 126
Wall	.279	.312	.312	.937

Above sizes are produced by pipe mills but dimensions do not conform to any regular standard or schedule.

PIPE WEIGHT FORMULA FOR STEEL PIPE (Pounds per foot) 10.68 (D-t) t
D — Outside Diameter
t — Wall Thickness

STAINLESS STEEL, HASTELLOY "C"* & TITANIUM PIPE□

PIPE	SIZE	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12	14	16	18	20	22	24
	Out. Dia.	.840	1.050	1.315	1.660	1.900	2.375	2.875	3.500	4.000	4.500	5.563	6.625	8.625	10.750	12.750	14.000	16.000	18.000	20.000	22.000	24.000
Schedule 5S & 5H	I.D.	.710	.920	1.185	1.530	1.770	2.245	2.709	3.334	3.834	4.334	5.345	6.407	8.407	10.482	12.438	13.688	15.670	17.670	19.634	21.624	23.563
	Wall	.065	.065	.065	.065	.065	.065	.083	.083	.083	.083	.109	.109	.109	.134	.156	.156	.165	.165	.188	.188	.218
Schedule 10S & 10H	I.D.	.674	.884	1.097	1.442	1.682	2 157	2.635	3.260	3.760	4.260	5.295	6.357	8.329	10.420	12.380	13.624	15.624	17.624	19.564	21.564	23.500
	Wall	.083	.083	.109	.109	.109	.109	.120	.120	.120	.120	.134	.134	.148	.165	.180	.188	.188	.188	.218	.218	.250
Schedule 40S	I.D.	.622	.824	1.049	1.380	1.610	2.067	2.469	3.068	3.548	4.026	5.047	6.065	7.981	10.020	12.000						
	Wall	● 109	● 113	● 133	● 140	● 145	● 154	● 203	● 216	● 226	● 237	● 258	● 280	● 322	● 365	◆ .375						
Schedule 80S	I.D.	.546	.742	.957	1.278	1.500	1.939	2.323	2.900	3.364	3.826	4.813	5.761	7.625	9.750	11.750						
	Wall	▲ .147	▲ .154	▲ .179	▲ .191	▲ .200	▲ .218	▲ .276	▲ .300	▲ .318	▲ .337	▲ .375	▲ .432	▲ .500	▲ .500	◆ .500						

* A registered trademark of Union Carbide Corp.

CONTROLOTRON
155 PLANT AVENUE
HAUPPAUGE, NEW YORK 11788
TEL. NO. (516) 231-3600

CAST IRON PIPE – AWWA STANDARD**

PIPE SIZE	Class A 100 Ft. 43 PSIG			Class B 200 Ft. 86 PSIG			Class C 300 Ft. 130 PSIG			Class D 400 Ft. 173 PSIG			Class E 500 Ft. 217 PSIG			Class F 600 Ft. 260 PSIG			Class G 700 Ft. 304 PSIG			Class H 800 Ft. 347 PSIG		
	O.D.	Wall	I.D.	O.D.	Wall	I.D.	O.D.	Wall	I.D.	O.D.	Wall	I.D.	O.D.	Wall	I.D.	O.D.	Wall	I.D.	O.D.	Wall	I.D.	O.D.	Wall	I.D.
3	3.80	0.39	3.02	3.96	0.42	3.12	3.96	0.45	3.06	3.96	0.48	3.00												
4	4.80	0.42	3.96	5.00	0.45	4.10	5.00	0.48	4.04	5.00	0.52	3.96												
6	6.90	0.44	6.02	7.10	0.48	6.14	7.10	0.51	6.08	7.10	0.55	6.00	7.22	0.58	6.06	7.22	0.61	6.00	7.38	0.65	6.08	7.38	0.69	6.00
8	9.05	0.46	8.13	9.05	0.51	8.03	9.30	0.56	8.18	9.30	0.60	8.10	9.42	0.65	8.10	9 42	0.71	8.00	9.60	0.75	8.10	9.60	0.80	8.00
10	11.10	0.50	10.10	11.10	0.57	9.96	11.40	0.62	10.16	11.40	0.68	10.04	11.60	0.74	10.12	11.60	0.80	10.00	11.84	0.86	10.12	11.84	0.92	10.00
12	13.20	0.54	12.12	13.20	0.62	11.96	13.50	0.68	12.14	13.50	0.75	12.00	13.78	0.82	12.14	13.78	0.89	12.00	14.08	0.97	12.14	14.08	1.04	12.00
14	15.30	0.57	14.16	15.30	0.66	13.98	15.65	0.74	14.17	15.65	0.82	14.01	15.98	0.90	14.18	15.98	0.99	14.00	16.32	1.07	14.18	16.32	1.16	14.00
16	17.40	0.60	16.20	17.40	0.70	16.00	17.80	0.80	16.20	17.80	0.89	16.02	18.16	0.98	16.20	18.16	1.08	16.00	18.54	1.18	16.18	18.54	1.27	16.00
18	19.50	0.64	18.22	19.50	0.75	18.00	19.92	0.87	18.18	19.92	0.96	18.00	20.34	1.07	18.20	20.34	1.17	18.00	20.78	1.28	18.22	20.78	1.39	18.00
20	21.60	0.67	20.26	21.60	0.80	20.00	22.06	0.92	20.22	22.06	1.03	20.00	22.54	1.15	20.24	22.54	1.27	20.00	23.02	1.39	20.24	23.02	1.51	20.00
24	25.80	0.76	24.28	25.80	0.89	24.02	26.32	1.04	24.22	26.32	1.16	24.00	26.90	1.31	24.28	26.90	1.45	24.00	27.76	1.75	24.26	27.76	1.88	24.00
30	31.74	0.88	29.98	32.00	1.03	29.94	32.40	1.20	30.00	32.40	1.37	30.00	33.10	1.55	30.00	33.46	1.73	30.00						
36	37.96	0.99	35.98	38.30	1.15	36.00	38.70	1.35	39.98	39.16	1.58	36.00	39.60	1.80	36.00	40.04	2.02	36.00						
42	44.20	1.10	42.00	44.50	1.28	41.94	45.10	1.54	42.02	45.58	1.78	42.02												
48	50.50	1.26	47.98	50.80	1.42	47.96	51.40	1.71	47.98	51.98	1.96	48.06												
54	56.66	1.35	53.96	57.10	1.55	54.00	57.80	1.98	54.60	58.40	2.23	53.94												
60	62.80	1.39	60.02	63.40	1.67	60.06	64.20	2.00	60.20	64.82	2.38	60.06												
72	75.34	1.62	72.10	76.00	1.95	72.10	76.88	2.39	72.10															
84	87.54	1.72	84.10	88.54	2.22	84.10																		

** Table for ASA Standard Cast Iron Pipe is shown on reverse side of this page.

Table 5-2: Pipe Data

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.2.6 Liner Material

The CREATE SITE command inserts NONE for the default Liner material. If the pipe does not have a liner, then you may bypass this menu cell. The Liner Material option List offers a selection of common liner materials.

IF THE PIPE IS NOT LINED:

- ☐ **Press the LEFT Arrow to move the cursor to PIPE DATA (Level B)**
- ☐ **Press the DOWN Arrow to move the cursor to LIQUID DATA (Level B)**

IF THE PIPE IS LINED:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 6)**
- ☐ **Use the UP or DOWN Arrow to scroll through the Liner Material List**

NOTE: If the specific Liner Material is not on the list, then select a listed material that is similar (i.e. select Plastic for PVC).

- ☐ **When the correct Liner Material appears on the CDU Screen, Press <ENTER> to register selection. This moves the cursor to LINER THICKNESS**

5.3.2.7 Liner Thickness

NOTE: This menu cell appears only if you select a Liner Material from Menu List 6.

If you indicate that a pipe liner is present, then you must enter the exact thickness of the liner in this menu cell using the measurement units you selected (see Para. 5.3.2.1).

TO ENTER THE LINER THICKNESS:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric keys to type the liner thickness value (in the selected dimension units)**
- ☐ **Press <ENTER> to register data. This moves the cursor to UNITS (Level C)**

TO SELECT LIQUID DATA:

- ☐ **Press the LEFT Arrow to move the cursor to PIPE DATA (Level B)**
- ☐ **Press the DOWN Arrow to move the cursor from PIPE DATA to LIQUID DATA (Level B)**

5.3.3 LIQUID DATA

The flow computer does not really need liquid parameters. It obtains this information automatically during installation, and on a continuous basis during operation. However, the flow computer uses the liquid type parameter to recommend the initial transducer placement (see Para. 5.4.1). If you enter an accurate liquid type in this menu, you will speed transducer installation because the first mounting location picked by the flow computer will be correct.

The LIQUID TYPE menu offers a list of liquid options to replace the system default, *water*. When you select a liquid, the flow computer loads a viscosity profile which it uses to implement Reynolds number-based flow profile compensation.

Selecting [Other] from the Liquid Type option list allows you to enter the liquid's sonic velocity in meters-per-second (m/s), and its viscosity in centistokes (cs). The Density (SG) menu cell accepts the liquid's specific gravity. This allows the flow computer to provide the flow rate output using mass units.

5.3.3.1 Liquid Type

The CREATE SITE command inserts water for the default liquid. You should edit the LIQUID TYPE if the application's liquid is not water. The LIQUID TYPE option List (Menu List 7) offers a selection of common liquids. If the application's liquid is not included on this list, then select [Other]. This allows you to enter the liquid's sonic propagation velocity (Vs) and its kinematic viscosity.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

TO SELECT A LIQUID:

- ☐ **Press the RIGHT Arrow to move the cursor from LIQUID DATA to LIQUID TYPE**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 7)**
- ☐ **Use the UP or DOWN Arrow to scroll List 7 until the correct liquid appears on the CDU screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to ESTIMATED Vs**

5.3.3.2 Estimated Vs (m/s)

During transducer installation (see Para. 5.4.1), the flow computer bases its initial transducer spacing recommendation on the data stored in this ESTIMATED Vs menu cell. ESTIMATED Vs allows you to review and modify (if necessary) the Vs value for the selected liquid. Although the displayed Vs can be changed at this time, the adjustment will only be valid until the transducer installation procedure. Once installed, the operating transducers permits the flow computer to measure Vs directly.

The Measured Vs (see Para. 5.4.1.7) determines the *actual* transducer spacing. If the displayed (or edited) Vs stored in this menu cell is accurate, the transducers will be spaced correctly. This will eliminate the need to re-mount the transducers after their initial installation. However, if the estimated Vs is substantially different for the measured value, the initial transducer spacing will have to be adjusted. This will be indicated during transducer installation.

Table 5-3 lists the Vs (liquid sonic propagation velocity) values for some common liquids (including oils). Table 5-3a lists the sonic velocity of water over a range of temperatures.

TO EDIT THE DISPLAYED ESTIMATED Vs:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric keys to type the new Vs data (in meters-per-second)**
- ☐ **Press <ENTER> to register data. This moves the cursor to VISCOSITY**

NOTE: Although the flow computer measures the liquid's Vs during transducer installation, the Estimated Vs value stored in this menu cell will not change.

Table 5-3: Vs Values (meters/second) for Common Liquids

Liquids	Vs(m/s)	Liquids	Vs(m/s)
Acetate, Butyl (n)	1270	Diethyl Ketone	1310
Acetate, Ethyl	1180	Ethanol	1180
Acetate, Methyl	1150	Ethylene Glycol	1620
Acetate. Propyl	1180	Gasoline	1250
Acetone	1190	Glycerine	1920
Alcohol	1440	Linalool	1400
Alcohol, Butyl (n)	1270	Linseed Oil	1770
Alcohol, Ethyl	1180	Methylethyl Ketone	1210
Alcohol, Methyl	1120	Motor Oil (SAE 20/30)	1487
Alcohol, Propyl (i)	1170	Paraffin Oil	1420
Alcohol, Propyl (n)	1220	Pentane	1010
Benzene	1330	Petroleum	1290
Benzol, Ethyl	1340	Trichlorethylene	1050
Butyrate, Ethyl	1170	Transformer Oil	1390
Carbon Tetrachloride	938	Turpentine	1280

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table 5-3a: Sonic Velocity of Pure Water

Deg. C	Deg. F	(m/s)	Deg. C	Deg. F	Vs (m/s)
0	32	1402	120	248	1519
10	50	1447	130	266	1503
20	68	1482	140	284	1485
30	86	1509	150	302	1466
40	104	1529	160	320	1440
50	122	1543	170	338	1412
60	140	1551	180	356	1390
70	158	1555	190	374	1360
80	176	1554	200	392	1333
90	194	1550	220	428	1268
100	212	1543	240	464	1192
110	230	1532	260	500	1110

5.3.3.3 Viscosity

When the Cursor moves to VISCOSITY (Level C), the CDU shows the selected liquid's viscosity (in centistokes). Entering a correct viscosity value is more important than the estimated sonic velocity. The flow computer requires an accurate liquid viscosity to compute the flow profile compensation. If the displayed viscosity is correct, you may bypass this menu cell by pressing the DOWN Arrow.

TO EDIT THE DISPLAYED VISCOSITY:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric keys to type the correct Viscosity data (in centistokes)**
- ☐ **Press <ENTER> to register data. This moves the cursor to DENSITY (SG)**

5.3.3.4 Density (SG)

The DENSITY menu provides you with the option of entering the liquid's nominal specific gravity. This allows the flow computer to report flow in mass flow rate units, if required. This mode suits applications where the density is not only known, but fixed, due to well controlled liquid temperature and chemistry. The default setting is 1.000. If this suits the application, then you may bypass this menu cell by pressing the DOWN Arrow.

The flow computer uses the liquid's specific gravity to form a multiplier that allows it to convert volumetric flow to mass flow. Mass flow is displayed (in selected units) on the LCD Graphics screen and can also be viewed on the 995T CDU. Density (SG) (as it applies to this system) is defined as the ratio of the mass of the application's liquid to the mass of an equal volume of water at 20°C or 68°F.

TO ENTER THE SPECIFIC GRAVITY:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric Keys to type the liquid's specific gravity**
- ☐ **Press <ENTER> to register the specific gravity value. This moves the cursor to FLOW RATE UNITS (Level B)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.4 FLOW RATE UNITS

The FLOW RATE UNITS menu offers various volumetric and mass flow units with selectable time bases. It provides a range selection for the flow display. It allows you also to review the resultant scaling. The system default is Gallons-Per-Minute (GA/M). If this suits the application, you can bypass this menu entirely by pressing the DOWN Arrow.

Only systems with the LCD Graphics display option can show flow rate units. If your system has the LCD Digital Screen, you will have to place a 'units' transfer sticker (provided with the system) next to the flow rate display window. Check the Display Scaling menu cell (see Para. 5.3.4.4) for rate display units.

5.3.4.1 Units (Vol/Mass)

The UNITS (Vol/Mass) option list (Menu List 8) allows you to choose units for the flow computer to use when reporting the volumetric or mass flow. The CREATE SITE command inserts GALLONS for the system default. If this suits the application, you can bypass this menu cell by Pressing the DOWN Arrow.

TO SELECT A VOL/MASS UNIT:

- ☐ **Press the RIGHT Arrow to move the cursor from FLOW RATE UNITS to UNITS (VOL/MASS)**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 8)**
- ☐ **Use the UP or DOWN Arrow to scroll List 8 until the required units appear on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to TIME UNITS**

5.3.4.2 Time Units

The TIME UNITS option list (Menu List 9) allows you to choose Seconds, Minutes, Hours or Days for the flow display time base. The CREATE SITE command inserts MINUTES for the system default. If this suits the application, you may bypass this menu cell by pressing the DOWN Arrow.

TO SELECT A TIME UNIT:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 9)**
- ☐ **Use the UP or DOWN Arrow to scroll List 9 until the required time unit appears on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to DISPLAY RANGE**

5.3.4.3 Display Range

The DISPLAY RANGE option list allows you to choose AUTORANGE or HIGH Range. AUTORANGE moves the digital flow display decimal point automatically for the best resolution at low flow rates. The CREATE SITE command inserts AUTORANGE as the system default. If this suits the application, you may bypass this menu cell by pressing the DOWN Arrow.

TO EDIT THE DISPLAY RANGE:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 10)**
- ☐ **Use the UP or DOWN Arrow to scroll List 10 until the required display range appears on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to DISPLAY SCALING**

5.3.4.4 Display Scaling

The "view only" DISPLAY SCALING menu cell shows the results of the cumulation of the flow volume units, flow time units and pipe size that you specified (e.g. KGAL/MIN). This scaling applies to flow rate data displayed on LCD Graphics Screens, even if the units do not appear next to the data (because there may not be room on the display screen).

TO EXIT DISPLAY SCALING:

- ☐ **Press the LEFT Arrow to move the cursor to FLOW RATE UNITS (Level B)**
- ☐ **Press the DOWN Arrow to move the cursor to FLOW TOTAL SETUP (Level B)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.5 FLOW TOTAL SETUP

The FLOW TOTAL SETUP menu selects the flow total units, a totalizer resolution (capacity), a totalizer operating mode, and a total flow threshold for Batching or Sampling operations. A "view only" menu cell shows the units selected for flow total scaling. The system provides three totalizer display modes, plus a batch total function. These are designated:

POSFLOW *Positive (forward) flow total only*

NEGFLOW *Negative (reverse) flow total only*

NETFLOW *The net of the Positive and Negative flow accumulation (default)*

BATCHTOT *For product batching and sampling applications (see Para. 5.3.5.4)*

The flow computer stores positive and negative accumulations in separate independent registers. It develops the NETFLOW output by combining the positive and negative registers. It maintains a separate register for the BATCH TOT function. You cannot access the BATCHTOT register directly. It is used for relay control only (see Para. 5.3.5.4).

The CDU function and numeric keys control the flow totalizer. When the CDU is not connected, the flow total is secure from accidental reset or tampering. The CDU controls the flow totalizer in the following ways:

FOR SINGLE CHANNEL SYSTEMS OR CHANNEL 1 OF MULTI-CHANNEL SYSTEMS:

- ☐ **Press the F1 key, then press Numeric key 1 to reset the POS [+], NEG [-] and NET [+/-] Totalizer registers**
- ☐ **Press the F1 key, then press Numeric key 2 to invoke NOTOT**

Invoking the NOTOT command disables the Totalizer. Totalization will not resume until you repeat the F1 and Numeric 2 key sequence. On Graphic Displays, when NOTOT is active, an N precedes the TOTAL symbol (i.e. [NTOTAL]).

The NOTOT and RESET functions can be controlled also by external TTL-compatible switches. This permits automatic coordination of totalization counting by external hardware, as may be required for either a weigh tank flow calibration or actual process operational control. Connect the switches to terminal strip TB1 on the optional 993C/M AFAC Module (see Installation Drawing 993-7). TB1-pin 9 provides the TTL low (or ground) reference. Pins 1 through 4 control the NOTOT functions of channels 1 through 4 respectively (i.e. pin 1 for channel 1, etc.). Select NOTOT by connecting a NOTOT pin to TB1-pin 9 (ground). This will disable the channel's totalizer.

Similarly, Pins 5 through 8 control the RESET functions of channels 1 through 4 respectively (i.e. pin 5 for channel 1, pin 6 for channel 2, etc.). Connect TB1-pin 9 (ground) to any of these pins to RESET the corresponding channel's totalizer.

FOR SINGLE CHANNEL SYSTEMS OR CHANNEL 1 OF MULTI-CHANNEL SYSTEMS:

- ☐ **Press the F1 key, then press Numeric key 3 to invoke LAPTOT**

The LAPTOT command freezes the Totalizer display. However, the internal registers continue to be updated. Actual total(s) will not be displayed until you repeat the F1 then Numeric 3 key sequence. On Graphic displays, if LAPTOT is active, an L precedes the TOTAL symbol (i.e. [LTOTAL]).

FOR CHANNEL 'N' OF MULTI-CHANNEL SYSTEMS:

- ☐ **Press the F'n' key, then press Numeric key 1 to reset the POS [+], NEG [-] and NET Totalizers**
- ☐ **Press the F'n' key, then press Numeric key 2 to invoke NOTOT**

The results are the same as channel 1. Repeat the F'n' - Numeric Key 2 sequence to resume Totalization.

- ☐ **Press the F'n' key, then press Numeric key 3 to invoke LAPTOT**

The results are the same as channel 1. Repeat the F'n' - Numeric Key 3 sequence to display actual total(s).

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

NOTE: Disconnecting the 995T CDU clears the NOTOT and LAPTOT commands.

5.3.5.1 Units (Vol/Mass)
You select *flow rate* units and *flow total* units separately. Since this UNITS (Vol/Mass) menu cell is within the FLOW TOTAL SETUP menu, it specifies the Totalizer's measurement units. CREATE SITE inserts Gallons for the Flow Total system default. If this suits the application, you may bypass this menu cell by pressing the DOWN Arrow.

TO CHANGE THE CURRENT SETTING:

- ☐ **Press the RIGHT Arrow to move the cursor from FLOW TOTAL SETUP to VOLUME UNITS**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 8)**
- ☐ **Use the UP or DOWN Arrow to scroll List 8 until the correct unit appears on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to RESOLUTION**

5.3.5.2 Resolution (Totalizer Capacity)
The flow computer assigns automatically the multiplier prefix for the flow total units you selected (e.g. MGPM). It provides three resolution (or capacity) levels. The actual Totalizer display units applied to flow total output depends on the multiplier the flow computer selects. You can check the total units by accessing the (Totalizer) Display Scaling Menu (see Para. 5.3.5.5).

If you intend to use the totalizer (TOTCNT) relay, you must take into account that the TOTCNT relay closes at a maximum rate of 5 pulses per second (5 Hz), and that a relay closure will occur whenever the least significant visible digit on the display increments. It is therefore possible for a high flow rate to persist long enough to exceed the relay's 5 Hz closure rate. If this occurs, the flow computer stores the excess pulses in an overflow buffer, then routes them back to the relay when the flow rate drops enough to allow the TOTCNT relay to "catch up". However, exceeding the 5 Hz rate for long periods could cause an excessive accumulation of buffered pulses. These will continue to trip the relay after the flow rate drops, or even stops. If this occurs, an external Totalizer driven by the relay will be unable to deliver the actual flow total. Therefore, you should select a resolution to ensure that, even at the maximum expected flow rate, the TOTCNT relay will not be activated more that five times per second. Note that resetting the Totalizer also clears the overflow buffer.

TO CHANGE THE DEFAULT RESOLUTION:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 11)**
- ☐ **Use the UP or DOWN Arrow to scroll List 11 until the correct Resolution appears on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to TOTALIZER MODE**

5.3.5.3 Totalizer Mode
The System 990 Flow Totalizer operates in one of three modes:

- POSFLOW *(positive flow only)*
- NEGFLOW *(negative flow only)*
- NETFLOW *(combination of positive & negative flow)*

The CREATE SITE command inserts NETFLOW for the system default. NETFLOW mode suits applications where there may be zero flow for long periods. It minimizes false Totalizer register increments due to data scatter. If this fits the application, you may bypass this menu cell by pressing the DOWN Arrow.

TO SELECT A TOTALIZER MODE:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 12)**
- ☐ **Use the UP or DOWN Arrow to scroll List 12 until the required Totalizer Mode appears on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to BATCH/SAMPLE TOT**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.5.4 Batch/Sample Tot

The system's relay function accommodates Batching or Sampling applications. If you assign a relay to this activity (see Para. 5.3.12), a momentary (100 mS) relay pulse occurs whenever the BATCHTOT register accumulates a specified liquid quantity. The BATCH/SAMPLE TOT command defines the total flow volume that will activate the relay. The numeric entry must be expressed in the flow total units the system is using. The Totalizer Display Scaling menu cell (see Para. 5.3.5.5) shows the flow total units.

NOTE: The BATCH/SAMPLE TOT relay requires the same consideration for exceeding the 5 Hz pulse rate as the TOTCNT relay (see Para. 5.3.5.2).

FOR CHANNEL 'N' OF MULTI-CHANNEL SYSTEMS:

- ☐ **Press F'n' key, then press Numeric key 4 to reset Batch/Sample Total registers**

TO ENTER A BATCH/SAMPLE TOT THRESHOLD:

- ☐ **Press the DOWN Arrow to move the cursor from TOTALIZER MODE to BATCH/SAMPLE TOT**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric keys to type the new BATCH/SAMPLE TOT value**
- ☐ **Press <ENTER> to register data. This moves the cursor to DISPLAY SCALING**

5.3.5.5 Display Scaling *(Totalizer)*

The "view only" DISPLAY SCALING menu cell shows the flow computer-selected multiplier for the flow total display. These units apply to all numeric data entries for Totalizer related items. Graphics Screens show the multiplier with the Flow Total Display. If this system uses the optional LCD Digital screen, you should access this menu location to find out the flow total units and multiplier. Use the transfer letters and numbers provided with the system to mark the units and multiplier on the LCD Digital Screen permanently.

TO EXIT DISPLAY SCALING *(Totalizer)*:

- ☐ **Press the LEFT Arrow to move the cursor to FLOW TOTAL SETUP**
- ☐ **Press the DOWN Arrow to move the cursor to ANALOG SPAN**

5.3.6 ANALOG SPAN

The ANALOG SPAN menu defines the analog output range and sets the scaling of the stripchart and bargraph displays. You enter maximum and minimum values using the flow rate units you selected. If you change the flow rate units after spanning the system, the flow computer automatically updates the analog span to reflect the change. The following paragraphs describe the system's analog outputs and their analog span settings.

Vo *spanned volumetric or mass flow rate*

The minimum and maximum flow rate entries establish the Vo span. Max Flow Rate (Para. 5.3.6.1) sets 100% of span. Min Flow Rate (Para. 5.3.6.2) sets 0% of span. Use signed numbers for a bidirectional analog span. Note that negative (reverse) flow always is lower than positive flow, whatever its absolute magnitude. For example, for a flow measurement range of -30 GPM to +10 GPM, the 4 mA span will be -30 GPM, and the 20 mA span will be +10 GPM.

Vf *spanned liquid flow velocity*

Vf is a measure of the absolute magnitude of flow velocity. The flow velocity measurement unit always is feet-per-second (f/s). The flow computer interprets the Vf span using the Vo analog span entries. It converts the volumetric flow units to feet-per second. The minimum value for the Vf output is 0 f/s. The maximum span for Vf is the largest absolute value of either the min. or the max. flow rate entries. For example, an analog span between +10 f/s and -30 f/s, ranges the Vf output from 0 f/s to +30 f/s.

Vs *spanned liquid sonic velocity*

Vs is the sonic velocity of the flowing liquid, presented in meters-per-second (m/s). The minimum and maximum Vs entries establish the Vs span. Max Vs (m/s) (Para. 5.3.6.3) defines 100% of span. Min Vs (m/s) (Para. 5.3.6.4) defines 0% of span.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Maximum analog span values represent:
- 100% of span
- Current output of 20 mA
- Voltage output of 10 Vdc
- TTL Pulse output of 5000 Hz

Minimum analog span values represent:
- 0% of span
- Current output of 4 mA
- Voltage output of 0 Vdc
- TTL Pulse output of 0 Hz

5.3.6.1 Max Flow Rate
The MAX FLOW RATE command sets the maximum flow range for the Vo analog span. It can be a positive or negative value. Enter the data using the flow rates you selected.

TO SET MAX. FLOW RATE:

☐ **Press the RIGHT Arrow to move the cursor from ANALOG SPAN to MAX FLOW RATE**

☐ **Press the RIGHT Arrow to move the cursor to Level D**

☐ **Use the Numeric keys to type the max. flow rate (100% of range)**

☐ **Press <ENTER> to register data. This moves the cursor to MIN FLOW RATE**

5.3.6.2 Min Flow Rate
The MIN FLOW RATE command sets the minimum flow range for the analog span. It can be a positive or negative value. Enter the data using the flow rate units you selected.

TO SET THE MIN. FLOW RATE:

☐ **Press the RIGHT Arrow to move the cursor to Level D**

☐ **Use the Numeric keys to type the minimum flow rate (0% of range)**

☐ **Press <ENTER> to register data. This moves the cursor to MAX Vs**

5.3.6.3 Max Vs
The liquid's sonic velocity (Vs) can be displayed on the stripchart and drive any analog output or alarm relay. The Max Vs command restricts the 100 percent Vs range 2100 meters-per-second to enhance detection resolution.

TO SET MAX. Vs:

☐ **Press the RIGHT Arrow to move the cursor to Level D**

☐ **Use the Numeric keys to type the maximum Vs (100% of range)**

☐ **Press <ENTER> to register data. This moves the cursor to MIN Vs**

5.3.6.4 Min Vs
The Min Vs command restricts the 0 percent Vs range to 400 meters-per-second to enhance detection resolution.

TO SET MIN. Vs:

☐ **Press the RIGHT Arrow to move the cursor to Level D**

☐ **Use the Numeric keys to type the minimum Vs (0% of range)**

☐ **Press <ENTER> to register data. This moves the cursor to ALARM SET (Level B)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.7 ALARM SET

The ALARM SET menu allows you to select alarm functions that will appear on the display and trigger an alarm relay. You may select from high or low flow rate, liquid interface (Vs), and liquid aeration alarm functions. All entered alarm setpoints will be scaled in accordance with the rate units you selected.

5.3.7.1 High Flow Alarm

The HIGH FLOW ALARM command sets the HI Alarm relay trip-point and the position of the HI Alarm cursor on Stripchart Displays. The value you enter must fall within your Vo analog span if you want the Hi Alarm cursor to appear on the Graphic Screen.

TO SET HIGH FLOW ALARM:

- ☐ **Press the RIGHT Arrow to move the cursor from ALARM SET to HIGH FLOW ALARM**
- ☐ **Press the RIGHT Arrow to move cursor to Level D**
- ☐ **Use Numeric keys to type the required High Flow Alarm setpoint**
- ☐ **Press <ENTER> to register data. This moves the cursor to LOW FLOW ALARM**

5.3.7.2 Low Flow Alarm

The LOW FLOW ALARM command sets the LO Alarm relay trip-point and the position of the LO Alarm cursor on Stripchart Displays. The value you enter must fall withing your Vo analog span if you want the LO Alarm cursor to appear on the Graphic Screen.

TO SET THE LOW FLOW ALARM:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use Numeric keys to type the required Low Flow Alarm setpoint**
- ☐ **Press <ENTER> to register data. This moves the cursor to INTERFACE Vs**

5.3.7.3 Interface Vs

The flow computer measures the liquid's sonic velocity (Vs) and tracks any changes in this parameter dynamically. Therefore, it can distinguish between two different liquids flowing through the same pipe.

To set the interface alarm, you select a detection setpoint that falls in the middle of the Vs values of the two liquids. For example, if Liquid 'A' has a sonic velocity of 1249 m/s, and Liquid 'B' has a sonic velocity of 767 m/s, then you should enter 1008 m/s for the interface setpoint. The Interface Alarm becomes active when the measured Vs meets or exceeds the reference value you enter in this menu cell.

NOTE: The valid Interface Vs range is: 400 to 2100 m/s. Your entry should not exceed this range.

TO ENTER A LIQUID INTERFACE VALUE:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric keys to type the required Interface Vs value**
- ☐ **Press <ENTER> to register data. This moves the cursor to AERATION ALARM**

5.3.7.4 Aeration Alarm

System 990's ability to operate with substantial aeration (caused by either a mixing condition or cavitation) surpasses all other transit-time systems. Some applications may require an alarm indication if aeration exceeds a particular level. Therefore the flow computer creates a numeric scale for the degree of aeration it detects.

The aeration number published by the flow computer is not an absolute measurement, it is simply a relative scale. Therefore, to set the aeration alarm, you observe or create an alarm level then enter the related aeration number in this menu cell. The aeration number (Vaer) appears on the Diagnostic Menu (see Para. 5.4.4). During operation, Graphics Screens show the current aeration number. The aeration level triggers the alarm whenever it meets or exceeds the threshold you set in this menu cell. Obviously, you cannot set this alarm until the system is fully operational.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

TO LEAVE AERATION ALARM (Level C) WITHOUT SETTING THE ALARM:

- ☐ **Press the LEFT Arrow to move the cursor to ALARM SET (Level B)**
- ☐ **Press the DOWN Arrow to move the cursor to STRIPCHART SETUP (Level B)**

TO SET THE AERATION ALARM:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D. The CDU becomes active for numeric entry**
- ☐ **Use the Numeric keys to type the required aeration alarm setpoint**
- ☐ **Press <ENTER> to register data. This moves the cursor to STRIPCHART SETUP (Level B)**

5.3.8 STRIPCHART SETUP

The STRIPCHART SETUP menu allows you to select spanned flow rate (Vo), spanned flow velocity (Vf), spanned liquid sonic propagation velocity (Vs), spanned sonic signal amplitude (Valc) or liquid aeration or liquid nonhomogeneity (Vaer) from the Data Selected option list. You can select also the type of scaling and the scaling interval.

If your system is equipped with the LCD Digital Display screen (see Figure 5-2, in Section 5.5), you will not have a Stripchart display. However, these screens provide an analog Barchart that can display the spanned flow rate, the spanned flow velocity, the aeration number or the sonic signal amplitude. It presents the data on 0% to 100% scale in accordance with your analog span settings. You select data for the analog bargraph using the Stripchart Data selected Menu List.

5.3.8.1 Data Selected *(Stripchart & Barchart)*

The Stripchart DATA SELECTED option list provides a selection of data functions for the Stripchart display. Data will be plotted using the data units and time base selected by the flow computer.

If your system uses the optional LCD Digital Screen, then you use this DATA SELECTED menu to select data for the Barchart Display. The Barchart display uses the rate units and time base selected by the flow computer.

TO SELECT DATA FOR THE STRIPCHART (OR BARCHART):

- ☐ **Press the RIGHT Arrow to move the cursor from STRIPCHART SETUP to DATA SELECTED**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 13)**
- ☐ **Use the UP or DOWN Arrow to scroll List 13 until the required data appears on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to SCALE UNITS (Level 2 & 3 Systems), or ANALOG INPUTS (Level 1 Systems)**

NOTE: All data except Valc and Vaer will be ranged identically to the Analog Span.

5.3.8.2 Scale Units

The SCALE UNITS option list offers the choice of displaying Stripchart data either in data units or as a percent of span. A percent of span is the default selection. If this suits the application, then you may bypass this menu cell by pressing the DOWN Arrow. Barchart displays show data as a percent of span only.

TO SELECT A SCALE UNIT:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 14)**
- ☐ **Use the UP or DOWN Arrow to scroll List 14 until the required Scale Unit appears on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to TIME INTERVAL**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.8.3 Time Interval

The Stripchart plots an average of the readings obtained during the elapsed time between reports. Each The Stripchart resolution is one data point per pixel, of which there are approximately 100 on the short Digital Display Chart and approximately 200 on the full screen Stripchart Display. Five pixel reports occur between major Stripchart divisions. These are marked in appropriate time graduations. The TIME INTERVAL SET option list defines the interval between single pixel reports. Note that the Stripchart display identifies the 'real time' when the flow computer records the most recent graduation. Therefore, any graduation can be time-stamped merely by counting back in graduation intervals. The default interval setting is 1 second. If this suits the application, then you may bypass this menu cell by pressing the LEFT arrow, then pressing the DOWN arrow to move the cursor to DATALOGGER SETUP (Level B).

TO SELECT A TIME INTERVAL:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 15)**
- ☐ **Use the UP or DOWN Arrow to scroll List 15 to the required interval**
- ☐ **Press <ENTER> to register data. This moves the cursor to DATALOGGER SETUP (Level B)**

5.3.9 DATALOGGER SETUP *(Level 2 & 3 Systems)*

The flow computer's datalogger records data for eventual display on the Graphics Screen, or for transmission to an RS-232 compatible external device (printer, computer, network, etc.). DATALOGGER SETUP allows you to select time interval-based data categories, event-based status alarms and auxiliary analog inputs. You can select also the interval between data records.

5.3.9.1 Datalogger Mode

The DATALOGGER MODE option list allows you to disable the Datalogger, transmit reports to an external target via the RS-232 port, or store selected data in the 993M AFAC for later display. Note that the system provides two options for data memory management (see Para. 5.5.3). The default setting is OFF. If this suits the application, then you may bypass this menu cell by pressing the DOWN Arrow.

TO SELECT A DATALOGGER MODE:

- ☐ **Press the RIGHT Arrow to move the cursor from DATALOGGER SETUP to DATALOGGER MODE**
- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 16)**
- ☐ **Use the UP or DOWN Arrow to scroll List 16 until the required mode appears on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to DATA SELECTED**

NOTE: After enabling the datalogger, select a data format before generating a report.

5.3.9.2 Data Selected *(Datalogger)*

You can set the datalogger to record any system data and status alarm function. You may select any or all of the data offered on the option list (Menu List 17). However, you should be aware that recording unneeded data wastes valuable 993M AFAC memory space. Always select Site ID (name) and Time to identify each line of data. You can select also Date, Average Flow Rate, Instantaneous Flow Rate, Flow Total, Liquid Sonic Velocity (Vs), Signal Strength (Valc), Aeration Level (Vaer), Alarms, and Analog Inputs.

If you select Alarms, upon generating a report, the datalogger shows the state of each of the alarm functions in an eight-character field. A dash [-] represents an inactive alarm. A letter code represents an active alarm. The letter codes assigned to Alarm functions are:

- **S** . . Transducer spacing needs re-adjustment (see Para. 5.4.1.5)
- **E** . . Pipe is empty
- **R** . . Flow above high setting or below low setting
- **F** . . Three continuous seconds without new data update
- **A** . . Current aeration/cavitation number exceeds the alarm setpoint
- **M** . . Displaying last valid reading for specified interval during fault condition
- **K** . . In-Process Makeup invoked
- **I** . . . Liquid Interface detected

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Note that if you use the datalogger in its time-interval mode (see Para. 5.3.9.4), it will record the state of all the status alarms at the designated report time only. Therefore, if an alarm condition occurred, but was cleared before the report time, it would not appear on the report. If you require notification of transient alarm conditions, then you should operate the datalogger in its event-based mode (see Para. 5.3.9.3). This mode generates a report whenever an alarm event occurs.

TO SELECT DATALOGGER DATA:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 17)**
- ☐ **Use the UP or DOWN Arrow to scroll List 17. Press <ENTER> to select a data item when it appears on the CDU Screen. This moves the cursor to the next selection**

NOTE: Selected data items flash. Data items not selected (or cleared) do not flash.

- ☐ **Press CLEAR to deselect a data item when it appears on the CDU Screen**

TO LEAVE LIST 17:

- ☐ **Press the LEFT Arrow to move the cursor to DATA SELECTED (Level C)**
- ☐ **Press the DOWN Arrow to move the cursor to EVENT SELECTED (Level C)**

5.3.9.3 Event Selected

System 990 offers "event-based" datalogging that operates concurrently with "time-interval" based datalogging. The event-based function generates a Datalogger report upon the triggering of any of the eight status alarms. This is useful for recording transient alarms (for example, a liquid interface, or a short aeration alert). Event-based Datalogger messages conserve memory, however if you use this feature to monitor a level such as aeration, set the threshold high enough to avoid repetitive triggering of the Datalogger. Always select Site ID (Name) and Time (see Para. 5.3.9.2) when using this function. A [-] represents an inactive alarm. A letter code represents an active alarm.

TO SELECT STATUS ALARMS FOR THE EVENT-BASED DATALOGGER:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 18)**
- ☐ **Use the UP or DOWN Arrow to scroll List 18. Press <ENTER> to select a status/alarm function when it appears on the CDU Screen. This moves the cursor to the next list selection**

NOTE: Selected data items flash. Data items not selected (or cleared) do not flash.

- ☐ **Press CLEAR to deselect a status alarm when it appears on the CDU Screen.**

TO LEAVE LIST 18:

- ☐ **Press the LEFT Arrow to move the cursor to EVENT SELECTED (Level C)**
- ☐ **Press the DOWN Arrow to move the cursor to LOG INTERVAL SET**

5.3.9.4 Log Interval Set

At the log interval that you select, the datalogger records your selected data as a "snapshot" of the existing conditions at the time of the data report. The reported average flow rate represents the average flow rate measured since the last Datalogger report. Only select short log intervals if frequent reporting is fully justified. Data logging uses a considerable amount of 993M AFAC memory. Paragraph 5.5.3.2 describes a method for estimating how long the available memory will last.

TO SET THE LOG INTERVAL:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 19)**
- ☐ **Use the UP or DOWN Arrow to scroll List 19 until the required interval appears on the CDU Screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to ANALOG INPUTS (Level B)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.10 ANALOG INPUTS

The ANALOG INPUTS Menu, in conjunction with the 994-9 option module, allows the flow computer to receive analog data from external instrumentation. The flow computer will not use auxiliary input data. However, the input signals appear on the Diagnostics Menu and you may include them in Datalogger reports (see Para. 5.4.4). If an auxiliary input is disabled, a value of zero will be inserted in the Diagnostics Menu and on Datalogger reports.

The 994-9 board has a four input capacity. Its port designations are AUX 1, AUX 2, AUX 3 and AUX 4. The 994-9C version receives 4-20 mA input signals. The 994-9V version receives 0-10 Vdc input signals. Please refer to engineering drawing 994-9-7 in the Drawing Section of this manual for installation and wiring instructions.

Single-channel systems provide four separate auxiliary inputs (AUX 1 through 4). Dual-channel systems provide two analog inputs per channel. Channel 1 uses AUX 1 and AUX 2. Channel 2 uses AUX 3 and AUX 4. Four-channel systems provide one auxiliary input per channel. Channel 1 uses AUX 1, etc.. The following chart summarizes the distribution of Analog Input Ports among single, dual and four-channel systems:

DISTRIBUTION OF 994-9 ANALOG INPUT PORTS

		ANALOG INPUT PORTS			
SYSTEM	CHANNEL	AUX 1	AUX 2	AUX 3	AUX 4
SINGLE CHANNEL	1	•	•	•	•
DUAL CHANNEL	1 2	•	•	•	•
FOUR CHANNEL	1 2 3 4	•	•	•	•

This section describes the programming procedure for Analog Inputs AUX 1 through AUX 4 as it would be presented on a single-channel system's Installation Menu. The Installation Menus for dual and four-channel systems will be abbreviated to Analog Input ports assigned to measurement channel being programmed. For example, on a dual-channel system, when programming measurement channel 1, the Installation Menu presents AUX 1 and AUX 2. When programming measurement channel 2, the Installation Menu presents AUX 3 and AUX 4.

5.3.10.1 Auxiliary 1 (2, 3 or 4) Input

The programming sequence for an auxiliary input channel, is first enable the input, then specify the full range and zero range points using whatever scaling fits the input data. The AUX 1, 2, 3 and 4 ENAB menu cells allow you to activate each auxiliary input. The AUX 1, 2, 3 and 4 HIGH menu cells allow you to set the full range span points. The AUX 1, 2, 3 and 4 LOW menu cells allow you to set the zero range span points. The programming procedure for the four Analog Inputs is identical. Repeat the AUX 1 procedure described below to activate inputs AUX 2 through 4.

TO ENABLE THE AUX 1 ANALOG INPUT:

- ☐ **Press the RIGHT Arrow to move the cursor from ANALOG INPUTS to AUX 1 ENAB**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 2)**
- ☐ **Use the UP or DOWN Arrow to scroll List 2 to [YES]**
- ☐ **Press <ENTER> to enable AUX 1. This moves the cursor to AUX 1 HIGH**

Artisan Scientific.- Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

TO SPAN THE AUX 1 INPUT:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric Keys to type the 20 mA (10 Vdc) value for AUX 1 (use any scaling)**
- ☐ **Press <ENTER> to register data. This moves the cursor to AUX 1 LOW**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric Keys to type the 4 mA (0 Vdc) value for AUX 1 (use any scaling)**
- ☐ **Press <ENTER> to register data. This moves the cursor to AUX 2 ENAB (Level C)**
- ☐ **Follow the assignment procedure for AUX 1 to enable AUX 2 to AUX 4.**

AFTER ENABLING THE LAST REQUIRED INPUT (AUX 2, 3 or 4):

- ☐ **Press the LEFT Arrow to move the cursor to ANALOG INPUTS (Level B)**
- ☐ **Press the DOWN Arrow to move the cursor to ANALOG OUTPUTS (Level B)**

5.3.11 ANALOG OUTPUTS

Single and dual-channel systems can be equipped with four selectable analog outputs per channel (V1 through V4). The V1, V3 and V4 outputs provide 0 to 10 Vdc signals. The V2 output drives an instrumentation 4 to 20 mA output, with a parallel TTL compatible pulse (see Para. 5.3.11.2). These analog outputs vary in proportion to any analog function that you select from the Analog Output option list (Menu List 20). With four-channel systems, (Io/V1) provides the 4-20mA/TTL-pulse output for each channel.

5.3.11.1 V1 (V3 & V4)

The V1, V3 and V4 analog outputs vary linearly from 0 to 10 Vdc in relation to selected analog functions. You access these analog outputs on the terminal strip located on the front edge of each 994-7 module installed in your system. The function selection procedure for the V1, V3 and V4 outputs is identical. Repeat the V1 assignment procedure described below, to select functions for V3 and V4.

TO ASSIGN A FUNCTION TO V1:

- ☐ **Press the RIGHT Arrow to move the cursor from ANALOG OUTPUTS to V1**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 20)**
- ☐ **Use the UP or DOWN Arrow to scroll List 20 until the required function appears on the CDU screen**
- ☐ **Press <ENTER> to register function. This moves the cursor to Io/V2**

5.3.11.2 Io/V2 *(Io/V1, four-channel systems)*

System 990N provides an isolated 4-20 mA instrumentation output, with a simultaneous 0 to 5000 Hz pulse rate, that varies linearly with any analog data function. Single and dual-channel systems use voltage V2 to drive the 4-20mA/Pulse output. The menu cell is designated Io/V2.

Four-channel systems provide an isolated 4-20 mA instrumentation output that varies linearly with any analog data function. However, these systems do not provide a concurrent pulse rate. Four-channel systems use voltage V1 to drive the 4-20mA output. The menu cell is designated Io/V1.

TO ASSIGN A FUNCTION TO Io/V2 *(or Io/V1 on four channel systems):*

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 20)**
- ☐ **Use the UP or DOWN Arrow to scroll List 20 to the required function on the CDU Screen**
- ☐ **Press <ENTER> to register function. This moves the cursor to V3 (or RELAY SETUP for four-channel systems)**

SINGLE & DUAL-CHANNEL SYSTEMS:

- ☐ **Repeat the V1 assignment procedure for V3 & V4. After assigning a function to V4, the cursor moves to RELAY SETUP (Level B)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.3.12 RELAY SETUP

Single and dual-channel systems equipped with a Relay Output Module provide up to four alarm relays per channel. Four-channel systems provide two alarm relays per channel. The default relay function selection is OFF. If you do not intend to use any relays, or if your system does not have the optional Relay Output Module, you may bypass this menu by pressing the LEFT Arrow to move the cursor to SITE SETUP (Level A), then pressing the DOWN Arrow to move the cursor to INSTALLATION (Level A). We can equip your system with either NORMALLY OPEN or NORMALLY CLOSED relays. You can choose to use them either for *Status Alarm* or *Pulse Count* functions.

Status Alarm relays function in a *fail-safe* manner regardless of the relay type. *Fail-safe* means that under normal conditions (no alarm) the flow computer *energizes* the relay. In an *energized* state, the contacts on a NORMALLY OPEN relay will be *closed*. In an *energized* state, the contacts on a NORMALLY CLOSED relay will be *open*. When the flow computer detects an alarm condition, it *de-energizes* the alarm relay for the duration of the alarm. *De-energizing* a NORMALLY OPEN relay opens its contacts. *De-energizing* a NORMALLY CLOSED relay closes its contacts. Therefore, if the system loses power, a Status Alarm relay will *de-energize* - triggering the POWER Status Alarm. Status Alarms appear on the display screen and on the CDU hand-held terminal. System 990N Status Alarm functions are: power on/off, high flow, low flow, flow alarm, fault alarm, spacing, empty, aeration, reverse flow, interface and soft fault.

Pulse count relays do not operate in a *fail-safe* manner. A *no-pulse* condition *de-energizes* the relay. When the flow computer generates a pulse, it *energizes* the relay for approximately 100 mS. Pulse count relay functions do not appear on the display screen or the CDU terminal. System 990N pulse relay functions are: pos tot, neg tot and batch/sample tot.

5.3.12.1 Channel Relay 1 (2, 3 & 4)

The CHANNEL RELAY option list (Menu List 21) allows you to assign functions to channel relays. The procedure below explains how to assign a function to Channel Relay 1. You can repeat this procedure for all the relays installed on your system.

TO ASSIGN AN ALARM OR FUNCTION TO CHANNEL RELAY 1:

- ☐ **Press the RIGHT Arrow to move the cursor from RELAY SETUP to CHANNEL RELAY 1**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 21)**
- ☐ **Use the UP or DOWN Arrow to scroll List 21 until the required function appears on the CDU screen**
- ☐ **Press <ENTER> to register selection. This moves the cursor to CHANNEL RELAY 2**
- ☐ **Repeat for all Relays. After CHANNEL RELAY 4 (single and dual channel systems) or CHANNEL RELAY 2 (four channel systems), the cursor moves to INSTALLATION (Level A)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.4 HOW TO ENTER INSTALLATION DATA

The Installation Data Menu includes routines for transducer mounting, site adjustment and external flow calibration. A Diagnostic menu provides application data and system test and recovery routines.

Reinstalling the system at a former site simply requires recalling saved site data. This avoids repeating the site programming. However, the reinstallation must carefully comply with the transducer size, track type and spacing indices of the recalled data. If the transducers were left in place, make sure that they have not been changed since the last installation. If liquid conditions have changed since the previous installation, the transducer may have to be moved to a different Number Index. A Spacing Alert after operation resumes indicates that the installation procedure will have to be repeated.

The following sections explain the flow computer programming for an original transducer installation and how to perform final site adjustments. However, the flow computer will not allow installation programming if you failed to enter any prerequisite Site Setup data (e.g. pipe dimensions and pipe material).

For an original installation, the first job is mounting the transducers on the pipe. Mounting tracks must be installed on the pipe to hold the transducers. Please refer to the Transducer Installation Drawings in Appendix B for instructions on how to install the mounting tracks.

After completing the transducer mount procedures, the Installation Menu advances to Site Adjustment. This menu sets empty pipe and zero flow parameters to "fine-tune" the system for the application. After completing the Site Adjustments, Installation provides commands for calibrating the system with an external source. The Diagnostics Menu presents system data, current operating information, test commands and recovery routines.

☐ **Pressing the DOWN Arrow moves the cursor from SITE SETUP to INSTALLATION**

5.4.1 XDCR (Transducer) MOUNT

The XDCR MOUNT menu provides the programming steps for mounting the transducers on the pipe. Each step is designed to achieve an optimum installation while being flexible enough to accommodate unusual situations.

NOTE: The 991 Flow Transducers come in matched pairs. Before installing the transducers, be sure that their serial numbers match.

The XDCR MOUNT menu shows you the correct choice(s) for transducer size and (in some cases) the mounting track type. After selecting a mounting track (Direct or Reflect), the flow computer issues mounting track spacing indices that define the exact placement of the transducers on the mounting track. The Diagnostic Menu item: Ltn (see Para. 5.4 4.1) shows the actual distance between the transducers (in inches or millimeters).

The flow computer bases the initial transducer spacing on the Liquid and Pipe Data you entered during Site Setup. However, the flow computer will actually measure the Vs after you connect the transducers. If the *measured Vs*, disagrees with your Site Setup entries, you may have to move the transducers to new assigned indices.

The *measured* Vs serves another important purpose. The *displayed* Vs might not match the *known* value. This can be confirmed if the liquid's Vs is listed in this manual. If the measured Vs appears to be inaccurate, this may be due to an inadvertent error. For example, you might have entered incorrect pipe dimensions during Site Setup. Also, you might have installed the transducers at incorrect spacing indices. If you notice an inconsistency between the *known* and *displayed* Vs, you should recheck these factors first. If you do not find an error, you can simply enter the correct Vs (see Para. 5.4.1.7). This will permit the system to operate within its specified accuracy.

☐ **Pressing the RIGHT Arrow moves the cursor from INSTALLATION to XDCR MOUNT**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.4.1.1 Xdcr (*Transducer Size*)

When you move the cursor to XDCR (Level C), the CDU screen displays recommended transducer size(s). For example, the screen might show [2,3]. It is alright to use a different size, if the mounting track will accommodate the pipe's diameter. The flow computer shows that it accepts the transducer size if it issues a transducer spacing number index between: 0 and 15, and operation begins without a re-spacing request.

NOTE: Characters following the dash in a transducer's part number (P/N) identifies the transducer's size (e.g. 991NM-2A is a size "2A" transducer).

An "A" type transducer may outperform the standard model, depending upon the pipe's wall thickness and material. You should consider obtaining an "A" model if your application is extremely critical. For example, if you intend to use the system for Custody Transfer, or at a Nuclear Power Plant. In very rare cases, you may have to use an "A" type transducer to avoid a Detection Fault Alarm.

Controlotron provides 991XA Bulletins that list transducer recommendations for various pipe materials. If a 991XA Bulletin for a particular pipe material is not in print, then Controlotron's Application Engineering Department can assist in the transducer selection. This assistance is available before or after you purchase the equipment.

TO REGISTER THE TRANSDUCER:

- ☐ **Press the RIGHT Arrow to move the cursor from XDCR MOUNT to XDCR (Level C)**
- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 22)**
- ☐ **Use the UP or DOWN Arrow to scroll List 22 until the correct transducer size appears on the CDU Screen**
- ☐ **Press < ENTER> to register selection. This moves the cursor to TRACK TYPE (Level C)**

5.4.1.2 Track Type

The flow computer usually recommends a transducer mounting track type [Direct or Reflect] on the TRACK TYPE Level C Screen. Direct mount tracks provide a greater transducer signal and require less mounting length than Reflect mount tracks. This can be important if the liquid exhibits high sonic attenuation. However, it is easier to install Reflect mount tracks. They allow you to mount the transducers on pipes that do not allow back or side access. Also, these tracks feature an intrinsic compensation for flow profile distortion (crossflow) that could be caused by an insufficient upstream straight run.

NOTE: Only use Direct Mount on Plastic pipes.

You must know the mounting track size that accommodates the pipe diameter range of the transducer size you intend to use. Some applications require the use of a particular transducer size with a pipe diameter range usually assigned to the next larger transducer size. This would require a special mounting track (compatible with both the required transducer's size and the larger pipe diameter range). You may be able to order these tracks from Controlotron. Consult Controlotron Application Engineering for details.

TO SELECT A MOUNTING TRACK:

- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 23)**
- ☐ **Use the UP or DOWN Arrow to scroll List 23 until the correct track type appears on the CDU Screen**
- ☐ **Press < ENTER> to register selection. This moves the cursor to TRACK SIZE (size 5 systems) or LETTER INDEX (all other systems)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.4.1.3 Track Size

NOTE: The TRACK SIZE menu will only appear if the system is using Size 5 transducers. This menu cell will be suppressed for all other transducer sizes.

Usually the Track Size number matches the number that represents the transducer's pipe diameter range. For example, the diameter range number [3] identifies a transducer intended for use on a 20" pipe. The track size number for this transducer is also [3]. However, a Size 5 transducer (whose default track size is 5) can be used with four different pipe diameter ranges. Each of these pipe diameter ranges has a different track size designation:

Xdcr Size	Pipe OD	Use Track Size
5	36" to 84" (914.14mm to 2133.6mm)	5
5	72" to 120" (1828.8mm to 3048.0mm)	5X
5	120" to 216" (3048.8mm to 5486.4mm)	5Y
5	216" to 360" (5486.4mm to 9144.0mm)	5Z

Note the pipe diameter overlap between track sizes 5 and 5X (72" to 84"). Track size 5 or 5X can be used within this range. When the pipe is over 84 inches in diameter, the default track size selection (size 5) should be replaced with reference to table above.

There another situation where you may want to override the default selection. With some Uniflow models, it is acceptable to use a given transducer size with a pipe assigned to the next larger pipe diameter group (i.e., to use a size 2 transducer on a 20 inch pipe). Naturally, this will require selection of a track that will have the width and Spacing indices conforming to the transducer size, and length conforming to the next larger pipe diameter group. This track type must be specially ordered. It has a size designation that is the sequential combination of the actual transducer size number and the next larger diameter range. For example, a size "23" track mounts a size 2 transducer on pipes in the Size 3 diameter range (between 6 and 24 inches).

IF THE DEFAULT SELECTION IS APPLICABLE:

- ☐ **Press the DOWN Arrow to move the cursor to LETTER INDEX**

If you must select track sizes 5X, 5Y or 5Z (or the special track described above), then Menu List 24 a offers a selection of track sizes.

TO SELECT A TRACK SIZE:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 24)**
- ☐ **Use the UP or DOWN Arrow to scroll List 24 until the correct Track size appears on the CDU Screen**
- ☐ **Press < ENTER> to register data. This moves the cursor to LETTER INDEX (after a short delay)**

5.4.1.4 Letter Index

The transducer mounting tracks have Letter and Number Index labels. This ensures simple and error-free placement of the Upstream and Downstream transducers. When the cursor moves to LETTER INDEX, Level C, the flow computer publishes a recommended Letter Index on the CDU Screen. This is the first step in establishing the correct transducer spacing. Higher Letter indices provide moderately greater signal levels but, in some cases, slightly decreased zero flow stability.

System 990 uses a pair of precisely matched transducers. Therefore, you can place either one at the Letter Index position. Note that you must connect the UP transducer cable to the transducer mounted on the upstream side of the mounting track. This allows the flow computer to show the flow direction correctly.

For a reinstallation, you must remount each transducer in its original position. To simplify this, transducer pairs have matching serial numbers except for the appended letters "A" and "B". This permits you to identify each transducer positively. It is therefore important that you note each transducer's serial number and its Index position during the original installation.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

TO REGISTER THE LETTER INDEX:

- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 25)**
- ☐ **Use the UP or DOWN Arrow to scroll List 25 until the recommended (or preferred) Letter Index (A, B, C or D) appears on the CDU Screen**
- ☐ **Press < ENTER> to register Letter Index. This moves the cursor to NUMBER INDEX (Level C). The CDU shows a Number Index and prompts you to press < ENTER>**

5.4.1.5 Number Index

The Number Index establishes the spacing between a pair of transducers. Initially, the flow computer bases its Number Index selection on the pipe diameter and estimated liquid sonic velocity (Vs) entered during Site Setup. Any subsequent recommendation will be based on either the *measured* Vs, or on a "known" entry (see Para. 5.4.1.7). To obtain the greatest accuracy, it is essential that you locate the second transducer at the recommended Number Index. After you complete the transducer installation procedure, accuracy is assured if there is no *Spacing Alert*. The flow computer issues a *Spacing Alert* to inform you that you will have to adjust the transducer spacing.

Immediately after the CDU shows the recommended Number Index, the actual spacing between transducers appears in the Diagnostics Menu under the item [Ltn]. The distance will be either in inches or millimeters, depending on the pipe dimension units you selected. To view Ltn, scroll the Diagnostics list to Item [Ltn] (see Para. 5.4.4).

To comply with the flow computer's calculations, you must mount the transducers at the recommended spacing indices in accordance with the mounting instructions. Refer to the Transducer Installation Drawings in Appendix B for detailed instructions. The pipe should be filled completely with the process liquid. The liquid can be flowing, or at zero flow. You must use a proper sonic coupling compound when mounting the transducers. Table 5-4 provides a list of the recommended sonic coupling compounds for permanent or temporary use.

AFTER INSTALLING THE TRANSDUCERS ON THE MOUNTING TRACK:

- ☐ **Press < ENTER> to confirm that they are mounted at the recommended spacing indices and that you have attached the transducer cables correctly**

5.4.1.6 Initial Makeup

Immediately after you press ENTER, the flow computer invokes an internal process called an *Initial Makeup*. The current Initial Makeup activity: *Drive* (code #), *Selected Drive* (code #), and *Stage* (from 2 to 5), appears on the CDU Screen. During the Initial Makeup, the flow computer verifies the sonic characteristics of the pipe and the liquid and adjusts internal parameters to optimize flow measurement. The time this process takes depends on the pipe size and application conditions. It may take several seconds or several minutes to complete so please remain patient. There is no direct relationship between the time taken for the Initial Makeup and system performance. The Initial Makeup for larger pipes (and more difficult application conditions) simply takes longer.

5.4.1.6.1 Successful Initial Makeup

Cursor movement to MEASURED Vs indicates a successful Initial Makeup. This occurs if the pipe and liquid agrees with the Site Setup parameters and application conditions are suitable. The selected Letter and Number Indices will be confirmed and the system will be operational. You will only have to complete the final site adjustments.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table 5-4: Recommended Sonic Coupling Compounds

ITEM	CC#	USE	CHARACTERISTICS
1	101	Temporary and portable use on Clamp-on flow transducers. Temp. range: -40°F to 100°F.	Low in halogens and sulphur content.
2	102	Temporary and portable use for all Clamp-on flow transducers. Well suited for survey use. Temp. range: -30°F to 100°F.	Low in halogens and sulphur content. Water soluble.
3	109	Temporary and portable use for all Clamp-on flow transducers. Temp. range: -40°F to 300°F.	Low viscosity Petroleum product.
4	110	High temp. temporary couplant to be used when setting up high temp. plastic flow transducers. Temp. range: 255°F to 450°F.	Resists breakdown and thinning out at high temperatures.
5	111	Permanent high temp. couplant for plastic flow transducers. Temp. range: 255°F to 450°F.	Room temperature vulcanizing silicone rubber.
6	112	Permanent ambient temperature couplant for plastic flow transducers. Temp. range: -40°F to 250°F.	Room temperature vulcanizing silicone rubber.
7	113	Protective spray for providing corrosion resistance to exposed transducer and track parts.	Spray on liquid. Excellent resistance to salt water atmosphere.
8	114	Temporary and long term couplant for all flow transducer types. Temp. range: -40°F to 255°F.	Teflon filled grease. Water resistant.
9	117	Long term and permanent couplant for Clamp-on flow & temperature transducers. Temp. range: -40°F to 450°F.	Silicone grease loaded with metal oxides. Resists Breakdown and thinning at high temperatures.
10	120	Submersible couplant. To be used on all submerged transducer applications.	Extremely water resistant. Consult Controlotron before using.
11	122	Long term and permanent couplant for Clamp-on transducers. Temp. range: -40°F to 450°F.	Long chain polymer grease. Resists breakdown and thinning at high temperatures.
12	124	Long term and permanent couplant for Clamp-on transducers. Temp. range: -40°F to 250°F.	Two part room temperature cure adhesive.

NOTICE: Controlotron holds US Patent Number 4,929,368 on the CC# 122 Coupling Compound and all compounds of this type. Its use is restricted to Controlotron products only, unless a special license has been obtained. Licenses for use with other products are available through the Controlotron Sales Department.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.4.1.7 Measured Vs

MEASURED Vs is only active during installation. The flow computer restricts access to this item after the installation proceeds to Site Adjustment. However, if you re-spaced the transducers, then press < ENTER> at the NUMBER INDEX screen (Level D) to re-select MEASURED Vs.

MEASURED Vs offers an opportunity to ensure accuracy by allowing the flow computer to correct any inconsistencies between the Site Setup data you entered and actual Site conditions. Also, it allows you to correct noncompliance with the designated Spacing Indices.

An accurate Vs measurement depends on certain parameters that the flow computer cannot sense directly (e.g. pipe dimensions). In other words, entering incorrect pipe parameters or not complying with the recommended spacing indices will result in an inaccurate Measured Vs. This may reduce the system's accuracy. You can reduce this error substantially simply entering the correct value for Vs in this menu cell. However, only consider editing the Measured Vs after you remove all the primary causes for the inaccuracy. Check your pipe dimensions and pipe material entries. Re-check the transducer spacing. Large Vs discrepancies are almost always due to erroneous pipe data or incorrect transducer placement.

You can review the tables provided in this field manual if you do not know the liquid's Vs. Also, our Application Engineering or Technical Service department can assist you. Be prepared to identify the liquid's generic name, concentration and operating temperature. We may be able to suggest a way to measure this important parameter independently. Note that it is more difficult to obtain an accurate Vs measurement on small pipes (under 2 inches) since the pipe tolerance has a greater effect on measurement accuracy in this range.

NOTE: After the system is on-line, you can adjust the Measured Vs using the Diagnostics Menu item (see Para. 5.4.4.1).

TO ACCEPT THE MEASURED Vs:

- ☐ **Press the DOWN Arrow to confirm the Measured Vs. This moves the cursor to SITE ADJUSTMENT**

IF YOU DECIDE TO EDIT THE DISPLAYED Vs:

- ☐ **Press the RIGHT Arrow to move cursor to Level D**
- ☐ **Use the Numeric keys to type the correct Vs value (in meters-per-second)**
- ☐ **Press < ENTER> to register the corrected VS. This returns the cursor to NUMBER INDEX. The CDU shows a new NUMBER Index recommendation**
- ☐ **Remount the transducer at the new NUMBER Index**
- ☐ **Press < ENTER> to repeat the Initial Makeup process (see Para. 5.4.1.6)**

5.4.1.8 Alternate Initial Makeup Results

If the pipe conforms to your Site Setup entries, and application conditions meet minimum system requirements, the flow computer will complete its Initial Makeup. However, the end result of an Initial Makeup can vary. It is also possible that the flow computer cannot complete the Initial Makeup. The following paragraphs point out all the alternatives.

a. Successful Initial Makeup with the need to Respace Transducers:

Application conditions might be acceptable, but not in compliance with your Site Setup parameters. If so, the flow computer may keep the cursor at the NUMBER INDEX menu cell and recommend that you relocate the transducer at a different Number Index. After you move the transducer to the new Number Index, press < ENTER> to confirm your action. In rare cases, the flow computer may issue a second respace command.

Although not recommended, you could ignore the respace request by moving the cursor to Site Adjustment. However, leaving the system with a *spacing alert* increases the possibility of a Vs error that reduces output accuracy.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

b. Unsuccessful Initial Makeup:
If the flow computer does not accept the application conditions, one of following error messages may appear on the CDU screen:

- INVALID SETUP SPECIFICATION
- LOW (or HIGH) SIGNAL - PRESS ENTER
- DETECTION FAULT

Invalid Setup Specification Message: Refer to the Invalid Setup item in Paragraph 7.7 for instructions if the CDU displays an [INVALID SETUP SPECIFICATION] message.

Low Signal Message: If a [LOW SIGNAL] message appears, then very poor signal conditions may be hampering system operation by contaminating the data registers. Press the MENU key to terminate transducer installation. Inspect all installation conditions before attempting to reinstall the transducers. If you want to restart the installation procedure immediately, press < ENTER> instead of the MENU key.

High Signal Message: A [HIGH SIGNAL] message implies that due to extremely high liquid and pipe wall transmissivity, the signal strength is such that the receive circuitry cannot attenuate the signal to the level required for correct operation. Usually, if you select a closer Letter Index (for example, Index "A"), this will reduce the signal level enough. If changing the Letter Index is inconvenient (or not possible due to application conditions), We can supply a pair of signal attenuators to reduce the signal level sufficiently. A [HIGH SIGNAL] message implies that after proper attenuation, the signal-to-noise ratio will very likely be excellent, allowing the system to deliver top-notch performance.

NOTE: Section 7.7 includes a list of attenuator part numbers.

Detection Fault Message: If the [DETECTION FAULT] message appears during an Initial Makeup operation, the receive signal failed to meet the standards set for its acceptance. You must remove any cause for the DETECTION FAULT before re-attempting installation. Recheck the transducer cabling and conformance to installation instructions. Make sure that there is no turbulence (aeration) occurring in the pipe (see Para. 7.7).

c. Incomplete Initial Makeup:
The flow computer may not be able to complete its Initial Makeup. This is revealed by excessive attempts by the flow computer to complete a Makeup stage. Or, the system might appear to be locked at a particular stage. You should abort the Initial Makeup by pressing the LEFT Arrow or pressing < ENTER> . Occasionally, the flow computer triggers the [DETECTION FAULT] message to inform you of its inability to complete the Initial Makeup.

Before you repeat the transducer installation, check the Diagnostic List for an indication of the problem. Recheck your Site Setup data and all aspects of the equipment, the installation and application conditions. If the flow computer cannot complete the Initial Makeup, you should note the highest Stage number reached during the Initial Makeup. This will help our Technical Service Dept. to diagnose the cause of the problem.

5.4.1.9 In-Process Makeup
If an application condition (e.g. a power failure or emptying of the pipe) interrupts normal operation, flow measurement will be suspended and a *fault alarm* will be declared. The operating system includes an AUTOSTART function that restarts the flowmeter automatically after the *fault* condition clears. The flow computer's Initial Makeup records critical operating data. AUTOSTART invokes an *In-Process Makeup* to re-install these vital parameters. Usually, this takes few seconds after recovery from the *fault*. Even if the liquid characteristics changed during the *fault* condition, all installed site adjustments will be restored.

An *In-Process Makeup* triggers a Makeup Alarm to inform you that there was a loss of operation. The flow computer sets the Makeup Alarm flag [-K-] on LCD Graphic Screens, or illuminates the [MAKEUP] symbol on LCD Digital Screens. Pressing the MENU key resets an active Makeup Alarm and provides immediate access to the Re-Registration procedure (see Para. 5.4.1.9.1).

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

After completing the In-process Makeup, the flow computer resets the Makeup Alarm and resumes normal operation. Also, you can clear the Makeup Alarm Flag by generating a Datalogger Report that includes Status Alarms. The operating system also includes a Makeup Alarm *Latch* (see Para. 5.5.1.3) that, if invoked, forces the alarm flag to remain active until you clear it manually.

5.4.1.9.1 Re-Registration

In some cases, especially during the re-filling of an empty pipe, high aeration may occur as fluid replaces air. These conditions may corrupt or "mis-register" the receive signal parameters established during the Initial Makeup. A "mis-registered" receive signal could produce a zero offset that may be apparent under flow conditions. However, you can correct any offset without having to repeat the Zero Set procedure (see Para. 5.4.2.2) by invoking a "Re-Registration" routine (see Para. 7.5.1).

NOTE: Receive signal mis-registration is extremely rare.

5.4.2 SITE ADJUSTMENT

Each Site has unique pipe and liquid conditions that influence key elements of the installation procedure. Therefore, you should not expect to simply recall Site Data from a different Site and achieve successful operation. The SITE ADJUSTMENT menu allows you to adjust the flowmeter to accommodate individual site conditions.

SITE ADJUSTMENT allows you to set empty pipe and zero flow parameters. Also, you can set Slew Rate and Damping factors to customize the flow computer's response to rate changes. You can define a flow rate Deadband, within which, flow measurement will be disabled. You can invoke a Memory operating mode that directs the flow computer to report its last valid flow reading for a defined interval during a fault condition that disables flow measurement.

- ☐ **Pressing the DOWN Arrow moves the cursor from XDCR MOUNT to SITE ADJUSTMENT**

5.4.2.1 Empty Set

The Initial Makeup includes an MTYmatic procedure that provides a standard setting for the Empty Pipe alarm. Ideally, you should set the empty pipe alarm by emptying the pipe and performing the Actual Empty procedure (see Para. 5.4.2.1.1). Also, you can set the empty pipe alarm by entering a signal strength level indicative of an empty pipe (see Para. 5.4.4.2).

5.4.2.1.1 Actual Empty Procedure

If application conditions allow you to empty and refill the pipe, then you can perform the Actual Empty procedure. This is the recommended way to define the empty pipe threshold.

NOTE: <u>NEVER</u> perform this procedure on a full pipe. Doing so could inhibit flow computer operation.

TO PERFORM THE ACTUAL EMPTY PROCEDURE:

- ☐ **Press the RIGHT Arrow to move the cursor from SITE ADJUSTMENT to EMPTY PIPE SET**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 26)**
- ☐ **Use the UP or DOWN Arrow to scroll List 26 until [ACTUAL EMPTY] appears on the CDU Screen**
- ☐ **Press < ENTER> . [Empty Pipe / Press < Enter>] appears on the CDU screen**
- ☐ **Empty the pipe completely, then press < ENTER> . [Fill Pipe / Press < Enter>] appears on the CDU screen**
- ☐ **Refill the pipe completely, then press < ENTER> . This completes the procedure and moves the cursor to ZERO FLOW SET**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.4.2.1.2 MTYmatic Procedure

The operating system allows you to invoke manually the MTYmatic procedure performed by the Initial Makeup. You can use MTYmatic to correct quickly an inaccurate Actual Empty setting if application conditions do not allow you to repeat the Actual Empty procedure.

NOTE: Only invoke the Mtymatic procedure when the pipe is full. Using this command when the pipe is empty could inhibit flow computer operation.

TO INVOKE MTYmatic:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 26)**
- ☐ **Use the UP or DOWN Arrow to scroll List 26 until [MTYmatic] appears on the CDU Screen**
- ☐ **Press < ENTER> . This moves the cursor to ZERO FLOW SET**

5.4.2.2 Zero Flow Set

ZERO FLOW SET is a required installation procedure. It removes any zero offset due to pipe or transducer asymmetry and enhances the system's ability to sense absolute flow direction and magnitude under low flow conditions. We recommend using the *Actual Zero* command to program the flow computer's zero registers. ZERO FLOW SET includes a *Reversamatic* command to accommodate applications where flow cannot be reduced or stopped. However, you should use *Actual Zero* at the first opportunity. The *Zeroclr* command instantly resets the zero registers to [0.000].

For the best accuracy, you must invoke *Actual Zero* when the flow through the pipe equals zero. When you send the command, the flow computer measures the zero flow rate for a set duration, integrating (averaging) the data for the best zero correlation. Zero integration occurs for up to sixty seconds. During this time, the CDU screen shows a timer that counts from zero to sixty. You can allow zero averaging for the entire period, or terminate the process at any time by pressing the < ENTER> key. This controls the amount of data averaged to obtain a zero level. If you need to set a zero offset, or know the current instantaneous flow rate, you can enter this data via the Numeric keypad. The flow computer will begin the zero integration based on the numeric entry. Also, you can bypass the zero integration period entirely by pressing the < ENTER> key twice in rapid succession.

TO SET ACTUAL ZERO:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 27)**
- ☐ **Use the UP or DOWN Arrow to scroll List 27 until [ACTUAL ZERO] appears on the CDU Screen**
- ☐ **Press < ENTER> . The CDU Screen becomes active for numeric entry**
- ☐ **If the flow rate equals zero, press CLEAR (if [0.000] is not displayed on the CDU Screen)**
- ☐ **To set a zero offset, use the Numeric keys to type the offset value**
- ☐ **Press < ENTER> to register zero setting. The CDU displays [Integrating - Press < Enter>] and the integration count (from 0 -60)**
- ☐ **Press < ENTER> at any time during the count to set the Actual Zero, or wait until the integration time expires. This moves the cursor to DAMPING SET**

TO BYPASS ZERO INTEGRATION:

- ☐ **If the flow rate equals zero, press CLEAR (if [0.000] is not displayed on the CDU Screen)**
- ☐ **To set a zero offset, use the Numeric keys to type the offset value**
- ☐ **Press < ENTER> to register zero setting. As soon as the CDU displays [Integrating - Press < Enter>], press < ENTER> immediately. This moves the cursor to DAMPING SET**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

TO REMOVE ANY PREVIOUSLY ENTERED ZERO SET DATA (*if required*):

- ☐ **Use the UP or DOWN Arrow to scroll List 27 until [ZEROCLR] appears on the CDU Screen**
- ☐ **Press < ENTER> to remove data. ACTUAL ZERO will now equal 0.000. This moves the cursor to DAMPING SET**

TO INVOKE REVERSAMATIC:

- ☐ **Use the UP or DOWN Arrow to scroll List 27 until [REVERSAMATIC] appears on the CDU Screen**
- ☐ **Press < ENTER> . The CDU Screen shows: [-- Working --]**

The flow computer measures the positive flow rate briefly, then the CDU beeps and shows [Reverse Xdcrs / press < ENTER>]. You must now remount the Letter Index and Number Index transducers *without disconnecting transducer cables in their **reversed** positions* (i.e., mount the UP transducer and cable in the DOWN transducer/cable location - mount the DOWN transducer and cable in the UP transducer/cable location). When you remount the transducers, make sure that you couple them to the pipe properly.

- ☐ **Press < ENTER> (after re-installing the transducers). The CDU again shows: [-- Working --]**

The flow computer measures the negative flow rate briefly, then the CDU beeps and repeats the prompt: [Reverse Xdcrs / press < ENTER>]. You must now remount the transducers for normal operation (in their original orientation). When you remount the transducers, make sure that you couple them to the pipe properly. This completes the ReversaMatic procedure. The system's zero accuracy will be very close to the degree obtainable using the Actual Zero method. You should perform the Reversamatic procedure as quickly as possible to ensure that the flow rate remains consistent for the positive and negative measurements.

- ☐ **After the flow computer completes the REVERSAMATIC procedure, the cursor moves to DAMPING SET**

5.4.2.3 SmartSlew™

The operating system includes a SmartSlew™ routine to optimize the system's response to flow changes by minimizing data scatter when the liquid flows at a steady rate. The *damping factor* controls the system output response time during steady flow periods (where there are no significant rate changes). The *slew rate* controls the system output response time to an actual rate change. These controls operate independently. You are encouraged to modify the default *damping* and *slew rate* settings. Precise adjustment will achieve the best possible combination of data stability and meter response to flow changes.

NOTE: Damping and slew rate settings do not alter the update rate for data display screens (1 sec.) or the update rate for output signals (1/10 sec.).

5.4.2.3.1 Damping Set

The DAMPING SET control defines the length of time (from 0.2 up to 60 seconds) over which the flow rate will be averaged in data reports. A fast setting allows the flow computer to track and display very brief flow transients. A slow setting allows the flow computer to ignore any data scatter (produced by pulsating pumps, etc.) when there is no significant variation in the flow rate. The default setting is 5 seconds. If this suits the application, then you may bypass this menu cell by pressing the DOWN Arrow.

TO SET DAMPING:

- ☐ **Press RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric keys to type the required averaging period (in 0.1 second increments) up to 60 seconds**
- ☐ **Press < ENTER> to register Damping Value. This moves the cursor to SLEW RATE (F/S/S)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.4.2.3.2 Slew Rate (F/S/S)

The system switches from *damping* to *slewing* when the flow rate exceeds the monitored data scatter level, in the same flow direction, for between one to four successive 1/10 second data updates. The flow output will then *slew* from the former stable level toward the newly reported rate. This will occur at the maximum of the slew rate that you select. The default slew rate setting is 0 feet per second per second (F/S/S). This disables the slewing routine. Any slew rate value from 0.1 to 40 ft/sec^2 enables slewing. You may disable slewing at any time by simply entering [0] in this menu cell. Slower slew settings allow the flow computer to ignore pulsating pumps to give a steady report of the average flow rate. You should use a faster setting if you want to track very fast flow transients.

TO SET THE SLEW RATE:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D. The CDU becomes active for numeric entry**
- ☐ **Use the Numeric keys to type in a slew rate value (from 0 to 40 F/S/S in 0.1 increments)**
- ☐ **Press < ENTER> to register slew rate. This moves the cursor to DEADBAND SET**

5.4.2.4 Deadband Set

DEADBAND SET offers you the option of instructing the flow computer to ignore flow rates below a desired level. To set a Deadband threshold, you enter a flow rate using the flow rate unit you selected (see Para. 5.3.4.4). Note that the Deadband threshold is usually a very low rate.

The Deadband function supports flow total applications where the flow rate is normally very high - *but interrupted by long periods of zero flow*. The system may exhibit a small amount of zero drift during long zero flow periods. The effects of minute zero drifting can accumulate, causing the flow total to increment. You can set a Deadband to avoid increasing the flow total during these periods. Also, a Deadband will mask the small data scatter that the flow computer would normally report.

TO DEFINE A DEADBAND:

- ☐ **Press the RIGHT Arrow to move cursor to Level D**
- ☐ **Use the Numeric Keys to type the required Deadband value in selected flow rate units (see Para. 5.3.4.4)**
- ☐ **Press < ENTER> to register Deadband setting. This moves the cursor to MEMORY OR FAULT**

5.4.2.5 Memory or Fault

Certain situations (e.g. an empty pipe or excessive aeration) will interrupt data production. The system's default response is to trigger a Fault Alarm and drop all flow outputs to zero. For some applications, sporadic Fault conditions may be unavoidable and do not require an alarm response when they occur. The system includes a Memory operating mode to support such an application. Memory Mode suspends the system's Fault response by preventing the flow outputs from dropping to zero for a duration (*Memory Interval*) that you specify. The default Memory Interval is 60 seconds. You may select any duration from 3 to 604,800 seconds (one week).

During the Memory Interval, the flow computer sets the [M]emory and [F]ault alarms. However, all flow outputs will be latched at the last valid flow rate measured before the Fault occurred. If the Fault condition clears before the Memory Interval expires, the flow computer resets the [M] and [F] alarms and immediately resumes flow measurement. If the Fault condition remains after the Memory Interval expires, then all flow outputs drop to zero, the [F] alarm remains active and the [M] alarm clears. If you select FAULT ALARM or SOFT FAULT for a relay function (see Para. 5.3.12), the relay will assume an alarm state until the Fault condition clears.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

TO SELECT MEMORY:

- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 28)**
- ☐ **Use the UP or DOWN Arrow to scroll List 28 until MEMORY appears on the CDU Screen**
- ☐ **Press < ENTER> to enable MEMORY. This moves the cursor to MEMORY INTERVAL**
- ☐ **Press the RIGHT Arrow to activate data entry**
- ☐ **User the Numeric Keys to type the required MEMORY INTERVAL**
- ☐ **Press < ENTER> to invoke MEMORY mode. This moves the cursor to FLOW CALIBRATION**

5.4.3 FLOW CALIBRATION

System 990's intrinsic calibration is excellent. This has been confirmed by many laboratory and field trials under various application conditions. Occasionally, unusual installation conditions or regulatory requirements require that the meter be calibrated to an external accepted standard.

Calibration of the non-intrinsic factor,"Kc", can be performed in several ways. For example, use of the prevailing "Weigh Tank" method, or by comparison to a respected standard. Since Kc is a slope factor, it is recommended that the Kc calibration value be equivalent to the average correction desired over the entire flow range of interest. The value entered must be the percent of increase (+) or decrease (-), determined necessary to produce the best average correlation between System 990 and the reference standard. You should be aware that the majority of conventional flowmeters cannot match either the range or the linearity of System 990. You should be aware also that the Kc Calibration does not eliminate the factory set intrinsic calibration. You may switch between intrinsic or external flow calibration at any time via the Calibration Type menu.

5.4.3.1 Calibration Type

The CALIBRATION TYPE option list selects either intrinsic or external flow calibration. The CDU displays the current calibration mode in this menu cell. Either Calibration mode can be activated at any time. The default selection is intrinsic calibration. If this suits the application, then you may bypass this menu cell by pressing the DOWN Arrow.

TO CHANGE THE CURRENT CALIBRATION MODE:

- ☐ **Press the RIGHT Arrow to move the cursor from FLOW CALIBRATION to CALIBRATION TYPE**
- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 29)**
- ☐ **Use the UP or DOWN Arrow to scroll List 29 until the required Calibration type appears on the CDU screen**
- ☐ **Press < ENTER> to register selection. This moves the cursor to CALIBRATE Kc**

5.4.3.2 Calibrate Kc

To apply the Kc Calibration method, you must calculate the required change in the system's response slope. To accomplish this, you will have to review comparative data taken simultaneously with a reference of established accuracy. It is essential that such data be obtained by comparing a reference meter's Flow Totalizer with System 990's Flow Totalizer. It is also important that the totalization measurement occurs over a sufficient period of time to average out differences in flow fluctuation between the locations of the two meters.

TO PERFORM THE CALIBRATION:

- ☐ **Press the DOWN Arrow to move the cursor from CALIBRATION TYPE to CALIBRATE Kc**
- ☐ **Press the RIGHT Arrow to move cursor to Level D**
- ☐ **Use the Numeric keys to type the desired calibration change. For example: -0.29% produces a negative 0.29% change in system calibration at all flow rates**

NOTE: The input is restricted to a range of -50% to + 50%. Entry of a value outside this range will result in the Kc being set to the corresponding limit.

- ☐ **Press < ENTER> to register the value. This moves the cursor to DIAGNOSTICS (Level B)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.4.4 DIAGNOSTICS

The Diagnostics Menu provides a selection of data displays and test/control functions for equipment and application analysis. To describe the Diagnostics Menu conveniently, this manual refers to two separate list "modes", a Data mode and a Test/Control mode. The CDU does not distinguish between these "modes" when you scroll through the Diagnostics Menu. Data mode items include current operating conditions and flow related parameters. Test/Control mode consists of test functions and recovery routines.

☐ **Press the RIGHT Arrow to move the cursor to Diagnostics List 30 (Level C)**

5.4.4.1 Data Mode

Data Mode Diagnostic items show current flow measurement data, current operating conditions and how the Initial Makeup routine configured the system for operation. These are *view only* items, except for the Vs data. When you select the Vs item, you can use the CDU [+] key to increase, or [-] key to decrease, the displayed value. The pipe diameter and transmission frequency determines the amount of increase or decrease per key press. This allows you to 'fine-tune' the measured sonic velocity.

NOTE: The Vs adjustment is intended for our technicians or experienced users only. Please consult our Technical Service Dept. before using this control.

Data Mode - Diagnostic Items:

Flow Rate	Current (updated) flow rate in selected data units
Flow Total	Current (updated) flow total in selected data units
Alarm Status	Current (active) alarms in letter code format
Vs	Current (updated) liquid Vs (m/s) (adjustable)
Valc	Receive signal strength (using proprietary scaling)
Vaer	Current (updated) number for amount of liquid aeration/nonhomogeneity
AUX 1	Data from 1st auxiliary analog input
AUX 2	Data from 2nd auxiliary analog input
AUX 3	Data from 3rd auxiliary analog input
AUX 4	Data from 4th auxiliary analog input
fx	Transmit frequency code (for Tech. Service reference)
N	Transmit drive count (for Tech. Service reference)
n	Receive count (for Tech. Service reference)
x	Receive offset count (for Tech. Service reference)
Vfmax	Flow velocity (in current rate units) of one whole cycle offset between upstream and downstream receive signals (Re-registration increment)
Vs max (m/s)	Maximum correctly calibrated Vs for current transducer spacing
Vs min (m/s)	Minimum correctly calibrated Vs for current transducer spacing
TN	Current (updated) transducer-to-transducer transit time *(μsecs)*
TL	Current (updated) liquid path transit time *(μsecs)*
Ltn	Transducer spacing in inches or millimeters (appears on list after flow computer issues spacing indices)
Specific Gravity	Current liquid specific gravity
Contour	An indication of the consistency of receive signals. The contour value will be close to 1.00 (either above or below)
Reynolds #	Current (updated) Reynolds Number. Used by the system for flow profile compensation
Delta-T (uSECS)	Current difference between the upstream & downstream transit-times
Checksum	Software integrity check code
Code	Controlotron Program Control Code
Version	Flow computer's operating system version

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.4.4.2 Test/Control Mode

The Test/Control Mode offers functions to optimize system operation, analyze application conditions and recover system operation. The AN CAL function provides a selectable reference output signal for calibrating ancillary equipment.

Test/Control Items: Upper Flow Limit, Lower Flow Limit and Empty Set accept numeric data. When you select these items you can move the cursor to Level D by pressing the RIGHT Arrow, where the CDU becomes active for numeric entry.

We recommend that you edit the Upper and Lower Flow Limits to match your application. This will optimize calculations if the flow computer has to perform a signal re-registration. The Upper Flow Limit is the most **positive** flow rate expected for the application. It should not exceed 90% of Vfmax (see Path Diagnostics List). The Lower Flow Limit is the most **negative** flow rate expected for the application. It should equal at least 5%, but no more than 90% of Vfmax. The Lower Flow Limit entry must be a negative number. After you type the number, press the [+ /-] key to change its sign (do not confuse this key with the subtract operator key [-]).

NOTE: The CDU will not accept invalid Upper or Lower Flow Limits. An audible beep indicates rejection.

The Empty Set number represents the signal strength level that corresponds with an empty pipe. Empty Set uses proprietary scaling. There is no direct correlation between the displayed number and any amplitude unit (e.g. volts, peak-to-peak). Therefore, setting Empty from this list is really intended for our service technicians. We recommend that you consult Technical Service before deciding to edit the Empty Set number. When you select Empty Set, the CDU cursor can be moved to Level D by pressing the RIGHT Arrow, where the CDU becomes active for numeric entry. Be aware that If you set the number too low, the flow computer may not detect a true empty pipe. If you set it too high, the flow computer may incorrectly trigger the empty pipe alarm. This will suspend flow measurement even though the liquid is flowing.

The Test/Control Functions:

TUk . . . . . Invokes signal transmission in one direction only

FIXED Valc . . . . . A way of fixing the gain of the signal amplifier to permit pipe signal noise tests

Upper Flow Limit . . . The most positive expected flow rate for the application (adjustable)

Lower Flow Limit . . . The most negative expected flow rate for the application (adjustable)

Re-register . . . . . Invokes a procedure to correct a signal mis-registration after an In-Process Makeup (you will probably never need this control)

INPROCESS MAKEUP . . . . . Invokes an In-Process Makeup. Don't use if application conditions are marginal.

AN CAL (Flow) . . . . . Forces the flow computer to output a specified flow rate for setting an analog scale, alarm level or calibrating an external display, etc.

Empty Set . . . . . Specifies signal strength consistent with an empty pipe. A receive signal below this level trips the empty pipe alarm

NOTE: Certain Test/Control functions will not be accessible under FAULT conditions. Please See Section 7 for additional descriptions.

TO LEAVE THE DIAGNOSTICS LIST:

- ☐ **Press the LEFT Arrow twice to move the cursor to INSTALLATION (Level A)**
- ☐ **Press the DOWN Arrow to move the cursor to OPERATION SETUP (Level A)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.5 OPERATION SETUP

OPERATION SETUP parameters apply only to the flow computer. Options selected from this menu are not attached to a particular set of Site Data. They are permanent until you change them or use the "F4" key (see Para. 7.1) to reset the operating system. The OPERATION MODE Menu defines system behavior upon power-up and enables or disables a Security function and a Makeup Alarm Latch. The Display Select Menu offers various screen formats for the LCD Graphics Screen. The DATALOGGER menu provides commands to display the available Datalogger memory, clear obsolete Datalogger reports, and offers options for Datalogger memory management. The RS-232 Setup menu sets transmit/receive parameters for the serial I/O port. The serial port transmits print-outs in a selected data format, or functions as an on-line communicator for the Datalogger. System 990N can be integrated into a network via its RS-232 interface. You can select a network identification number for host computer polling. The Clock Set menu allows you to program the system real-time Clock/Calendar. This enables Stripchart and Datalogger time-stamping.

☐ **Press the RIGHT Arrow to move the cursor from OPERATION SETUP (Level A) to OPERATION MODE (Level B)**

5.5.1 OPERATION MODE

The OPERATION MODE menu provides a SECURITY function to protect the system from unauthorized modification of any activity normally accessed through the 995T CDU. Also, you can enable or disable a MAKEUP ALARM LATCH.

5.5.1.1 Security

If you activate Security, anyone that doesn't know the security code will not be able to access any menu cell where data can be changed, or invoke any activity that could interrupt or affect system operation. When active, Security limits Installation Menu access to the *viewing of parameters only.* This means that you may review installed Site Data, but will not be able to make any changes.

Once you activate Security, it can only be deactivated by accessing the Level D ON/OFF commands. To access Level D, you must enter the correct Security code. It is essential that you never forget or misplace the Security code. Without the security code, the Security function can only be deactivated by returning the meter to Controlotron. In such a case, there is a possibility that any existing Site Data would be lost.

TO BYPASS THE SECURITY MENU CELL:

☐ **Press the DOWN Arrow to move the cursor to MAKEUP LATCH**

TO INSTALL SECURITY:

☐ **Press the RIGHT Arrow to move cursor to SECURITY (Level C). The CDU displays the current Security status (e.g. [Security > OFF])**

☐ **Press the RIGHT Arrow to move cursor to Level D. The CDU displays [Enter Code ?]. The cursor will be in the first character position**

NOTE: If you intend to use numbers or a decimal point in the code, you can type these characters directly from the CDU keypad.

☐ **Use the Numeric keys and/or the UP or DOWN Arrows to select the first character of security code**

☐ **Press the RIGHT Arrow to move the cursor to the second character position. Repeat the selection process for the second character, then all required characters (8 max.)**

☐ **Press < ENTER> to register code. The CDU displays [Confirm Code (?)]**

☐ **Re-type code (as above). Press < ENTER> . The cursor moves to Level C, where the CDU displays [Security Enable > OFF]**

☐ **Press the RIGHT Arrow to access Level D (Menu List 31)**

☐ **Use the UP or DOWN Arrow to scroll List 31 until the CDU displays [Security Enable :ON]**

☐ **Press < ENTER> to activate Security. This moves the cursor to MAKEUP LATCH (Level C)**

NOTE: Make sure that you record the Security Code for future reference.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.5.1.2 Makeup Alarm Latch

System operation may be interrupted by a fault condition. This might be caused by an empty pipe or a transient loss of power, etc.. After recovery from the fault, the flow computer sets a Makeup Alarm flag and invokes an In-Process Makeup to restore operating parameters.

The flow computer clears the Makeup Alarm flag after it completes the In-Process Makeup. Therefore, if you were not monitoring the unit, you would not know that an In-process Makeup occurred. However, you have the option of latching the Makeup Alarm to alert you that the system invoked an In-Process Makeup. The latch holds the Makeup Alarm active until you reset it manually.

On extremely rare occasions, the system may require signal re-registration (see Para. 7.5.1) after an In-Process Makeup. An active (latched) Makeup Alarm provides immediate access to the Re-registration routine. Pressing the MENU key causes the CDU to display the [Re-register] statement on its top line. The second line displays a flashing: [CLR ALARM]. Pressing the Up Arrow or Down Arrow scrolls the screen to the options [INCREASE FLOW] or [DECREASE FLOW]. Pressing < ENTER> executes the displayed option. Section 7.5.1 contains instructions for the proper usage of [INCREASE FLOW] and [DECREASE FLOW]. Note that if you invoke [CLR ALARM] the CDU display will not change. You should then press the MENU key. This will select the Installation Menu, advancing the cursor to [Site Setup]. You can then exit the Installation Menu by pressing the MENU key again.

If you activate the Datalogger and select Status Alarms as a Datalogger item, generating Datalogger report will clear the Makeup Alarm Latch. This ensures that the Alarm will not appear on succeeding Datalogger reports. A Makeup Alarm appearing on a subsequent Datalogger report indicates that an In-Process Makeup must have occurred since the previous Datalogger report.

TO ENABLE (OR DISABLE) THE MAKEUP ALARM LATCH:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 31)**
- ☐ **Use the UP or DOWN Arrow to scroll List 31 until the required selection (ON or OFF) appears on the CDU Screen**
- ☐ **Press < ENTER> to turn Makeup Latch ON or OFF. This moves the cursor to DISPLAY SELECT** *(Level 3 Systems)* **or DATA MEMORY** *(Level 1 or 2 Systems)*

5.5.1.3 LCD Digital Display Option

The operating program for systems equipped with the LCD Digital Display option (see Figure 5-2) detects the screen and configures the display windows automatically. The flow rate and flow total display windows do not show units. Therefore, we provide permanent 'rate units' transfer stickers with these systems. You can find out the rate scaling by accessing the Display Scaling menu cells located in the Flow Rate Units Menu (see Para. 5.3.4.4) and the Flow Total Menu (see Para. 5.3.5.5).

The LCD Digital Screen includes the following displays:

1) A four-digit flow rate display (in two ranges) with a flow direction indicator
2) A six-digit Totalizer Display, three selectable ranges, with the choice of positive, negative, or net total modes
3) Eight Status/Alarm Symbols for the following conditions:
   - **SPACE:** . . . . Transducer spacing alert (see Para. 5.4.1)
   - **EMPTY:** . . . . Empty pipe alarm
   - **FAULT:**. . . . . Three continuous seconds without new data update
   - **MEMRY**:. . . . Displaying last memorized flow reading for a specified interval (during Fault condition)
   - **INTFC:** . . . . . Liquid Interface Detected
   - **MAKEUP:**. . . In-Process Makeup invoked, Re-registration routine enabled
   - **HI/LO:** . . . . . Flow above high flow rate alarm setpoint or below low flow rate alarm setpoint
   - **AER**:. . . . . Amount of aeration/cavitation or liquid nonhomogeneity exceeds alarm setpoint
4) Fifty-two segment Analog Barchart, with 3-1/2 Digit percentage display. You select a data category in the Stripchart Setup menu. Flashing bars represent the alarm setpoints.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

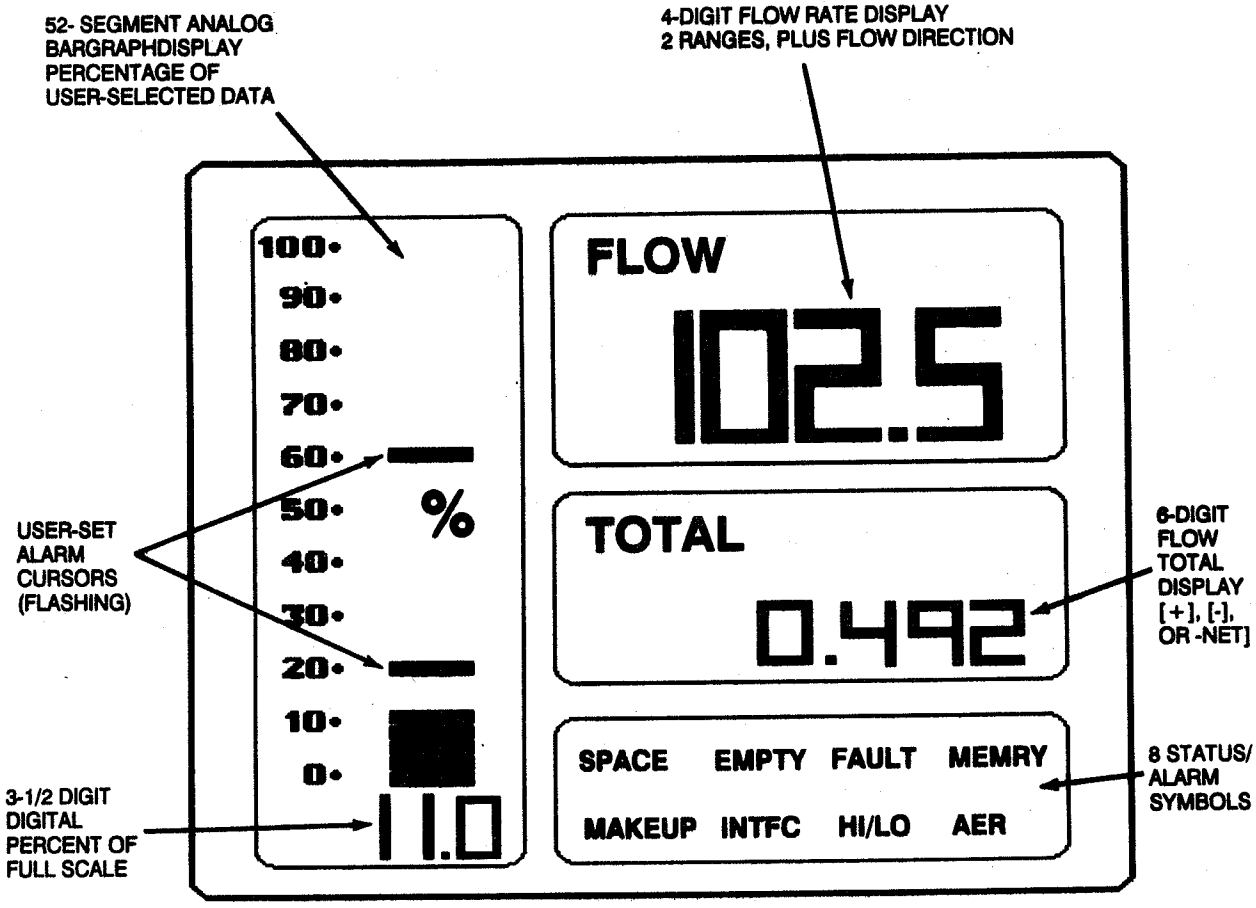


Figure 5-2: Optional LCD Digital Display Screen

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.5.2 DISPLAY SELECT *(Level 3 Only)*

The DISPLAY SELECT Menu provides display formats for the optional LCD Graphics Screen. You should examine each one to find which screens suit your application. Figures 5-3a through 5-3f show different graphic display formats. Figure 5-3g is a typical Stripchart print-out obtained from our Model 996P Portable Printer. Below are brief descriptions and the figure numbers of the screen formats available with this model:

Figure 5-3a: Single-Channel Digital Display: shows average/instantaneous flow rate & scaling, flow total & scaling, real-time stripchart & bargraph, site name, pipe O.D., alarm indicators

Figure 5-3b: Dual-Channel Digital Display: shows channel 1 & 2 average/instantaneous flow rate & scaling, channel 1 & 2 flow total & scaling, channel 1 & 2 real-time bargraph, channel site names, channel 1 & 2 alarm indicators

Figure 5-3c: Four-Channel Digital Display: shows average/instantaneous flow rate & scaling (channels 1 - 4), flow total & scaling (channels 1 - 4), real-time bargraph (channels 1 - 4), site names (channels 1 - 4), alarm indicators (channels 1 - 4)

Figure 5-3d: Datalogger Display: shows selected data items inc. report date & time (separated by a comma), alarm indicators

Figure 5-3e: Single-Channel Stripchart: plots selected data with bargraph (real-time data only), includes time scale, scaling units, alarm indicators

Figure 5-3f: Dual-Channel Stripchart: plots selected data with bargraph (real-time data only) for channels 1 & 2, includes time scale, scaling units, alarm indicators and channel site names

LCD Graphics Screens include the following Status/Alarm Indicators (the striped four-channel, Datalogger and CDU screens use single-letter codes).

- SPACE, [S]. . Transducer spacing alert (see Para. 5.4.1)
- EMPTY, [E] . Empty pipe alarm
- HI/LO, [R]. . . Flow above high flow rate, or below low flow rate alarm setpoint
- FAULT, [F] . . Three continuous seconds without new data update
- AER, [A] . . . . Amount of aeration/cavitation or liquid nonhomogeneity exceeds selected level
- MEMRY, [M]. Displaying last memorized flow reading for a selected interval (during Fault condition)
- MAKUP, [K] . In-Process Makeup invoked, Re-registration routine enabled

Single and multi-channel screens show identical data. However, with multi-channel operation, over-writing of the "units" legends may be unavoidable with some flow, bargraph, and totalizer options. However, you can obtain immediate clarification of any over-written "units" by invoking single-channel operation temporarily.

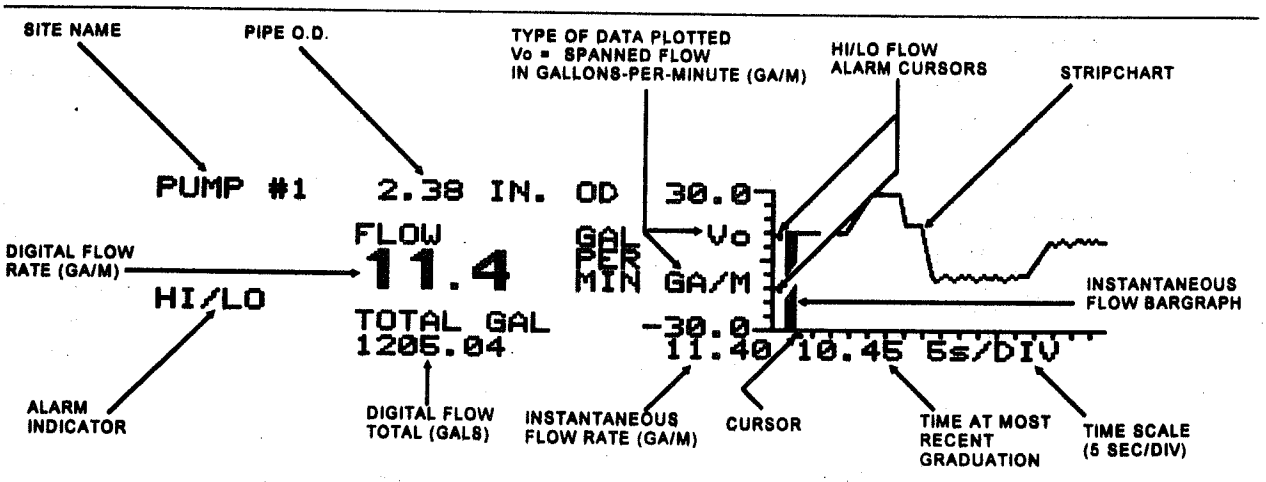


Figure 5-3a: Single Channel Digital Display

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

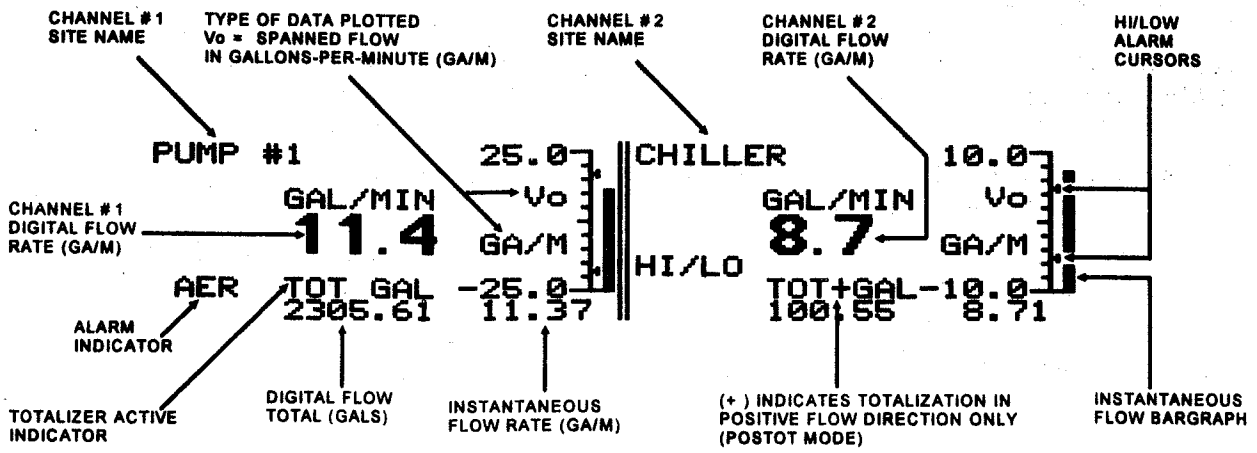


Figure 5-3b: Dual Channel Digital Display

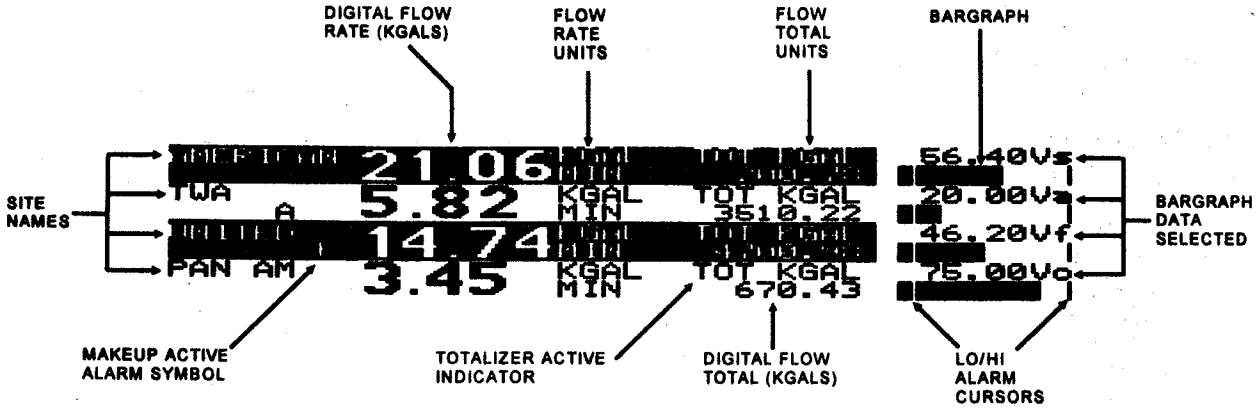


Figure 5-3c: Four Channel Digital Display

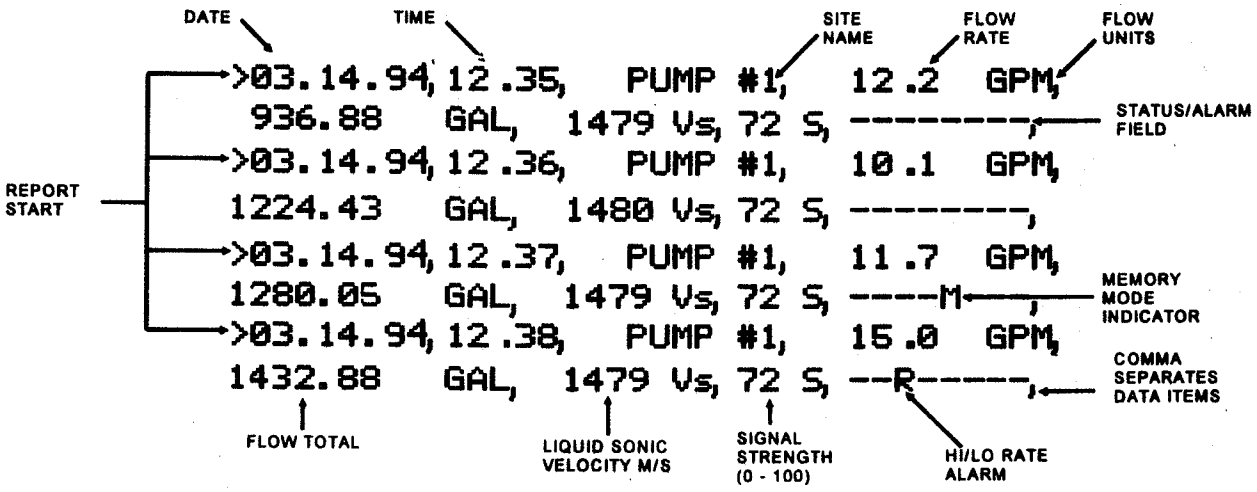


Figure 5-3d: Datalogger Display Screen

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

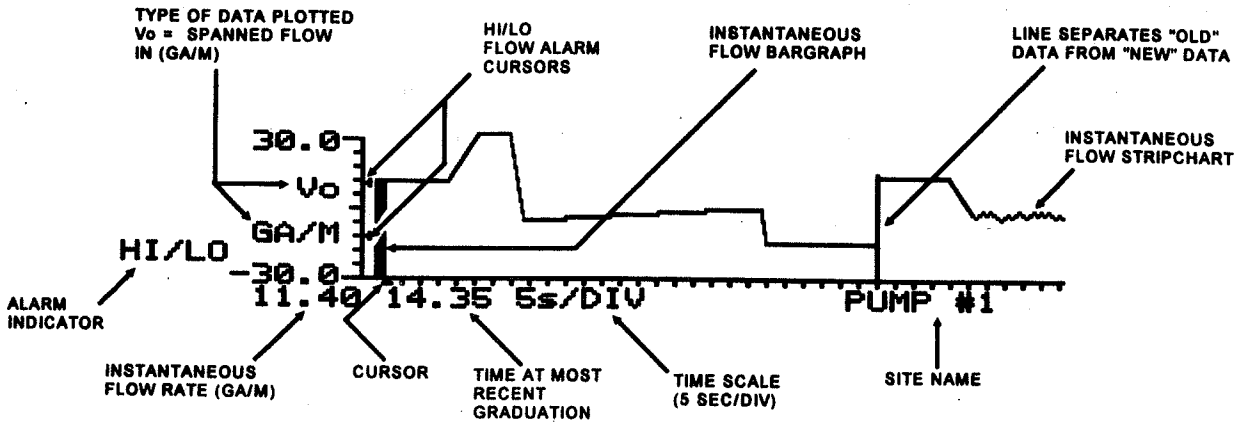


Figure 5-3e: Single Channel Stripchart Screen

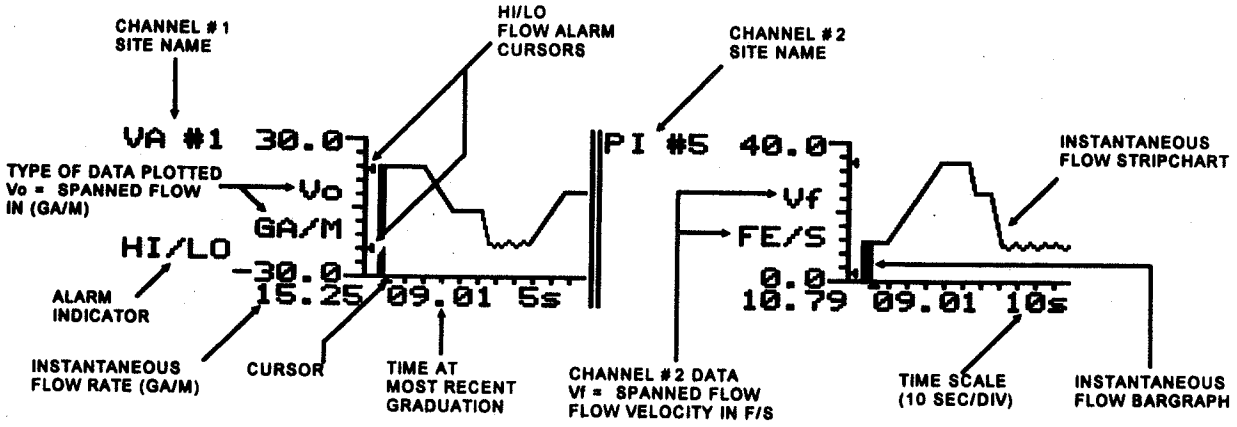


Figure 5-3f: Dual Channel Stripchart Screen

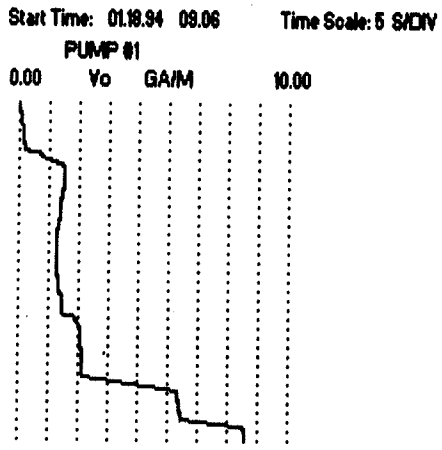


Figure 5-3g: Typical Stripchart Printout (996P Printer)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

TO SELECT A DISPLAY MODE:

- ☐ **Press the DOWN Arrow to move cursor from OPERATION MODE to DISPLAY SELECT**
- ☐ **Press the RIGHT Arrow to move cursor to Level C (Menu List 32)**
- ☐ **Use the UP or DOWN Arrow to scroll List 32 until the required display appears on the CDU Screen**
- ☐ **Press < ENTER> to register selection. This moves the cursor to DATA MEMORY (Level B)**

5.5.2.1 Viewing the Datalogger Display *(Levels 2 & 3 Systems only)*
If you select [Datalogger] from List 32, the LCD Graphics Screen will show formatted Datalogger reports (see Figure 5-3d). The amount of data items you select governs how many reports will fit on the screen at one time. The CDU provides special command keys to simplify scrolling through Datalogger reports. The following CDU keys control the Datalogger display:

- ☐ The LEFT Arrow terminates the Datalogger output and returns the Graphics screen to the active data display.
- ☐ The UP and DOWN Arrows move through the data one line at a time in opposite directions.
- ☐ The [+] and [-] keys scroll data ten lines at a time in opposite directions.
- ☐ The [x] and [÷] keys permit instantaneous movement to the beginning or end of the Datalogger file. These are the best keys for selecting the most recent data.

NOTE: The DOWN, [-], and [÷] keys move the data forward in time.

5.5.3 DATA MEMORY *(Levels 2 & 3 Only)*
The DATA MEMORY menu provides the PRINT MEMORY command that allows you to select memorized data categories to transmit to an external device (usually a printer). DATA MEMORY OPEN reports how much Datalogger storage space is available. DATA MEMORY CLR erases obsolete Datalogger data. CIRCULAR MEMORY mode over-writes automatically the oldest Datalogger data when the Datalogger memory becomes full.

- ☐ **Pressing the DOWN Arrow moves the cursor from OPERATION MODE to DATA MEMORY (Level 2 Systems)**
- ☐ **Pressing the DOWN Arrow moves the cursor from DISPLAY SELECT to DATA MEMORY (Level 3 Systems)**

5.5.3.1 Print Memory
The PRINT MEMORY menu selects and transmits the Datalogger file to a serial device connected to the RS-232 port. You can identify the Datalogger data by its Site of origination (Site ID) and the Date when you collected the information. You can transmit also Stripchart, Site Setup and Installation data. The flow computer uses standard ASCII formatting when transmitting data.

The ideal receiving device is Controlotron's model 996P portable serial printer. However, it is relatively easy to interface the flow computer with most serial printers or personal computers. You must use the proper cabling between the flow computer and the external device. Also, you must configure the RS-232 Setup (see Para. 5.5.4) correctly. You should turn off the Datalogger function when transmitting an extensive print-out. This will avoid contaminating the print-out with new Datalogger data.

NOTE: The flow computer suspends flow measurement while it transmits serial data.

TO PRINT DATALOGGER, SITE SETUP OR INSTALLATION DATA:

- ☐ **Check the flow computer-to-printer connections and the RS-232 SETUP (see Para. 5.5.4)**
- ☐ **Press the RIGHT Arrow to move the cursor from DATA MEMORY to PRINT MEMORY**
- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 33)**
- ☐ **Use the UP or DOWN Arrow to scroll List 33 until data for print-out appears on the CDU screen**
- ☐ **Press < ENTER> to start print-out**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.5.3.1.1 Printing the Stripchart

A Stripchart print-out contains current, real-time information only. Therefore, when you select [Stripchart] from List 33, the CDU prompts you to select a time interval for the print-out. For this purpose, the cursor returns to the Stripchart Time Interval option list (List 15). Note that selecting a time interval for the Stripchart print-out does not change the Stripchart Time Interval you selected during Site Setup programming.

TO PRINT REAL TIME STRIPCHART DATA:

- ☐ **Check the flow computer-to-printer connections and the RS-232 SETUP (see Para. 5.5.4)**
- ☐ **Press the RIGHT Arrow to move the cursor from DATA MEMORY to PRINT MEMORY**
- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 33)**
- ☐ **Use the UP or DOWN Arrow to scroll List 33 until [Stripchart] appears on the CDU Screen**
- ☐ **Press < ENTER> to select Stripchart. This moves the cursor to Time Interval (Level C)**
- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 15)**
- ☐ **Use the UP or DOWN Arrow to scroll List 15 to the required interval for your Stripchart print-out**
- ☐ **Press < ENTER> to start Stripchart print-out**
- ☐ **Press LEFT Arrow to terminate Stripchart print-out**
- ☐ **Press the DOWN Arrow to move the cursor to DATA MEMORY OPEN**

5.5.3.2 Data Memory Open

DATA MEMORY OPEN is a 'view-only' menu cell. When selected, the second line of the CDU Screen displays the available AFAC memory (in BYTES). This is important if you intend to use the factory Datalogger Mode setting. The factory setting instructs the flow computer to assign a certain amount of AFAC memory for data logging and to stop collecting data when this memory is full. You can estimate how much Datalogger memory you have, and how long the flow computer will continue to log data, by performing the following steps:

1) Access the Datalogger Mode menu cell (Menu List 16). Create a Datalogger report by selecting [Memory].
2) Access the Datalogger Interval menu cell (Menu List 19). Select [Demand] (this prevents the flow computer from "auto" logging).
3) Access the Data Memory Clear menu cell (Para. 5.5.3.3). Clear the AFAC memory.
4) Access the Data Memory Open menu cell (Para. 5.5.3.2). Record the number of bytes available.
5) Generate Datalogger report by pressing the CDU < DATA LOG> key.
6) Return to Data Memory Open. Record the number of bytes available.
7) Subtract the number of bytes in step 6 from the number of bytes in step 4.
8) Divide the number obtained in step 4 by the number obtained in step 7.
9) The integer part of the result in step 8 is the number of reports your memory will hold.
10) Multiply the Datalogger interval you plan to use by the number obtained in step 9. The number obtained is how long the Datalogger will collect data before it becomes filled.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.5.3.3 Data Memory Clear

If you intend to use the Datalogger in its factory-set mode, eventually you will use all the AFAC memory space designated for Datalogger storage. When this occurs, you will not be able to log more data until you free-up the Datalogger memory. The DATA MEMORY CLR command erases ALL Datalogger data stored in the 993M AFAC. You should evaluate the currently stored data, and print any valuable information before you use this command. Note that this command cannot clear memorized Site Setups. Only the FIND/DELETE command (in the SITE LOAD menu) deletes stored Site Data.

TO CLEAR MEMORIZED DATALOGGER DATA:

- ☐ **Press the DOWN Arrow to move the cursor from DATA MEMORY OPEN to DATA MEMORY CLR**
- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 2)**
- ☐ **Use the UP or DOWN Arrow to scroll List 2 to [YES]**
- ☐ **Press < ENTER> to clear the memory. This moves the cursor to CIRCULAR MEMORY**

5.5.3.4 Circular Memory

Paragraph 5.5.3.2 pointed out that the factory sets the Datalogger to collect data until the memory designated for Datalogger storage becomes filled. When this occurs, the flow computer suspends data logging and requires you to clear the memory (see Para. 5.5.3.3) to restore Datalogger operation.

However, If you select the CIRCULAR MEMORY mode, new Datalogger reports will overwrite automatically the oldest ones whenever the Datalogger memory becomes full. Opting for CIRCULAR MEMORY guarantees that you will always collect the most recent data. However, you should take into account that you will lose older Datalogger reports.

TO INVOKE CIRCULAR MEMORY:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D (Menu List 2)**
- ☐ **Use the UP or DOWN Arrow to scroll List 2 to [YES] (Circular Memory enabled)**
- ☐ **Press < ENTER> to register selection. This moves the cursor to RS-232 SETUP (Level B)**

5.5.4 RS-232 SETUP *(Levels 2 & 3 Only)*

The RS-232 SETUP menu assigns operating parameters for the flow computer's serial I/O port. You can specify the baud (data transfer) rate, select a parity setting and instruct the flow computer to include line feed characters with the transmitted data. Only activate the RS-232 output (see Para. 5.3.10.1) if you intend to transmit serial data. This will avoid burdening the system with unnecessary data transferrals while it is performing flow computations. The RS-232 SETUP menu includes also a NETWORK I.D. entry to identify the system in a Network environment.

5.5.4.1 Baud Rate

The BAUD RATE menu cell sets the RS-232 port's asynchronous serial transmission data transfer rate. It provides a selection of standard baud rates up to 9600 baud. The selected baud rate must match the baud rate setting of the receiving external device. The factory-set Baud Rate is 9600. If this suits the application, then you may bypass this menu cell by pressing the DOWN Arrow.

TO CHANGE THE BAUD RATE:

- ☐ **Press the RIGHT Arrow to move the cursor from RS-232 SETUP (Level B) to BAUD RATE (Level C)**
- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 34)**
- ☐ **Use the UP or DOWN Arrow to scroll List 34 until the required baud rate appears on the CDU Screen**
- ☐ **Press < ENTER> to register selection. This moves the cursor to PARITY**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.5.4.2 Parity

Parity is a simple method to check the accuracy of an asynchronous serial data transfer. The parity setting tells the flow computer how to format data *words* it sends to an external device. Parity is usually an additional bit added to each data *word*. For example, if you select [EVEN] parity, the total sum of all the bits in a single data *word* (including the parity bit) will always be an even number. The PARITY option list includes all the standard parity settings for asynchronous serial transmission. The selected parity must match the parity setting of the receiving external device. Some devices ignore parity entirely; therefore the option list includes [NONE] (which is factory-setting). If this suits the application, then you may bypass this menu cell by pressing the DOWN Arrow.

NOTE: The Controlotron 996P Portable Printer's Parity setting is [SPACE].

TO EDIT THE PARITY SETTING:

- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 35)**
- ☐ **Use the UP or DOWN Arrow to scroll List 35 until the required parity appears on the CDU Screen**
- ☐ **Press < ENTER> to register selection. This moves the cursor to LINE FEED**

5.5.4.3 Line Feed

Some serial devices (printers, terminals, etc.) insert a *line feed* automatically after they receive a *carriage return* character. When communicating with these device types, you should set the Line Feed to [OFF]. This instructs the flow computer to send a *carriage return* character without adding a *line feed* character to avoid creating an additional blank line after each *carriage return*. Setting the Line Feed to [ON] tells the flow computer to insert a *line feed* character after each *carriage return* that it transmits. This may be necessary to avoid the constant "wrapping" of transmitted data onto a single line. The factory setting is [NO] (line feed disabled). If this suits the application, then you may bypass this menu cell by pressing the DOWN Arrow.

TO ENABLE (OR DISABLE) LINE FEED:

- ☐ **Press the RIGHT Arrow to move cursor to Level D (Menu List 2)**
- ☐ **Use the UP or DOWN Arrow to scroll List 2 to [YES] Line feed enabled, or [NO] Line feed disabled**
- ☐ **Press < ENTER> to register selection. This moves the cursor to NETWORK I.D. (Level C)**

5.5.4.4 Network I.D..

The Network I.D. menu cell stores an identification number to facilitate host computer polling when you use this system in a network environment. The Network I.D. number can be any value other than 0 (zero). The default setting, zero, disables the network function. Note that entering a Network I.D. number suspends all routine Datalogger activity - *regardless of any selected options*. If you are using the flowmeter for a 'stand-alone' application, then you must keep the zero NETWORK I.D. number. You may bypass this menu cell by pressing the LEFT Arrow to move the cursor to RS-232 Setup (Level B), then pressing the DOWN Arrow to move the cursor to CLOCK SET (Level B).

TO ASSIGN A NETWORK I.D.:

- ☐ **Press the RIGHT Arrow to move the cursor to Level D**
- ☐ **Use the Numeric keys to type a Network I.D. number**
- ☐ **Press < ENTER> to register Network I.D. number. This moves the cursor to CLOCK SET (Level B)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

5.5.5 CLOCK SET

The CLOCK SET menu sets the time and date. The flow computer uses the internal clock/calendar to record the *real-time* when certain data and diagnostic events occur. Also, the clock/calendar provides the Datalogger and Stripchart *date* and *time* stamps.

5.5.5.1 Date

The DATE command sets the month, day and year for the flow computer's internal clock/calendar. Enter the date using the [MM.DD.YY] format. Replace MM with 2 digits to indicate the *month*. Replace DD with 2 digits to indicate the *day*. Replace YY with 2 digits to indicate the *year*. Type the period (.) separator between each set of digits. For example, you would enter December 7th, 1995 by typing: **12.07.95**. You can use the RIGHT Arrow to move the cursor back to a number if you need to re-type it.

TO SET THE DATE:

NOTE: You can press the CLEAR key to remove the current setting.

- ☐ **Press the RIGHT Arrow to move the cursor from CLOCK SET to DATE**
- ☐ **Press the RIGHT Arrow to move cursor to Level D**
- ☐ **Use the Numeric keys to type the date (MM.DD.YY)**
- ☐ **Press < ENTER> to register date. This moves the cursor to TIME**

5.5.5.2 Time

The TIME command sets the hours and minutes for the flow computer's internal clock/calendar. Enter the time using the [HH.MM] format. Replace HH with 2 digits to indicate the *hour* (use 24-hr. clock format). Replace MM with 2 digits to indicate the *minutes*. You also have to type the period (.) separator between each set of digits. For example, you would enter ten minutes after two o'clock in the afternoon by typing: **14.10**. You can use the RIGHT Arrow to move the cursor back to a number if you need to re-type it.

TO SET THE CLOCK:

NOTE: You can press the CLEAR key to remove the current setting.

- ☐ **Press the RIGHT Arrow to move cursor to Level D. The CDU becomes active for numeric entry**
- ☐ **Use the Numeric keys to type the time using HH.MM format**
- ☐ **Press < ENTER> to register time. This moves the cursor to SITE SETUP (Level A)**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SECTION 6 MENU LISTS

NOTE: This section contains the Menu Lists referenced in Section 5. All lists contain single choice items except where noted. The first item on each list is the system default or factory setting.

6.1 OPENING SCREEN

Systems with the LCD Graphics Display Option only: If this system is fully installed, when you turn the power on, the Opening Screen (see below) appears for five seconds, then the Graphics Display switches to the Data Display format that you selected in the OPERATION SETUP Menu. Operation will be based on the Site Data present in the system's Active Memory. If the system is not fully installed, the graphics Screen will only show the Opening Screen. You will have to activate the 995T CDU and Create a new Site according to the instructions in this manual. If this is a multi-site storage system, and you have already installed this Site, then you can invoke RECALL/USE to load the correct Site Setup data. In this case, operation will begin as soon as you enable the measurement channel.

Controlotron
Uniflow Flowmeter
OPSYS V/M # Date: MM.YY
Copyright Notice
Check Site Setup and
Channel

Systems with the LCD Digital Display option only: If this system is fully installed, when you turn the power on, operation will begin within 10 seconds. If the system is not fully installed, the display will remain blank, with the exception of alarm indicators. You will have to activate the 995T CDU and Create a new Site according to the instructions in this manual. If this is a multi-site storage system, and you have already installed this Site, then you can invoke RECALL/USE to load the correct Site Setup data. In this case, operation will begin as soon as you enable the measurement channel.

6.2 SITE SETUP MENU LISTS

List 1: Channel Select
(Multi-Channel Systems)

Selects a channel for loading a new active Site Setup

CHANNEL 1 (*all systems*)
CHANNEL 2 (*2-channel systems*)
CHANNEL 3 (*4-channel systems*)
CHANNEL 4 (*4 - channel systems*)

List 2: Channel Enable; Circular Memory; Data Memory Clr; Line Feed

YES
NO

List 3: Site Name

Systems with Multi-Site storage option only. Optional in Create/Use or Save. Use Alpha/Numeric Characters)

XXXXXXXX

List 4: Units

Inches
Millimeters

List 5: Pipe Material

Pipe Material	Vps(in./sec)
Steel	126,000
ABS	90,000
Aluminum	120,000
Black Iron	126,000
Brass	89,400
Cast Iron	110,000
CuNi(70/30)	103,500
CuNi(90/10)	98,600
Copper	89,400
Ductile Iron	110,000
FRP	135,000
Glass	129,000
Hastelloy	118,000
Inconel	119,000
Kynar (PVDF)	100,000
Monel	107,000
Nickel	118,000
Polyethylene	76,800
PVC (Plastic)	100,000
Teflon	48,200
Titanium	124,000
Other	*As Entered*

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

List 6: Liner Material

Liner	Vpl (in./sec)
None	
Cement	165,000
Coal Tar	100,000
Enamel	100,000
Glass	235,000
Plastic	90,000
HidensPolyeth*[ylene]**	63,000
Teflon	57,000
Rubber	63,000

* *Letters in italics do not appear on CDU display due to space constraints.*

List 7: Liquid Type

Liquid	Vs (m/s)	Visc. (cs)
Water 20C/68F	1482	1.00
Water 50C/122F	1543	0.55
Water 75C/167F	1554	0.39
Water 100C/212F	1543	0.29
Water 125C/257F	1511	0.25
Water 150C/302F	1466	0.21
Water 175C/347F	1401	0.18
Water 200C/392F	1333	0.15
Water 225C/437F	1249	0.14
Water 250C/482F	1156	0.12
Acetic Acid	1173	1.25
Alcohol	1221	1.5
Bromine	892	0.32
Carbon Tet	938	0.61
Chlorine	812	0.12
Diesel Fuel	1377	2.3
Gasoline	1250	0.80
Glycerine	1950	1180.0
Kerosene	1324	2.3
MEK	1210	0.32
Oil (SAE 20)	1487	90.0
Sea Water	1531	0.98
Toluene	1330	0.69
Trichloroethyl*[ene]**	1042	0.82
Other	As Entered	

* *Letters in italics do not appear on CDU display due to space constraints.*

List 8: Units (Vol/Mass)

Units	Abbrev.	Kv (In^3/Unit)
Gallons	G	231
Liters	L	61.02
Cubic Feet	CU. FT.	1728
Cubic Meters	CU.M	61024
Cubic Inches	CU. IN.	1.0
Cubic Cm	CU. CM.	0.06102
Ounces (U.S.)	OZ	1.805
Imperial Gal	IG	277.4
31.0 GAL BBL	BBL 1	7161
31.5 GAL BBL	BBL 2	7276
42.0 GAL BBL	BBL 3	9702
55 GAL Drum	DRUMS	12705
Acre-Feet	ACRE-FT	75.3 E+ 6
Pounds	LBS	
Kilograms	KGS	
Tons	TON	
Metric Tons	MTO	
Ft/Sec (Vel)	FT/SEC	N/A
M/Sec (Vel)	M/SEC	N/A

Multiplier Prefixes for List 8:

(G) Giga	10^9
(M) Mega	10^6
(K) Kilo	10^3
none	1
(m) milli	10^{-3}
(u) micro	10^{-6}
(n) nano	10^{-9}

List 9: Flow Rate Time Units

MIN	(Minutes)
HR	(Hours)
DAY	(Days)
SEC	(Seconds)

List 10: Flow Rate Display Range

Autorange
High

List 11: Totalizer Resolution/Capacity

Three choices will be offered from List 11

0000000x (*implied decimal point*)
000000x0
00000x00
0000x000
000x0000

List 12: Totalizer Display Mode

NETFLOW
POSFLOW
NEGFLOW

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

List 13: Data Selected

Barchart (Levels 1 & 2); Stripchart (Level 3)

Vo	(spanned flow)
Vf	(spanned flow velocity)
Vs	(sonic velocity)
Valc	(signal amplitude)
Vaer	(aeration/cavitation)

List 14: Stripchart Scale Units *(Level 3)*

Percent of Span
Data Rate Units

List 15: Stripchart Pixel Time Interval *(Level 3)*

1 second	*(5 seconds per graduation)*
3 seconds	*(15 seconds per graduation)*
6 seconds	*(30 seconds per graduation)*
12 seconds	*(1 minute per graduation)*
24 seconds	*(2 minutes per graduation)*
1 minute	*(5 minutes per graduation)*
3 minutes	*(15 minutes per graduation)*
6 minutes	*(30 minutes per graduation)*
12 minutes	*(1 hour per graduation)*
24 minutes	*(2 hours per graduation)*
1.2 hours	*(6 hours per graduation)*

List 16: Datalogger Mode *(Levels 2 & 3)*

Off
Memory
RS-232 Output

List 17: Datalogger Data Selected *(Levels 2 & 3)*

This is a multiple entry list

Site Id (*recommended*)
Date *(recommended)*
Time (*recommended*)
Average Flow
Flow
Total
Vs
Valc
Aeration
Alarms
Analog Inputs

List 18: Datalogger Event Selected *(Levels 2 & 3)*

This is a multiple entry list

Spacing
Empty
Flow Alarm
Fault Alarm
Aeration
Memory
Makeup
Interface

List 19: Log Interval Set *(Levels 2 & 3)*

1 Min.	(minute sync.)
5 Min.	(quarter-hour sync.)
15 Min.	(quarter-hour sync.)
30 Min.	(half-hour sync.)
1 Hr.	(sync. hour)
2 Hr.	(even hour sync.)
4 Hr.	(sync. at noon)
6 Hr.	(sync. at noon)
12 Hr.	(sync. at noon)
24 Hr.	(sync. at noon)
Demand	(Time Int. disabled, reports via trigger only)
5 Sec.	(sync. not applicable)
15 Sec.	(sync. not applicable)
30 Sec.	(sync. not applicable)

List 20: Analog Outputs

Output	Description
Vo	spanned flow rate
Vf	spanned flow velocity
Vs	liquid sonic velocity
Valc	signal amplitude
Vaer	aeration/cavitation number

List 21: Relay Setup

Off	relay disabled
Power On	system power-up
High Flow	hi flow point exceeded
Low Flow	low flow point exceeded
Flow Alarm	hi or low flow point exceeded
Fault Alarm	receive signal loss
Spacing	transducer spacing
Empty	empty pipe
Aeration	aeration setpoint exceeded
Reverse Flow	neg. flow alarm
Batch/Sample Tot	batch threshold exceeded
Interface	liquid interface detected
Pos Total	pos. total exceeded
Neg Total	neg. total exceeded
Soft Fault	memory interval expired

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

6.3 INSTALLATION DATA MENU LISTS

List 22: Xdcr Size

Xdcr Size	Pipe OD Range
0, 0S, VH0	0.25" to 2" O.D.
1	0.5" to 4" O.D.
VH4A	20" to 48" O.D.
VH4	20" to 48" O.D.
4A	20" to 48" O.D.
4	20" to 48" O.D.
VH3A	6" to 24" O.D.
VH3	6" to 24" O.D.
3A	6" to 24" O.D.
3	6" to 24" O.D.
VH2A	1.25" to 8" O.D.
VH2	1.25" to 8" O.D.
2A	1.25" to 8" O.D.
2	1.25" to 8" O.D.
VH1	0.5" to 4" O.D.
5A*	36" to 360" O.D.
5*	36" to 360" O.D.

* *Pipe groups 5 & 6 flow computers only.*

List 23: Mounting Track Type

Direct
Reflect

List 24: Mounting Track Size

Xdcr Size 5 systems only
Systems using Size 5 Xdcrs only
5
5X
5Y
5Z

List 25: Letter Spacing Index

B
A
D
C

List 26: Empty Pipe Set

Actual Mty
MTYmatic

List 27: Zero Flow Set

Actual Zero
Reversamatic
Zeroclr

List 28: Fault Mode

Fault
Memory

List 29: Calibration Select

Intrinsic
Flow Cal

List 30: Diagnostics & Test Routines

Flow Rate	Current flow rate
Flow Total	Current flow total
Alarm Status	S-E-R-A-F-M-K-I (See Para. 5.5.2)
Vs	Current liquid sonic velocity
Valc	Signal strength
Vaer	Aeration number
Aux 1	User analog input data
Aux 2	User analog input data
Aux 3	User analog input data
Aux 4	User analog input data
fx	Transmit drive code
N	Transmit drive count
n	Receive count
x	Receive displacement
Vfmax.	Re-registration Vf increment
Vs max (m/s)	Max. calibrated Vs (for Ltn)
Vs min (m/s)	Min. calibrated Vs (for Ltn)
TN	Xdcr to Xdcr transit-time
TL	Liquid path transit-time
Ltn	Xdcr spacing (in. or mm.)
Specific Gravity	Liquid specific gravity
Contour	Receive signal consistency
Reynolds #	Flow profile comp. number
Delta-T (uSECS)	Up & Down transit-time difference
CheckSum	Software integrity check
Code	Controlotron code
Version	Operating system version

List 30: Test Routines

TUk	Set Xmit in Up direction only
FIXED Valc	Set signal gain
Upper Flow Limit	Most positive flow rate
Lower Flow Limit	Most negative flow rate
Re-register**	Invokes re-register routine
SUBSCROLL LIST:	INCREASE FLOW DECREASE FLOW CLR ALARM
IN-PROCESS MAKEUP	Invokes In-Process Makeup
AN CAL	Simulates flow rates
Empty Set	Empty pipe alarm setpoint

* *Report to Technical Service for analysis.*
** *Only appears if Inprocess Makeup occurs or is invoked*
Sections 5.4.4 & 7.6 contain detailed descriptions of Diagnostic List items.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

6.4 Operation Setup Menu Lists

List 31: Site Security; Makeup Latch

OFF
ON

List 32: Display Select

(Graphics Display Models)

Four-Channel	Dual-Channel
Striped Display	Dual Digital
Ch 4 Digital	Dual Stripchart
Ch 3 Digital	Dual Chart Clr
Ch 2 Digital	Ch 2 Digital
Ch 1 Digital	Ch 2 Stripchart
Chart Clr	Ch 2 Chart Clr
Datalogger	Ch 1 Digital
	Ch 1 Stripchart
	Ch 1 Chart Clr
	Datalogger

List 34: RS-232 Baud Rate

9600
4800
2400
1200
300

List 33: Print Memory *(Levels 2 & 3)*

Datalogger: . . . . . Prints all memorized Data-logger data

Stripchart:. . . . . Prints Real Time Stripchart Data (RS-232 off)

Ch 1 Site Setup and Diagnostics: . . . Prints Channel 1 Site Setup and Diagnostic Data

Ch "n" Site Setup and Diagnostics: . . . Prints Channel "n" Site Setup and Diag. Data (multi-channel models)

List 35: RS-232 Parity

None
Odd
Space (use for 996P printer)
Even
Mark

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP