KURZ™ INSTRUMENTS, INC.

IK-EVA™ 4200
Multi-Point Isokinetic Sampling System
User's Guide

Customer Name: ______________________

P.O. Number: ______________________

Date of Order: ______________________

Complete Model Number: ______________________

Kurz™ Order Number: ______________________

Serial Number: ______________________

Document Number: 360118, Rev. A

2411 GARDEN ROAD • MONTEREY, CA 93940 • TLX 172275 • (800) 424-7356 NATIONWIDE • (408) 646-5911 • FAX (408) 646-8901

Unit Description Sheet

Complete Model Number: ______________________

Kurz Order Number: ______________________

Customer P. O. Number: ______________________

Purchasing Specification:

Flow Rate/Velocity: ______________________

Stack/Duct Size: ______________________

Wall Thickness: ______________________

Nominal Pressure: ______________________

Nominal Temperature: ______________________

Series 193 System Enclosure: ______________________

Input Power To System Enclosure:

☐ 115 VAC - 60 Hz

☐ 230 VAC - 50 Hz

ADAM Configuration:

______ Input Channels (22 maximum)

______ Meters (12 maximum)

______ Analog Outputs (8 maximum)

______ Alarms (16 maximum)

______ Channel Kickout is Enabled

______ % (or more) of Full Scale Enables High Kickout

______ % (or less) of Full Scale Enables Low Kickout

______ Printer is ON

______ RS-232 is ON

IK-BAR Size:	☐ IK-BAR 12; Length: ________
	☐ IK-BAR 24; Length: ________
IK-BAR Construction:	☐ 316 Stainless Steel
	☐ Aluminum
	☐ Hastelloy
	☐ PVC
	☐ Other: ________________
Sensor:	☐ Mini Dual-Sting MetalClad Sensor
	☐ Dual-Sting MetalClad Sensor
	☐ Other: ________________
	☐ Tefzel Sensor Cable
Current-Transmitters:	465R____
Series 195 Enclosure:	____________________
Mounting Configuration:	☐ TASE (Transmitter Attached, Single-Ended)
	☐ TADE (Transmitter Attached, Double-Ended)
	☐ TSSE (Transmitter Separate, Single-Ended)
	☐ TSDE (Transmitter Separate, Double-Ended)
Mounting Hardware:	☐ Carbon Steel FMA (Flange Mounting Adapter) for duct
	☐ DESC; Material: ________________
	☐ IK-FMA; Material: ________________
Sampling Meter:	☐ 505- ________________
	Inlet Fitting Size: ________
	Outlet Fitting Size: ________
	☐ 450- ________________

2411 Garden Road

Monterey, CA 93940

(408) 646-5911

(800) 424-7356

Document Title: *IK-EVA 4200 Multi-Point Isokinetic Sampling System User's Guide (With ADAM)*

Document Number: 360118, Rev 0

Publication Date: May 1990

Because the IK-EVA systems are modular, each system and installation is unique. Kurz attempts to provide reasonable documentation generic in nature and covering typical systems and installations. No guarantee is made that an IK-EVA system was built accoding to standard procedures. Extensive typical drawings are available for use in field installations. Customers who desire as-built drawings should contact the factory for price quotations.

Equipment sold by Kurz Instruments, Inc. is not intended for use in connection with any nuclear facility or activity unless covered by a specific quotation where the conditions of such usage will be detailed. If the equipment is used in a nuclear facility or activity without supporting quotation, Kurz disclaims all liability for any damage, injury, or contamination, and the buyer shall indemnify and hold Kurz, its officers, agents, employees, successors, assigns, and customers, whether direct or indirect, harmless from and against any and all losses, damages, or expenses of whatever form or nature (including attorney's fees and other costs of defending any action) which they, or any of them, may sustain or incur, whether as a result of breach of contract, warranty, tort (including negligence), strict liability or other theories of law, by reason of such use.

Although every effort has been made to ensure the accuracy and completeness of this document, Kurz Instruments Incorporated makes no representations or warranties of any kind concerning the contents of this document. Under no circumstances will Kurz Instruments Incorporated be liable for any loss or other damages relating to the use of this document.

The information contained in this document is subject to change without notice. Kurz Instruments reserves the right to make engineering changes and product improvements at any time and without prior notice. Consult your local Kurz representative or a factory application engineer for information regarding current specifications.

Warranty Statement

The Kurz IK-EVA 4200 Multi-Point Isokinetic Sampling System is warranted to be free from defects in material or workmanship for one year from the date of shipment from the factory. Kurz's obligation is limited to repairing, or at its option, replacing products and components that, on verification, prove to be defective. Warranty work will be performed at the factory in Monterey, California. Kurz shall not be liable for installation charges, for expenses of buyer for repairs or replacement, for damages from delay or loss of use, or other indirect or consequential damages of any kind. Kurz extends this warranty only upon proper use and/or installation of the product in the application for which it is intended and does not cover products that have been serviced or modified by any person or entity other than Kurz Instruments Incorporated and its authorized service technicians. This warranty does not cover damaged sensors, units that have been subjected to unusual physical or electrical stress, or upon which the original identifications marks have been removed or altered.

Transportation charges for material shipped to the factory for warranty repair are to be paid for by the shipper. Kurz will return items repaired or replaced under warranty prepaid. No items shall be returned for warranty repair without prior authorization from Kurz. Call Kurz Instruments service department at (408) 646-5911 to obtain a return authorization number.

This warranty contains the entire obligation of Kurz Instruments Incorporated. No other warranties, expressed, implied, or statutory are given.

Table of Contents

Figures

Tables

About This Book

This book contains five sections and five appendixes, each of which is briefly described below. The book is not designed to be read cover to cover; rather, it is designed to present information to the IK-EVA 4200 user in as accessible a manner as possible.

Organization

Section 1: Product Overview

This section introduces you to the purpose, components, and specifications of the IK-EVA 4200 system.

Section 2: Installation

Section 2 explains how to install your IK-EVA system.

Section 3: Operation

This section describes the operator controls and explains how to use the IK-EVA system.

Section 4: Programming the ADAM

This section describes ADAM's programming mode that allows the system to be customized for the application.

Section 5: Routine Maintenance and Testing

This section describes how to perform routine maintenance such as cleaning the sensors and the 730 valve. It also provides test procedures for verifying the operation of the electronics of the system.

Appendix A: Engineering Drawings

Appendix A contains drawings that are helpful during installation because they illustrate the interconnections between components of the IK-EVA system.

Appendix B: Sensor Placement Examples

The EPA and ANSI both provide standards for monitoring gas velocities in ducts and stacks. In common use are EPA methods 1 and 2 and ANSI method N13.1-1969. Each is described briefly in this appendix.

Appendix C: Kurz Equipment Storage Requirements

The Kurz specification for equipment storage requirements provides general storage criteria and specifies the minimum storage and maintenance requirements for the supplied equipment for periods up to five years at the manufacturer's facilities, the plant sites, or other storage facilities.

Appendix D: Calculations and ADAM Setup Data

Appendix E contains reference data that is important to understanding the system configuration. A copy of the calibration sheets are included in this section as are tables summarizing the ADAM programming.

About the Art in This Book

The computer-generated art in the main sections of this book is intended to illustrate particular points under discussion. It includes only as much detail as is relevant to the discussion at hand. No attempt has been made to accurately scale these drawings or to include details not under discussion in the text that precedes and follows each drawing. If you need more detailed and precise visual information, refer to the appropriate engineering drawings included in Appendix A.

Section 1: Product Overview

1.1 Introduction to Isokinetic Sampling

The purpose of isokinetic sampling is to withdraw a representative sample of particles in an air or gas stream at the same rate (velocity) at which the air or gas flows through the stack. Isokinetic sampling means that the sample flow rate is proportional to the flow rate in the duct or stack. Under such conditions, minimal interference is imparted on the air or gas, such that particles in the air or gas do not cross streamlines either to enter or to bypass the sampling nozzles.

Isokinetic sampling is required for all extractive, particulate, source-measurement methods (EPA Methods 5 and 17 for example) and in sampling airborne, radioactive materials (ANSI N13.1-1969). EPA Method five is a manual test method which uses a Pitot tube for measuring velocity and a calibrated orifice for measuring sample flow rate at each specified sample point in the duct or stack being tested. A complex series of calculations are required to set the proper sample flow rate at each sample point. Equal sample times are used at each point where each sample point represents the center of an equal area of flow within the duct or stack, thereby obtaining an accurate isokinetic sample of the entire area of the duct or stack.

Continuous isokinetic sampling systems have generally used several fixed sampling nozzles and velocity sensors mounted within the duct, each of which are located at the center of equal flow areas, thereby performing an "instantaneous" velocity traverse. Many systems use an averaging, multi-point Pitot tube to measure the average velocity and a sampling "rake" (with several nozzles) to withdraw the sample. Generally, an orifice-type flow meter is used to measure the total sample flow rate, with the flow rate held proportional to the average velocity. Pneumatic isokinetic systems as described may be manually or automatically operated.

1.2 System Overview

The Kurz Series 4200 Isokinetic Sampling System is a continuous, automatic, isokinetic stack sampling system. Operation of the 4200 is fairly simple and straightforward. The 4200 system calculates the average flow in a duct or stack and draws an isokinetic sample based on that flow rate. The sample flow is controlled by comparing the 0-5 Vdc linear output signal representing the average flow in the duct or stack with the 0-5 Vdc linear output signal representing the flow rate through the sampling nozzles.

The sample is withdrawn by a vacuum system (typically a pump), with the flow rate regulated through the 730 Series Flow Control Valve. If the sample drawn through the nozzles is not proportional to the flow in the vent stack, the 710 Isokinetic Controller sends a signal to open or close the valve, until the velocity sample flow is proportional to the stack flow velocity. An isokinetic alarm can be activated when the sample is not drawn isokinetically.

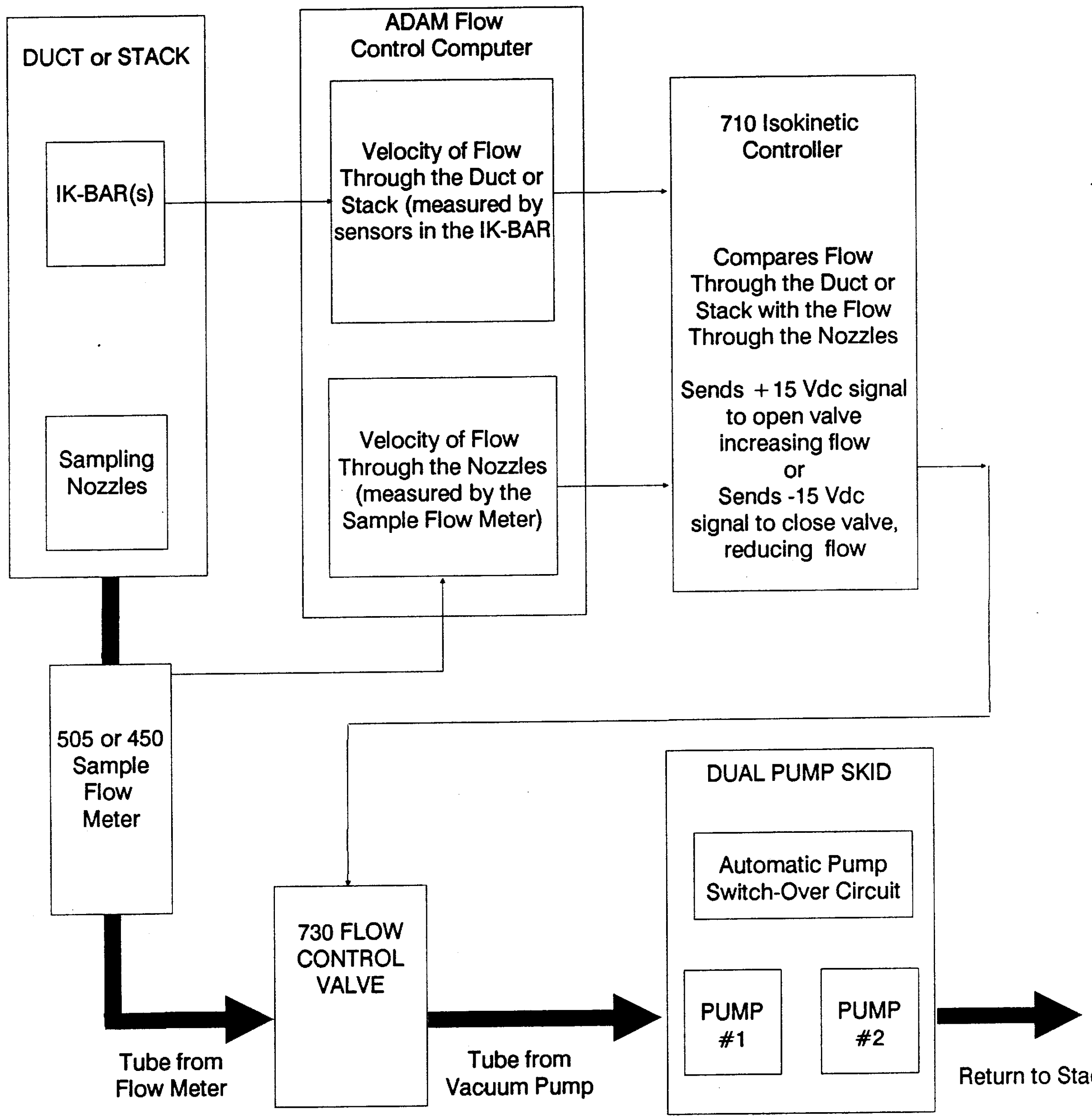
A simplified block diagram of the system's operations is provided on the next page in Figure 1-1.

1.3 System Components

Typical IK-EVA 4200 Systems include the following components:

- One or more IK-BAR(s) with attached sampling rakes
- Series 195 Current-Transmitter Enclosure
- 450 Insertion Sample Flow Meter or 505 In-Line Sample Flow Meter (may be integrated into a flow splitter)
- 730 Series Flow Control Valve
- Vacuum Pump (or dual-pump skid with 2 pumps and automatic switch-over circuitry)
- ADAM Series 155 Mass Flow Computer with Thermal Printer
- 710 Isokinetic Controller
- 111-8 Alarm Module
- One or more 132 Isolated 4-20mA Output Modules
- Model 40 Field Calibrator
- Series 193 System Enclosure with Series 191 Power Supply

Figure 1-1. *Simplified Block Diagram of Isokinetic Operation*



1.3.1 The IK-BAR Sensors and Sampling Nozzles

The 4200 uses one or more IK-BAR probe assemblies to measure the air or gas flow in the duct or stack and to withdraw a representative sample through sampling nozzles attached to the sample rake(s) on the IK-BAR. In most cases the low-particle loss screw-on nozzle tips are placed across from the sensors in the IK-BAR so that the sample rate is withdrawn proportionately to the velocity as measured by the corresponding sensors. The probe assembly drawing for the IK-BAR(s) in your system is included in Appendix A.

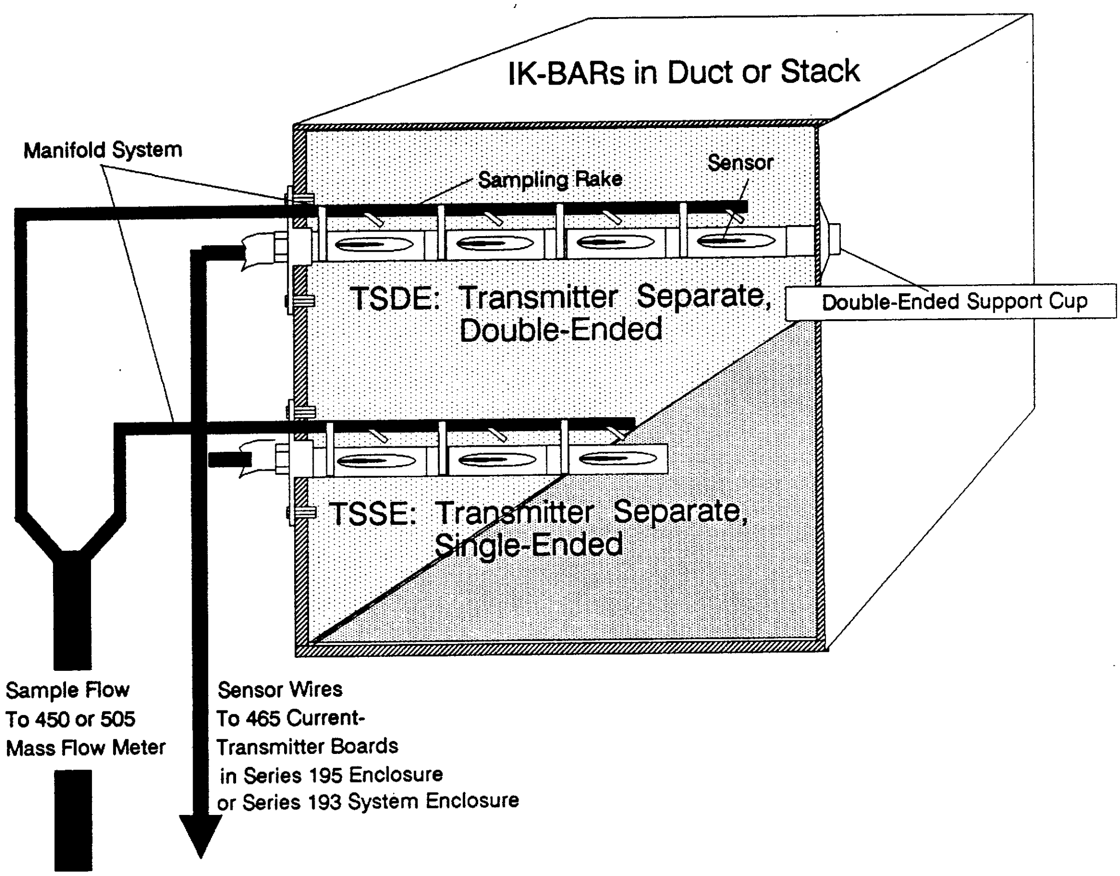
The sensors in the IK-BAR(s) measure the mass flow in the duct(s) or stack(s). The MetalClad velocity sensors on the IK-BAR(s) are housed within protective windows and joined by pipe-nipple sections. Each sensor in the IK-BAR(s) is connected to a matching 465 Current-Transmitter Board. The current-transmitter board provides the power to the sensor and contains the Whetstone bridge circuit that is the key to the operation of the thermal sensor. The signal from the current-transmitter boards is directed to the input channels of the ADAM Mass Flow Computer through field wiring terminals in the Series 193 System Enclosure.

Each IK-BAR probe can accomodate one or two individual sampling rakes per probe. Multiple sample rakes can be channeled into a common sample line using dual-junction, triple-junction, and quadruple-junction manifolds. The standard sample flow rate for each sample rake is 1-5 SCFM. Each sample line should be fitted with a full port stainless steel ball valve for shutoff.

A filter or sample box is optional. Most customers supply their own or route the sample into an analytical train. Kurz can optionally supply a fiberglass NEMA-type enclosure to house a stainless steel 4-inch filter assembly. A shut-off valve is included to allow for filter removal and replacement.

The IK-BAR probe flange bolts to the FMA Flange Mounting Adaptor welded to the duct or stack. If the IK-BAR is double-ended (it is to be secured at both ends of the duct), the DESC Double-Ended Support Cup is welded onto the opposite wall to support the end of the IK-BAR probe. Appendix A contains drawings of the IK-FMA and DESC mounting hardware. Figure 1-2 illustrates the physical installation of the IK-BARs in a duct.

Figure 1-2. *Installation of IK-BARs in a Duct or Stack*



1.3.2 450 or 505 Sample Flow Meter

The flow drawn through the nozzles is directed into the sample rake(s) on the IK-BAR. Sample lines are attached to the sample rakes through a compression union on the IK-BAR probe flange. The 450 or 505 Sample Flow Meter is installed in this sample line to measure the sample flow pulled by the vacuum pump. The sensor in the 450 or 505 is connected through a Killark junction box to it's associated 465 Current- Transmitter board. The sensor signal from the Sample Flow Meter is transmitted through the current-transmitter board to one of the input channels of the Series 155 ADAM Mass Flow Computer.

The 450 Insetion Mass Flow Meter can be integrated into a flow splitter to provide secondary samples to radiation or other types of secondary monitoring equipment in the plant. Typically one to two sampling nozzles installed inside the flow splitter body provide additional sample flows for the secondary monitoring equipment.

The assembly drawing for the 450 or 505 is provided in Appendix A.

1.3.3 730 Series Flow Control Valve

The 730 Series Flow Control Valve is an electrical metering valve that combines the electric drive motor, the valve body, and limit switches into a well designed integrated package. The 730 Flow Control Valve controls the sample flow rate. The valve opens or closes in response to a +15V or -15 Vdc correction signal from the 710RM-D Series Isokinetic Controller. If the sample flow rate is too low (when compared with the average velocity in the stack or duct), the valve opens to increase the sample flow rate. If the sample flow rate is too high (when compared with the average velocity in the stack or duct), the valve closes to decrease the sample flow rate.

The standard valve incorporates a high torque DC gear motor designed to be operated by "error signals" (+15 or -15 Vdc signals) from the Series 710 Controller. The flow coefficient (C_V) of the 730 is linear over a wide range due to its nearly 300 degree rotation between a complete flow shutoff and full open. The standard full open to full close time is 30 seconds, unless an optional valve speed has been specified. In addition, the orifice size is unaffected by changes in system pressure and the valve remains in its last position during constant flow or during power shutoff.

Because the motor is used only when the valve must move to a new position during flow control, the motor operates only for brief periods and is usually idle. In this type of application the motor should enjoy an extremely long life and should not require replacement of the brushes.

1.3.4 The Pumps and Automatic Switch-Over Circuit

The sample is drawn by a vacuum pump into a sample line through the sampling nozzles on the sample rake attached to the IK-BAR assembly. The optional Dual Pump Skid provides two vacuum pumps and an automatic pump switch-over circuit to ensure that an isokinetic sample will continue to be extracted in the event one pump fails.

If a pump fails, the switch-over circuit will activate the other pump. Both pumps will continue to operate to draw the sample and a relay contact will toggle so that you can connect an external device to provide an audible or visible indication that a pump has failed. Ladder logic and schematic diagram drawings of the switch-over circuit are provided in Appendix A if you have purchased the IK-EVA 4200 system with a dual-pump skid.

1.3.5 The Series 155 ADAM Module

The Series 155 ADAM Mass Flow Computer is a microcomputer housed in the Series 193 System Enclosure. The ADAM has a 20-key keypad and 2-line by 16 character LCD display that can be used to program the ADAM to perform specific functions and display system status. The ADAM can also be operated through an ASCII terminal or through a personal computer used as a terminal (by running one of many terminal emulation software programs available).

The ADAM performs the following functions:

- Conditions and linearizes up to 22 sensor input signals received from the current-transmitter boards associated with the sensors in the IK-BARs and the 450 or 505 Sample Flow Meter. These inputs are represented by Channels A through P in the ADAM.
- Configures up to eight meters, each meter can represent the measurements of a single channel or the measurements for a combination of selected channels or meters.
- Displays flow rates, totalized flow and elapsed time, average velocity, calibration factor, flow area, and channels or meters included in the meter measurements.
- Outputs up to eight 0-5 Vdc analog signals indicating the flow measurements for selected meters.
- Sets and displays system time and date.
- Sets the digital filter size.
- Sets and activates alarms used to monitor flow conditions.
- Kicks out sensor readings outside of a specified range.
- Reads and displays input voltages from each sensor channel.
- Logs meter data to printer.
- Controls access to critical system parameters through the setting and checking of user access codes .

The ADAM has been pre-programmed at the factory before shipment. Information regarding the general operating parameters of the ADAM are provided in the front of the manuals on the Unit Description Sheet. The meter configuration is documented in Appendix D. A state diagram of the ADAM operations is provided on drawing 340268, sheets 1 & 2 of 2, found in Appendix A.

Once the sensor signals are input the ADAM, the data from any sensor can be summed, averaged, and totalized with the measurements from other selected sensors. The resulting data is output as meter data. The ADAM has a maximum of 12 meters, each can be programmed to represent the data from a single channel or can represent the measurements from selected sensors or meters. The ADAM outputs a 0-5Vdc signal linearly proportional to the velocity or mass flow measurement for up to 8 meters.

In a typical IK-EVA 4200 System, at least one ADAM meter is used to represent the velocity of the air or gas in the duct or stack. This meter represents the data from the sensors on the IK-BAR installed in the duct or stack. A second meter represents the velocity of air or gas flow through the sample nozzles, measured by the sensor in the 450 or 505 Sample Flow Meter. The two linear 0-5Vdc analog output signals that represent the measurements of these meters are input to the 710 Controller.

1.3.6 710 Isokinetic Controller

The 710 Isokinetic Controller, installed in the system enclosure, operates to compare the flow rate of a sample extraction against the flow rate in the duct or stack in which the sample is withdrawn. To do this the 710 compares two 0-5 Vdc linear signals. The first input signal represents the flow rate in the duct or stack (calculated from measurements made by the sensors in the IK-BAR). The other 0-5 Vdc linear input signal represents the flow rate of the air or gas pulled through the nozzles (as measured by the 450 or 505).

If the sample rate measured by the 450 or 505 is greater than the flow rate in the duct or stack, the 710 will send a -15 Vdc signal to the 730 Series Flow Control Valve. The valve will respond by closing, which reduces the flow rate at which the gas or air can be pulled by the pump through the sample nozzles. When the flow rate through the nozzles is once again equal to the rate in the duct or stack, the 710 will stop transmitting the -15Vdc signal.

If the sample rate measured by the 450 or 505 is less than the flow rate in the duct or stack, the 710 will send a +15 Vdc signal to the valve. The valve will respond by opening, which increases the flow rate at which the gas or air can be pulled by the pump through the sample nozzles. When the flow rate through the nozzles is once again equal to the rate in the duct or stack, the 710 will stop transmitting the +15Vdc signal.

1.3.7 The 111-8 Alarm Module (Optional)

The 111-8 Alarm Module provides up to 8 relay contacts that can be used to provide an audible or visual indication that an alarm condition has occurred. The Unit Description Sheet in the front of this manual and the Meter Data Sheets in Appendix D provide information about the settings of the alarms. Also refer to the Field Wiring Diagrams for your system, provided in Appendix A. An example alarm configuration is shown in Table 1-1.

Table 1-1. *Example of an Alarm Setup in an IK-EVA 4200 System*

ALARM	ALARM TYPE	SYSTEM STATUS
K1	Sensor Kickout (Sensor Failure)	Alarms on any sensor malfunction; System is still otherwise functional
K2	Isokinetic Alarm	System is not drawing an isokinetic sample but is otherwise functional
K3	Calibration Mode	System is being calibrated using the Model 40 Field Calibrator. The +24 Vdc supply to the sensors has been removed. System is not functioning as an Isokinetic Sampling System
K8	+24 Vdc Power Supply Failure	System is non-functional, all system electronics are inoperable

1.3.8 Model 132 Isolated 4-20mA Output Modules (Optional)

The IK-EVA 4200 System can be equipped to provide multiple isolated 4-20mA outputs used to interface to other equipment placed remote from the system enlclosure. The field wiring terminals for these outputs are shown in the Field Wiring Diagrams in Appendix A.

1.3.9 The Printer (Optional)

When the "L"-key on the ADAM keypad is pressed, a thermal printer prints the meter data for each of the 12 meters. The following meter data is displayed:

Meter number and Meter ID
Flow rate
Totalized flow and Elapsed time
Average velocity
Calibration factor
Flow area
Averaged channels

1.3.10 Model 40 Field Calibrator

The Model 40 Field Calibrator is a testing device used to verify the calibration the sensors in the system. The Model 40 simulates mass flow sensor calibration currents sequentially into each input channel of the ADAM Mass Flow Computer. The exact input voltage and linearized output can be viewed directly on the LCD of the ADAM. Section 5.5 provides information on how to verify the calibration of the ADAM using the Model 40 Field Calibrator.

When Model 40 is in TEST MODE (as indicated by an LED on the front panel), a 10 amp relay energized so that a remote signaling device can be connected to indicate to operation personnel that the isokinetic sampling system is in a test mode.

1.3.11 The System Power Supply and Electronics Enclosure

Most of the electronics for the IK-EVA 4200 System is housed in the Series 193 System Enclosure. However, the 465 Current-Transmitter Boards may be placed in a separate Series 195 Current-Transmitter Enclosure. The Series 191-12 is a +24 Vdc/12A Power Supply that provides +24 Vdc power to all the electronics in the system except for the printer. The printer operates off the 115 VAC supplied to the system enclosure.

The system electronics can include:

- 465 Current-Transmitter Boards (one for each sensor)
- ADAM Series 155 Mass Flow Computer
- 710 Isokinetic Controller
- 111-8 Alarm Module
- 132-4 Isolated 4-20mA Output Module
- Thermal Printer
- One Kurz Model 40 Field Calibrator
- Series 191 Power Supply

1.4 Specifications for the IK-EVA Sensor and Probe

The specifications of the sensor and probe are given in Table 1-2.

Table 1-2. *Specifications for the IK-EVA Sensor and Probe*

Sensor Construction:	Each sensor is constructed of reference-grade 385 platinum RTD-type windings around a high-purity ceramic core, sheathed in 316 stainless steel.
Wetted Surfaces:	The only sensor material exposed to the working fluid is 316 stainless steel.
Accuracy:	Each independent sensor is accurate to +/- (2% of reading + 1/2 of full scale; linearized output) over the temperature range of 0° to +125° C.
Minimum Air Velocity Sensitivity:	Each sensor can accurately measure air velocities down to 50 SCFM/ft^2 (SCFM).
Sample Flow Rate:	Select full range between 0.5 and 5 SCFM, depending on the number of sample nozzles and average stack velocity
Temperature Compensation:	+ 2% degradation of accuracy at temperatures from +125° to 250° C; +3% degradation of accuracy at temperatures from +250° to 500° C
Repeatability:	Each sensor repeats a reading or output within 1% ten consecutive times when flow is cycled from 100% flow to 50% flow over a one minute period
Response Time:	Each sensor responds within 5 seconds within the accuracy specification to changes in air velocity from 100% to 50% of the calibrated range, and from zero (no flow) to 50% of the calibrated range.

Calibration:	Each sensor is factory calibrated in NBS-traceable wind tunnel for air at 25° C (77° F) and 760 mm (29.92") Hg. A Calibration Certificate showing output voltage vs air velocity is included.
Sensor Operating Temperature Range:	0° C to +250° C standard HHT-rated sensor optionally available for temperatures from 0° C to +500° C NOTE: The electronic components in the system should not be exposed to ambient temperatures above 120° F.
Pressure Compensation:	Each sensor compensates for variations in pressure of the working fluid between 0 psia and 1000 psia.
Sensor Integrity Verification:	The integrity and electrical continuity of each sensor is quickly verified by two ohmage measurements.
Sensor Electrical Terminations:	Each sensor's electrical wiring is terminated by spade lugs.
Probe Construction:	Most IK-BARs are constructed of 316 Stainless Steel. Hastelloy™ is available for temperatures to 500º C and for very corrosive environments. MetalClad sensors are mounted by screwing in protective windows, which in turn connect together by a screw fitting. All threads are NPT standard. Sensors are easily replaceable with hand tools. No welding or cutting on probe structures is required to exchange any of the sensors.

Probe Mounting:	Each IK-BAR probe structure can be mounted via an attached 4-bolt pattern, 6" round, ASA raised-face 150# flange.
Sample Rake Construction:	316 Stainless Steel with removable screw-on nozzle tips

1.5 ADAM Specifications

The specifications for the ADAM are provided in Table 1-3.

Table 1-3. *ADAM Specifications*

Analog Inputs:	0-5 Vdc Inputs, 22 Channels 2.2 second scan cycle (0.1 sec./channel) 1 part in 50,000 precision across full range Digital Finite Impulse Response (FIR) Filtering Up to 15 points digital linearization using second-order Lagrangian interpolations on NBS-traceable data tables Software selectable inputs to average Software totalization of average
ADAM Keypad:	20-key, 256 keypress data buffer
ADAM Display Output:	2 line by 16 character LCD display
ADAM Analog Output:	8 linear 0-5 Vdc analog outputs, available at field terminals in the system enclosure
Terminal I/O Port:	RS-232 terminal port
Clock:	24-hour Time-of-Day Clock/Calendar

Normal Display Loop:

Current time and date
Instructions to access:
- meter data
- programming
- hold
- help

User-Called Displays:

For each of 12 Meters:
- Meter I.D.
- Flow Rate (in SCFM)
- Totalized Flow & Elapsed Time
- Average Velocity in SFPM
- Calibration Factor
- Flow Area
- Averaged Channels

User-Accessible Variables:

Reset stack flow totalizer
Set Time and date
Enter Meter Data
- I.D.
- Select as an insertion or in-line meter
- Channels included
  - Flow area
  - Calibration factors
- Select as a temperature meter
  - Channels included
- Select as sum type meter
  - Meters in sum
  - Flow area
  - Calibration factors

Set box filter
Set analog out
- Meter #
- Avg. velocity, flow rate, or temperature
- Units at low and high output voltages

User-Accessible Variables: (cont.)

Set alarms 2-16
  Meter #
  Turn alarm on or off
  Select as N.O. or N.C.
  Select flow rate, velocity, or temperature
    Alarm when low, high, low or high
    Low alarm units
    High alarm units
  Configure as a channel kickout alarm
  Configure as a non-isokinetic alarm
    Meter # used for reference
    Enter velocity difference
Channel Kickout
  Turn channel kickout on or off
  High kickout % of full scale
  Low kickout % of full scale
  Alarm 1 on or off
  Alarm 1 N.O. or N.C.
View input voltages

Technician-Accessible Variables:

Enter calibration variables:
  "zero" and "span" voltages for each sensor input;
  "zero" and "span" voltages for the analog output

Linearization variables:
  Enter number of data points in the linearization table;
  Enter input voltage and units for each point the table

1.6 Specifications for the 710 Electronic Valve Controller

The specifications of the 710RMD Controller are given in Table 1-4.

Table 1-4. *710 Specifications*

Display:	4-1/2 digit LCD display driven by a 3-1/2 digit IC voltmeter. Maximum engineering units displayed 19990. Least significant digit is a static zero provided for convenience in readability.
Operator Controls:	ON/OFF DISPLAY SELECT: Selects Stack Flow Rate, Sample Flow Rate, Setpoint Flow Rate, or Temperature °F FUNCTION SELECT: Selects Isokinetic, Constant Flow Control, or Manual Valve MANUAL VALVE, momentary toggle Open or Close SET-POINT ADJUST, 10-turn locking potentiometer
Setpoint Span:	0-100% of flow
Setpoint Accuracy:	+/- 1%
Power:	115VAC/60Hz
Operating Temperature:	-20° C to +60° C

Enclosure:	Standard: 4.2" wide by 7" high rack module
Signal In:	External Setpoint: Accepts 0-5 Vdc process variable input provided by the ADAM reflecting flow rate in vent stack. Special configuration: The second input to the 710 is directly off the 5 ohm resistor for Channel P (the sensor signal from the 450). The 437 linearizer board in the 710 module linearizes and inputs the signal to the 710 comparator.
Signal Out:	+ 15 Vdc or -15 Vdc signal drives the 730 Flow Control Valve over a two-wire hookup (2nd wire is ground)

1.7 Specifications for the 730 Electric Rotary Ramp Metering Valve

The specifications of the Series 730 Flow Control Valve are given in Table 1-5.

Table 1-5. *730 Specifications*

Construction:	316 Stainless Steel construction is standard, other construction optionally available
Seals:	Viton™ flourocarbon is standard, other construction optionally available
Motor:	24 Vdc gearmotor derated by operation at 15 Vdc maximum.

Motor (cont.)

Available in several gear ratios to effect different OPEN/CLOSE cycle times. Normally the highest available gearing is used to achieve the most precise (smallest) movement in the output shaft. This results in the finest incremental movement of the valve rotor (that is, the most precise valve actuation).

Gear ratio: 2426:1, 1804:1, 1419:1, 728:1, 426:1, 218.4:1, 65.5:1

Cycle Times:

Full CLOSE to full OPEN is approximately 35 to 40 seconds when the 2426:1 ratio gearmotor is used. Less pronounced gear ratios result in faster cycle times but can result in a loss of precision in fine metering. Select other cycle times only where flow is rapidly changing.

It is very simple and economical to swap out gearmotors in the field with only a screwdriver should you wish to change the valve cycle time.

Hookup:

Two-wire hookup. One wire is ground. The other wire carries the + 15 Vdc or -15 Vdc signal from the 710 controller that opens or closes the valve respectively.

Motor Cover:

The cover for the motor is constructed of 316 stainless steel. All motor covers include cable fitting which may be removed to run conduit into the 1/2" FNPT fitting provided.

Shutoff:

While a pressure assisted shutoff plug is a standard feature, the 730 Series Valves are metering valves, not shutoff valves. For user's requiring 100% confidence in total shutoff, we recommend the installation of a normally open or closed solenoid valve downstream of the 730 valve.

Limit Switches:

Microswitches installed at the full closed and full open positions of the 730 valves break the circuit to the valve and prohibit further motion until reverse polarity voltage is received to move the valve off the limit switch.

End of Section 1

Section 2: Installing the IK-EVA 4200 System

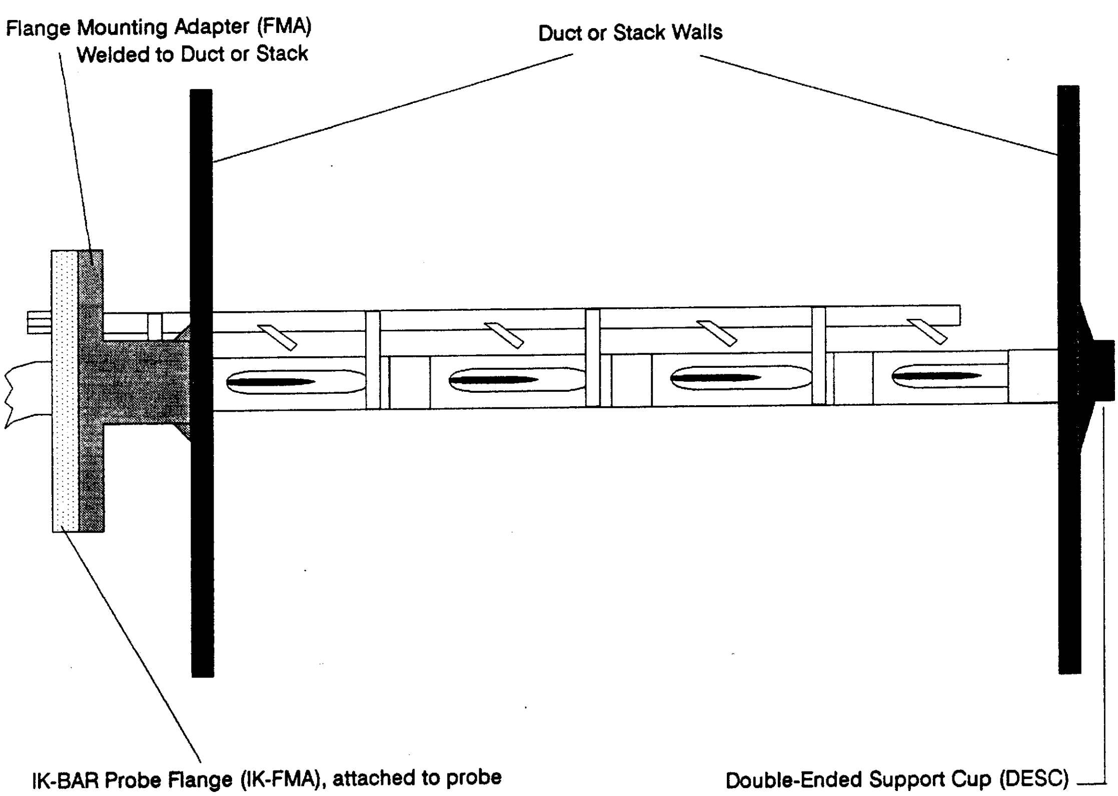
The installation procedures listed in this section are general in nature. Because each IK-EVA 4200 System is unique it is most important that you refer to the engineering drawings supplied with your system for information regarding the installation of your particular system.

2.1. Physical Installation and Connections

1. Figure 2-1 provides an illustration showing the installation of the IK-BAR in the duct or stack. For each IK-BAR probe assembly to be mounted:

   a. Cut an access hole for the IK-BAR probe, modifying the duct to mount the FMA (Flange Mounting Adaptors) to which the IK-BAR probe flange bolts. If you have a standard 6" FMA, drawing C420040004 provides a detail of the FMA and has been included in Appendix A.

Figure 2-1. *Mounting Hardware for the IK-BAR*

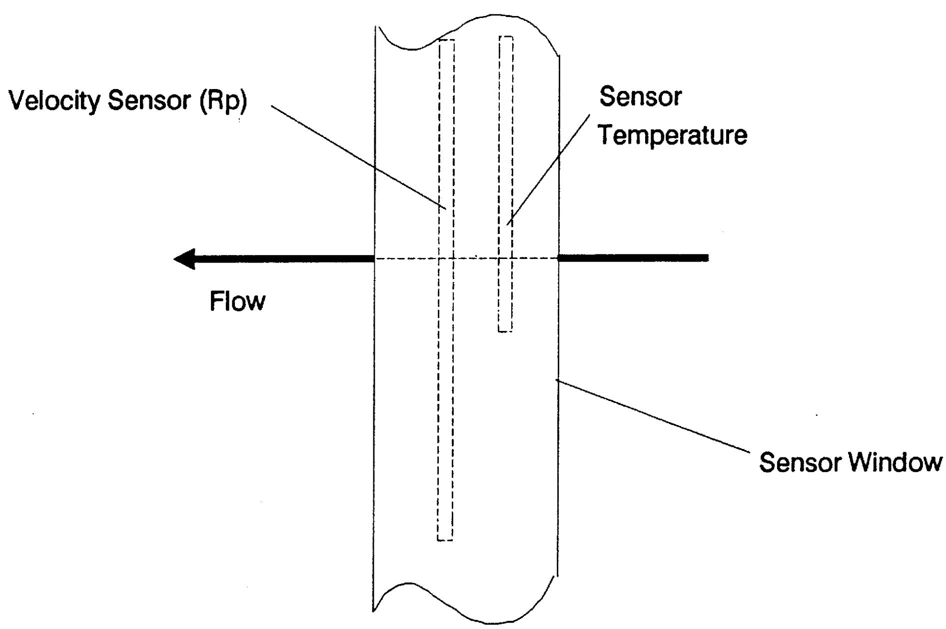


b. If the IK-BAR is double-ended, drill a clearance hole, with the approximate inside diameter of the DESC (Double-Ended Support Cup) to install the Double-Ended Support Cup. The DESC should be installed along the center line of the IK-BAR probe on the outside of the opposite duct wall. Drawing 150058 provides a detail of the DESC.

c. Weld the FMAs (Flange Mounting Adaptors) to one side of the duct and weld the DESC to the opposite side of the duct.

d. Carefully insert the IK-BAR probe assembly through the FMA welded on the ducts. Make sure the sealing ring is inserted between the two flanges. Ensure that the IK-BAR is inserted into the DESC fitting on the other side of the duct. The end cap of the DESC can be unscrewed and removed to ensure that the probe assembly has been mounted into the DESC correctly. The IK-BAR should be inserted into the duct or stack so that the air flow passes through the sensor as shown in Figure 2-2.

Figure 2-2. *Sensor Orientation to Flow*

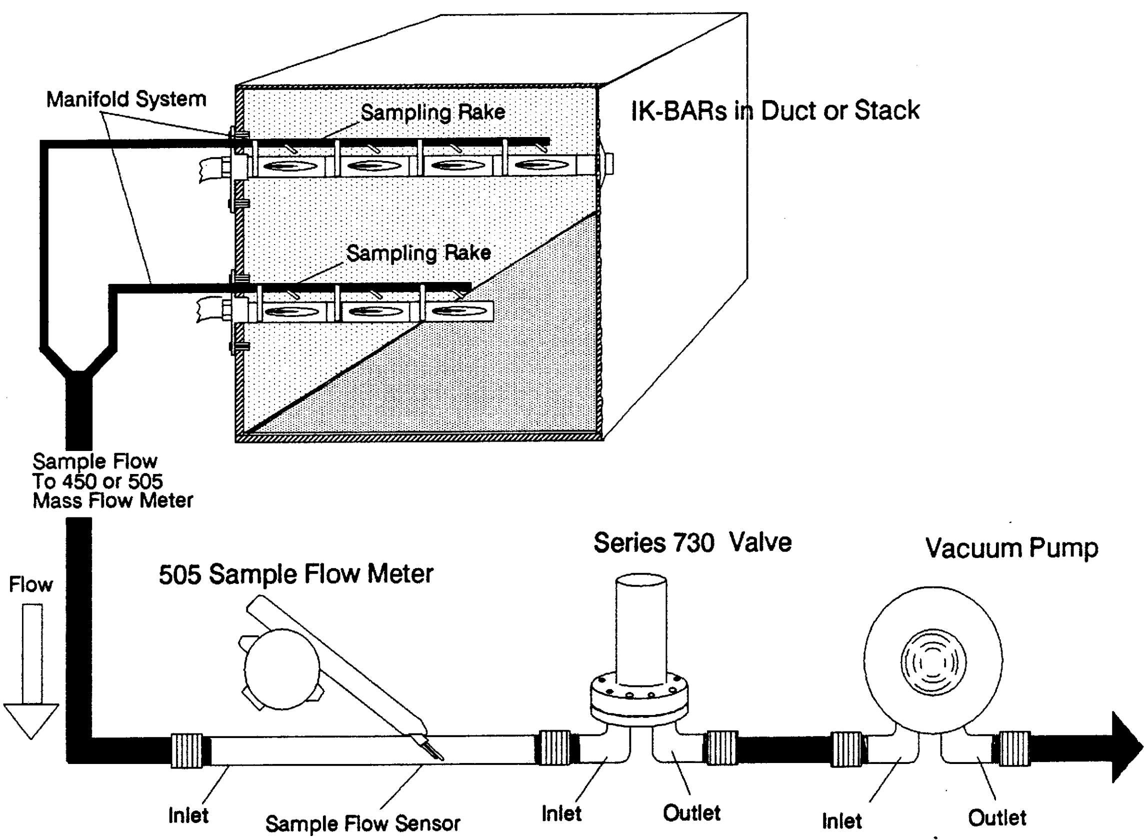


e. Connect the sampling rake(s) of the IK-BAR(s) to a manifold system that directs the sample flow to a single sample line. This sample line will be connected to the sample flow meter, the valve, and the pump.

2. Mount the Series 195 Current-Transmitter Enclosure(s) or remote junction box(es) using the appropriate bolts, lockwashers, and flatwashers. Using this hardware and fastening all four ears results in adequate support for the enclosure. High-quality bolts, lockwashers, flatwashers, and other hardware must be used to assure proper enclosure support. The dimensions of the Series 195 Current-Transmitter Enclosure or remote junction box are shown in the engineering drawings in Appendix A.

3. Install the 505 Sample Flow Meter (or 450 and flow splitter), 730 Series Valve, and vacuum pump (or other vacuum system) in the appropriate location(s). In some installations, the sample flow meter, the valve, and pumps are housed in the system enclosure. Other 4200 systems have installed and connected the sample flow meter, the valve, two pumps, and the pump switchover components on a single pump skid. The drawings in Appendix A provide detailed information on the installation of these components.

Figure 2-3. *Sample Flow Path*



a. Install the 505 or the flow splitter in the sample line. The flow should be directed into the 505 or flow splitter through the long pipe section (inlet) of the flow body. If you are using the 450 and a flow splitter, insert the 450 probe into the compression fitting on the flow splitter. Tighten the compression fitting when the 450 probe is in place.

b. Install the 730 Series Flow Control Valve. Be sure to orient the valve so that the sample line can be connected between the inlet of the valve and the outlet (short pipe section) on the 505 or flow splitter body. The outlet of the 730 valve should be oriented so that the sample line can be connected to the inlet of the pump. The inlet and outlet are marked on the valve.

c. Install the vacuum pump(s) or other system used to draw the sample through the sampling nozzles. The pump should be oriented so that the pump inlet can be connected to the sample line from the 730 valve.

4. Connect the sample line from the manifold system to the inlet of the 505 or flow splitter. If the 505 or flow splitter outlet is not directly connected to the 730 valve inlet, connect a sample line between them. Connect the sample line between the pump inlet and the valve outlet if it is not already installed. Finally, connect the sample return line to the pump outlet.

5. Connect the appropriate secondary sample lines to the sample flow splitter, if appropriate.

6. Mount the base of the 193 System Enclosure. The mounting holes for the enclosure are shown in a drawing in Appendix A. Again, Kurz recommends using the highest quality fasteners in an installation configuration offering generous safety factors.

2.2 Electrical Connections

Figure 2-4 summarizes the elctrical connections for the 4200 System.

1. Connect the sensor wires exiting each of the IK-BARs to the associated 195 Current-Transmitter Enclosure(s) or junction box(es) as shown in the field wiring interconnection drawings in Appendix A. The ends of the sensors wires (5 wires per sensor) are labeled with the tag number designation as well as the sensor serial number.

2. Connect conduit between the field terminals in the Series 195 Current-Transmitter Enclosure or junction box and the appropriate field terminals in the system enclosure. If the 465 Current-Transmitter Boards are installed in the Series 195 enclosure, two wires per sensor exit the 195 enclosure. If the 465 Current-Transmitter Boards are installed in the Series 193 System Enclosure, five wires per sensor exit the 195 enclosure or junction box.

3. Connect conduit between the Killark enclosure on the 450 or 505 Sample Flow Meter and the field wiring terminals in the Series 193 System Enclosure. If the Killark enclosure is remote, you must first connect the sensor wires exiting the 505 or 450 meter to the terminals in the Killark enclosure as directed by the engineering drawings in Appendix A. If the 465 Current-Transmitter Board is installed in the Killark enclosure, two wires per sensor exit the enclosure. If the 465 Current-Transmitter Boards are installed in the Series 193 System Enclosure, five wires per sensor exit the Killark enclosure.

4. Connect wiring between the terminals in the Degussa enclosure on the valve to the field terminals in the Series 193 System Enclosure. Internally, these wires are indirectly connected to the correction signal output by the 710 controller.

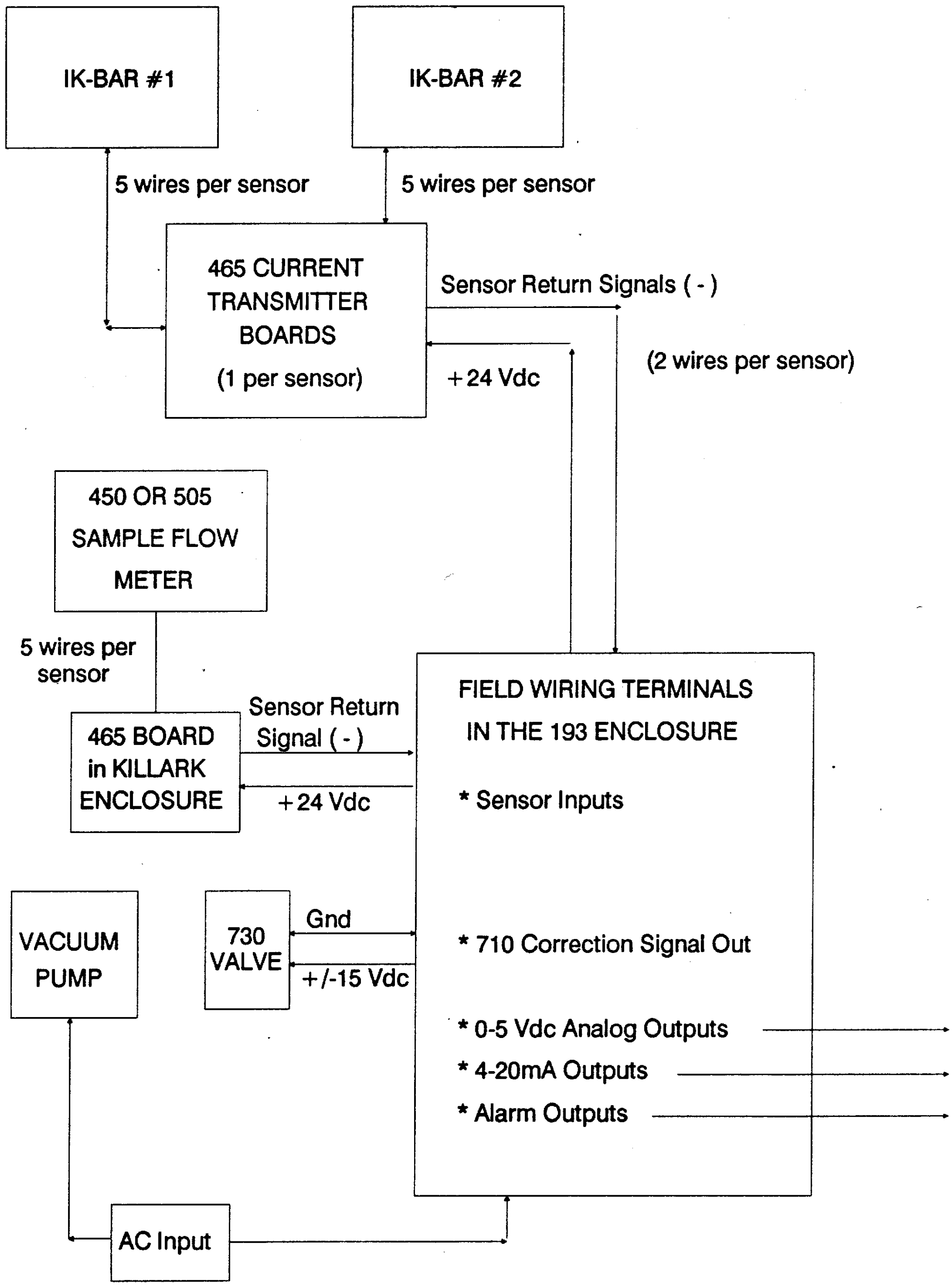
5. Connect external devices to the field terminals for analog outputs 1 through 8. These connections are shown on the field wiring drawings in Appendix A.

6. Connect external devices to the field terminals for the 4-20mA outputs. These connections are shown on the field wiring drawings Appendix A.

   Note: Kurz 4-20mA Output Modules are self-powered. Do NOT supply power to these modules or they may be damaged.

7. Connect external devices to the field terminals for the alarm relays. These connections are shown on the field wiring drawings Appendix A.

Figure 2-4. *Electrical Connections Between 4200 System Components*



2.3 Connect AC Lines to the System Enclosure and Pump

1. With AC power off, connect a 115 VAC/ 50-60Hz or 230VAC/50-60Hz line to the system enclosure. The AC connections are made at terminals in the system enclosure. Refer to the field wiring drawings supplied in Appendix A.

2. With AC power off, connect the appropriate power lines to operate the pump. If you have purchased the Kurz Dual Pump Skid, you will need to connect AC lines for the switch-over electronics and the pump. The pump enclosure on the skid provides terminals to make these connections.

   NOTE: Do not supply power to the system until a check-out procedure is satisfactorily completed.

2.4 Ensure that Wiring Interconnections are Correct

Perform point-to-point tests to ensure that signal cables, power cables, ground wires and other system connections are complete. This will minimize any equipment failures caused by improper wiring.

Check system wiring against the Kurz system drawings provided with your equipment **and** against the architect/engineer or OEM equipment vendor drawing to ensure that terminations have not been changed or altered during the design process or during installation.

Make sure that any other equipment interfacing with the 4200 System has been installed, with interconnections properly made (i.e., customer radiation monitoring equipment).

NOTE: Do not supply power to the system without sensors connected to the Series 193 enclosure. Damage to board components from overheating could result.

2.5 Supply Power to the System

The power sources used to provide power to the 4200 system should be checked to make sure that the power is fairly clean and stable (i.e., 115 VAC +/- 10% and 220VAC +/- 10%). After all connections have been checked, the power can be supplied to the 193 enclosure. Confirm power level to the enclosure.

After the power cord has been plugged into the receptacle, turn the key power switches (if so equipped) to the **ON** position. These switches are usually provided on the power supply module included in the 193 enclosure. Make sure that all fuses and/or other circuit protection equipment is functioning properly.

End of Section 2

Section 3: System Operation

3.1 4200 System Operation Overview

As discussed in the previous sections, the 4200 system measures the average flow in a stack or duct and draws an isokinetic sample based on that flow rate. In most cases the sample flow is controlled by comparing the 0-5 Vdc output signal representing the average flow (as measured by the EVA sensors in the stack or duct) with the 0-5 Vdc output signal generated by the 450 or 505 Sample Mass Flow Meter used to measure the sample flow rate.

When the sample flow rate (as indicated by the output signal from the 450) is proportionally less than the average flow rate (as indicated by the average output signal of the KBAR sensors), the 710 Controller outputs a + 15 Vdc error signal to open the valve, thereby increasing the sample flow rate. When the sample flow rate (as indicated by the output signal from the 450) is proportionally greater than the average flow rate (as indicated by the average output signal of the KBAR sensors), the 710 Controller outputs a -15 Vdc error signal to close the valve, thereby decreasing the sample flow rate. The valve stays in it's last position until it receives an error signal, and moves only while an error signal is present.

Once the system has been powered on, the operator can input information into the system through the ADAM's keypad and can get system information through the ADAM's display and optional printer.

3.2 Initial Power-Up Procedures

After the completion of system installation and interconnection, the following steps will allow the operator to initialize the IK-EVA system operation.

1. Turn key lock power switches to the "on" or vertical position.

2. Turn power supply on/off switch to the "on" or vertical position.

3. Turn the power switch on the 710 module to the "on" position. Ensure that the DISPLAY switch on the 710 module is set to SAMPLE SCFM and that the FUNCTION switch is set to ISOKINETIC.

When the system is powered up, the ADAM will:

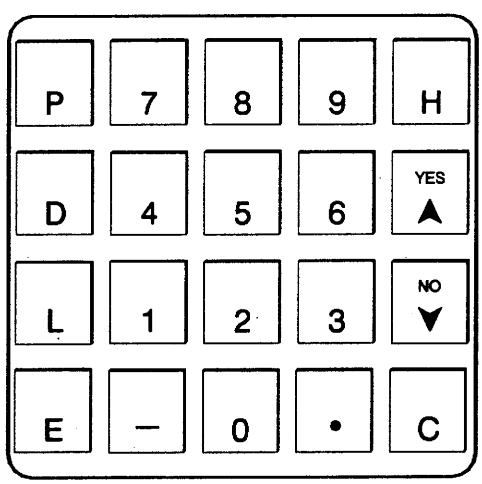
1.) Read the system time of day clock
2.) Initialize itself
3.) Allow the analog inputs to stabilize
4.) Enter the executive state and the LCD display will show the following information:

KURZ INSTRUMENTS KAS3F
SERVICE PHONE (800) 424-7356
PRESS H TWICE TO GET HELP

Then the ADAM will execute an automatic status loop. The automatic status loop display provides the time and date and prompts the operator to press the D-key to see meter data, press the P-key to enter the program mode, press H-key to hold the current display, or press the H-key twice to display the help screen. The ADAM display will continue to cycle through these messages until the operator presses one of those three keys. Section 3.4 provides further information about operating the ADAM.

The ADAM keypad is shown in Figure 3-1.

Figure 3-1. *ADAM Keypad.*



3.3 Interfacing the ADAM to a Terminal or a Personal Computer

You can operate and program the ADAM through an ASCII terminal or a personal computer executing ASCII terminal emulation software. Using a terminal or PC with the ADAM offers some advantages in that either of these operator interfaces can be remote from the system (up to 50 feet) and can display more data at one time than the 32-character ADAM display.

Each ADAM keypad key has a corresponding key on the terminal or PC keyboard. These keypad and keyboard keys are used to program and display information about the system setup and status. Table 3-1 provides an overview of the keys used.

Table 3-1. *Key Functions/Keypad and Keyboard Keys*

Key Function	ADAM Keys	Standard ASCII Key
Program Key - Allows an operator (with proper access code) to program the ADAM. Section 4 provides information on programming the ADAM.	P	P
Display Key - Calls the ADAM's meter display routine. LCD displays the meter ID, time and date, flowrate, totalized flow and elapsed time, average velocity, calibration factor, flow area, and averaged channels.	D	D
Log Key - Sends data to a terminal port and the printer	L	L
Enter Key - Used in Program Mode to enter setup variables for the ADAM module	E	{CR}
Hold Key - Holds current display until the Clear Key is pressed	H	H
Up-Arrow/Yes Key - Used to access items within a list, from the first selection toward the last selection in the list	^ Yes	^
Down-Arrow/No Key - Used to access items within a list, from the last selection back toward the first selection in the list	V No	V

Table 3-1. *Key Functions/Keypad and Keyboard Keys* (continued)

Key Function	ADAM Keys	Standard ASCII Key
Clear Key - Returns the operator to the entry point of the routine just cleared	C	C
Hypen Key - Used for operator text entry	-	-
Period Key - Used for operator text entry	.	.
Number Keys 0-9 - Used for operator text entry	0-9	0-9

Refer to the documentation provided with your PC or terminal for information regarding the location of keyboard keys. The PC or terminal keyboard key that corresponds to the keypad "ENTER"-key ("E") differs from terminal to terminal. That particular keyboard key is denoted here by {CR}

If your system is connected to a Terminal or PC, the following functions can be accomplished in the subsequent manner.

3.3.1 Echoing Displays to the Terminal or PC

The plus sign key acts as a toggle between echo on and echo off to a terminal or PC screen. If you press the plus sign key (" + ") on the PC or terminal keyboard, the system echoes the information sent to the ADAM display to the terminal or PC display as well. Pressing the plus sign key again turns the echo to the terminal or PC off.

3.3.2 Sending Configuration Data to the Terminal or PC

You can have the system send its configuration data, which are not included in a normal data log, to the terminal or PC display. To do so, press the Q-key on the terminal or PC keyboard.

3.3.3. Requesting Help from the Terminal or PC Keyboard

For help, press the ?-key. A list of help functions will be displayed for selection.

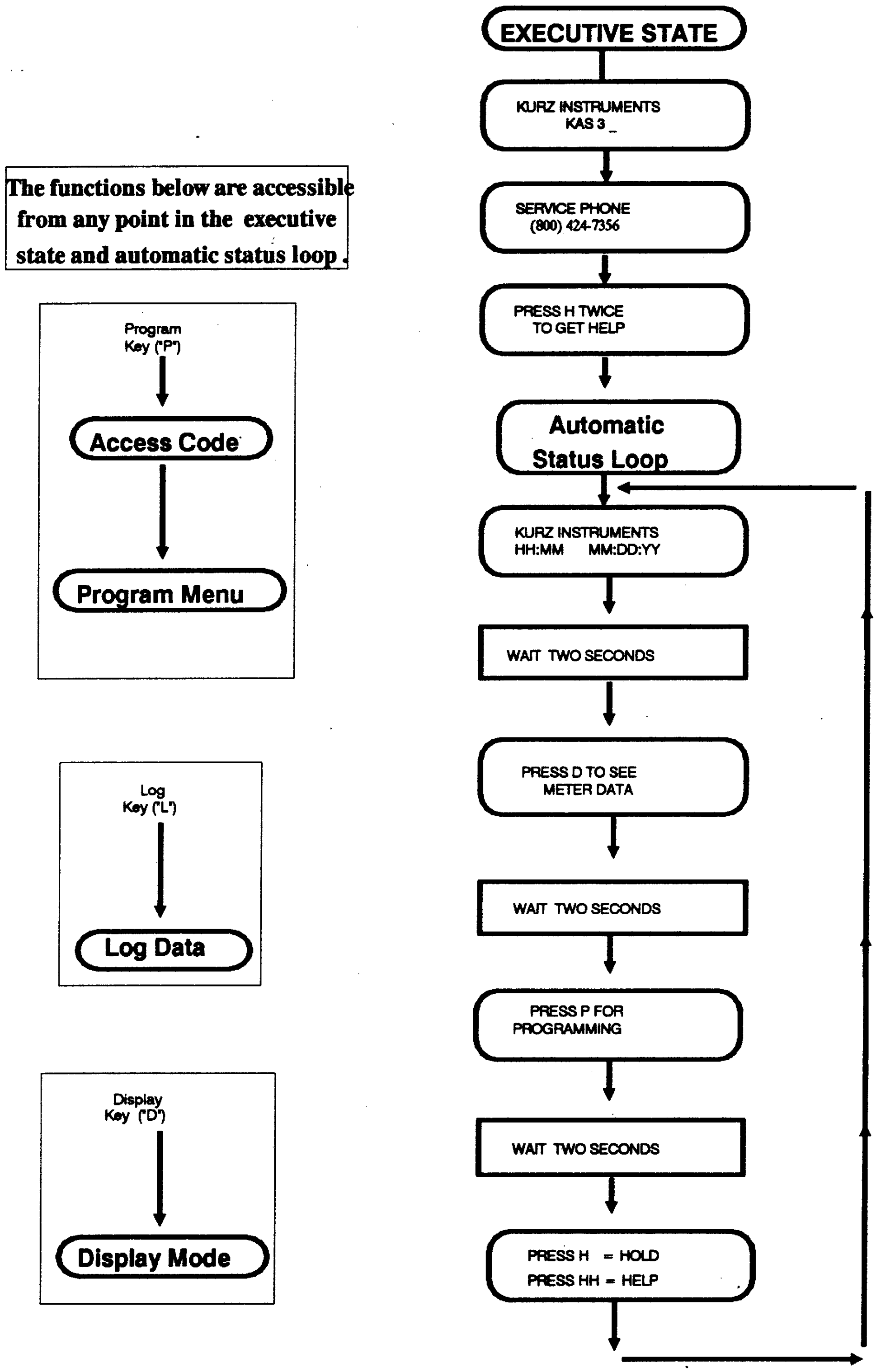
3.4 Operating the ADAM Mass Flow Computer

After startup, the ADAM automatically enters the executive state and displays a sign-on message (three individual displays) then executes the automatic display loop. The automatic status loop display provides the time and date and prompts the operator to press the D-key to see meter data, press the P-key to enter the program mode, press H-key to hold the current display, or press the H-key twice to display the help screen. The ADAM display will continue to cycle through these messages until the operator presses one of those three keys. Section 3.4 provides further information about operating the ADAM.

A state diagram of ADAM's operating program is provided in Appendix A on drawing 340268, sheets 1 and 2. A state diagram of the executive state and the automatic status loop is provided in Figure 3-2.

The executive state is the "home base" state of the system. Any time the system is not in the executive state, repeatedly pressing the C-key returns the system to the executive state. Think of it as a safe way home. The executive state is also the state to which the system is automatically returned by the autoclear function when the system has been inactive for a certain amount of time (i.e., when no keys on either the keypad or a keyboard terminal have been pressed for a certain amount of time – currently set to 5 minutes).

Figure 3-2. *State Diagram of ADAM's Executive State and Automatic Display Loop*



From both the executive state and the automatic status loop you can:

1.) **Press the D-key to enter an alternate display loop** which allows the operator to see the flow data for each meter. Section 3.4.1 provides further details on the display meter routine.

2.) **Press the P-key to enter the Program Mode** which allows the ADAM to be custom configured to each installation. Before the Program Mode can be entered, the operator will be prompted for an an access code. If entered correctly, the variables used by the ADAM can be displayed and/or changed. Section 4 provides detailed information on how to operate the ADAM in Program Mode.

3.) **Press the H-key to "freeze" the current display.** The words: "Hold is activated" will appear before your selection. To release the hold, press the C-key. Your screen will show you that "Hold is cleared".

   Note: This function is available at any time regardless of where you are in the system.

4.) **Press the H-key twice to enter the help screens.**

5.) **Press the L-key** to print meter data to the printer. This does not affect other scheduled logs, it simply causes the current meter data to be logged to the printer.

   Note: This function is available at any time regardless of where you are in the system.

3.4.1 Displaying Meter Data

Pressing the D-key when the system is in the executive state allows you to access and view individual meters and its values. A state diagram for the display program is provided in Figure 3-3.

Choose which of the 12 meters you wish to view by cycling through the list using the YES/UP-ARROW and the NO/DOWN-ARROW key or enter a meter number using the number keys. After you have selected a meter, press the D-key. The identification number(ID) of the meter and the system's time and day clock will be displayed.

Depending on the assigned function of the meter; whether it's a temperature meter or a flow meter; pressing "D" will display the meter's current reading.

If the meter has been programmed as a flow meter, the following values will be displayed:

1.) Flowrate in SCFM (standard cubic feet per minute)

2.) Totalized Flow and Elasped Time

3.) Average Velocity in SFPM (standard feet per minute)

4.) Calibration Factor

5.) Flow Area in square feet

6.) If the meter is assigned to:
    (a.) a channel, your screen will display the channel or channels (averaged) included
    (b.) several meters, your screen will display the meters included

The calibration factor is a correction factor that is applied to the linearized signal to compensate for an uneven profile in a duct or stack. Up to 15 calibration factors can be applied to the linearized signal for each meter in the system. This allows the signal to be corrected at different flows, according the flow profile. The calibration factors are programmed in the *Set Meter Data* routine.

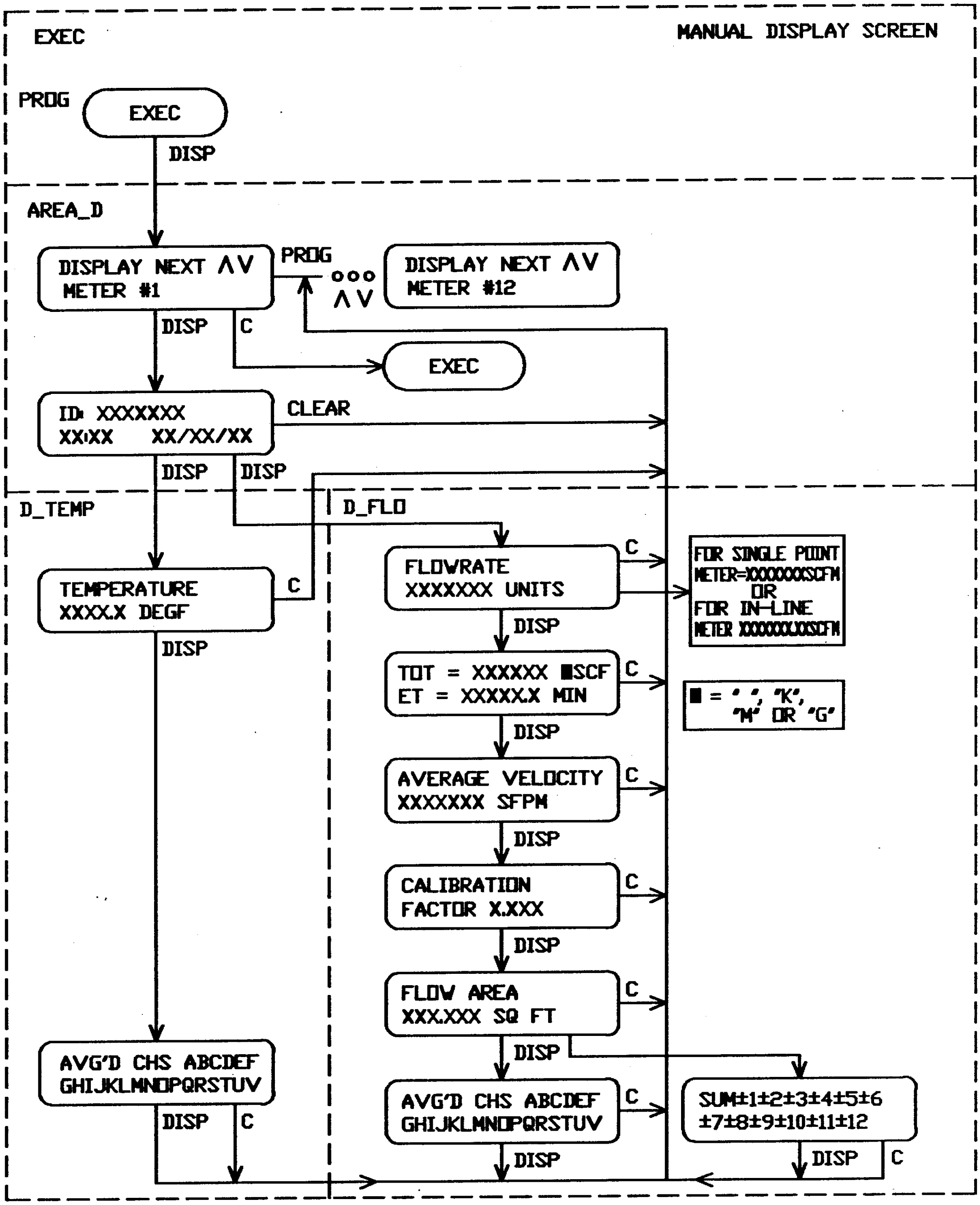
If the meter has been programmed as a temperature meter, the following values will be displayed:

1.) Temperature

2.) Which channel or channels (averaged) were used

You can display the values in sequence only. To proceed from one display to the next, press the D-key. To return the system to the meter listing at any point, press the C-key (CLEAR).

Figure 3-3. *State Diagram of the ADAM's Display Routine*



3.5 Operator Controls on the 710RMD Rack Module

As shown in Figure 3-4, the operator controls on the 710RMD Rack Module include:

ON/OFF Switch

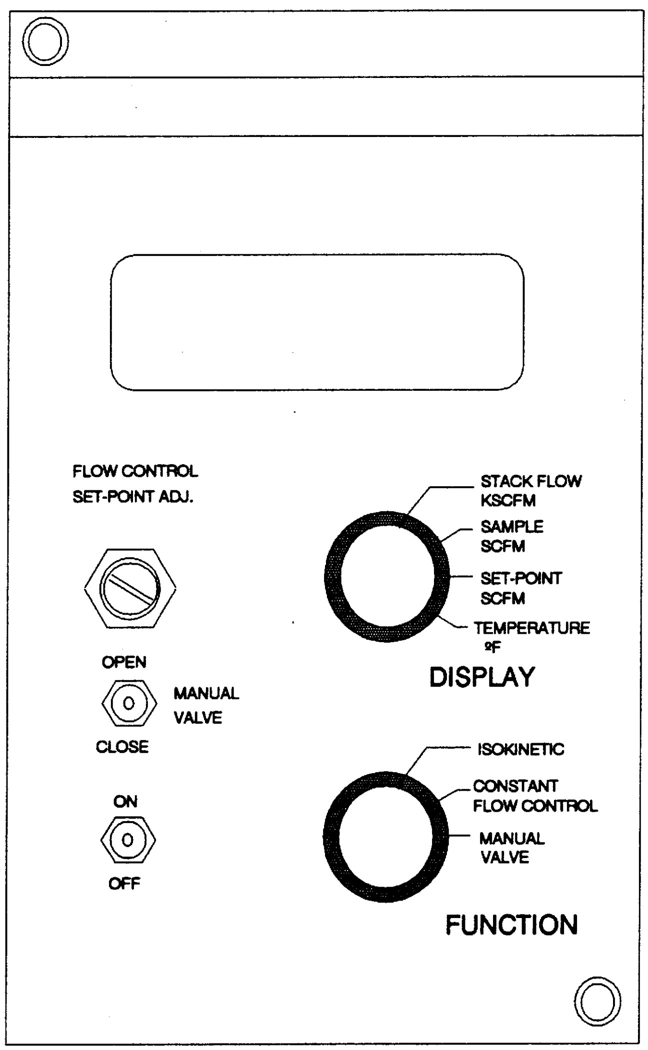
DISPLAY Select Switch

FUNCTION Select Switch

MANUAL VALVE OPEN/CLOSE Switch

SET-POINT ADJ. Locking Potentiometer

Figure 3-4. *Operator Controls on the Front Panel of the 710 Module*



3.5.1 The DISPLAY Select Switch

The DISPLAY select switch allows you to choose the type of reading that is displayed on the LCD display. Depending on the switch position, the LCD display indicates:

1.) the total stack flow rate in KSCFM (Standard Cubic Feet per Minute x 1000)

2.) the sample flow rate in SCFM

3.) the internal set-point flow rate in SCFM (if used)

4.) the stack temperature in °F (degrees Fahrenheit)

Normally the DISPLAY select will be set to SAMPLE SCFM. The reading displayed is the sample flow rate as measured by the 450 or 505 Sample Flow Meter. Because the flow meter is directly upstream of the flow control valve, the reading displayed is the actual flow rate of sample extracted from the stack or duct.

When the DISPLAY switch is set to the STACK FLOW KSCFM position, the LCD display provides a flow reading derived from the measurements of the velocity sensors. The value is displayed in Standard Cubic Feet per Minute x 1000 and represents the current flow through the stack or duct.

When the DISPLAY switch is set to SET-POINT SCFM, the internal setpoint of the 4200 system is displayed. The internal setpoint is set by the SET-POINT ADJ. locking potentiometer and can be used to determine the sample rate. When the FUNCTION switch is set to "Constant Flow Control" the 4200 system is operated non-isokinetically and the sample rate is determined by the internal setpoint instead of the stack velocity as measured by the velocity sensors.

If the 4200 system includes a triple-sting sensor that measures both velocity and temperature, the temperature can be displayed by turning the DISPLAY switch to TEMPERATURE °F. If your system does not contain the optional temperature sensor the TEMPERATURE °F selection is locked-out.

3.5.2 The FUNCTION Select Switch

The FUNCTION switch selects the source of the signal used to open or close the valve. The valve can be controlled by three sources:

1.) the error signal generated by comparing the output signal from IK-EVA's velocity sensors to the output signal from the 450 or 505 Sample Flow Meter

2.) the error signal generated by comparing the 4200's internal setpoint reference signal to the 450 or 505 flow meter's output signal

3.) the MANUAL VALVE OPEN/CLOSE momentary toggle switch

The 710 controls the sample rate by controlling the opening or closing of the 730-Series valve. Typically, the 710 accepts the 0-5 Vdc (or optional 4-20 mA) output signal from the 450 or 505 Flow Meter, compares it to a reference setpoint, and generates a +15 Vdc or -15 Vdc error signal that opens or closes, respectively, the valve. Alternatively, the valve can be opened or closed manually.

When the FUNCTION select switch is set to ISOKINETIC, the setpoint reference signal that is compared to the sample flow meter's output signal is generated from sensor electronics. The reference setpoint in this case is the averaged and linearized output signal from the meter in the ADAM module that represents the flow rate in the stack as measured by the sensors in the K-BARs. When the FUNCTION switch is set to ISOKINETIC the sample rate is proportional to the stack or duct velocity.

When the FUNCTION select switch is set to CONSTANT FLOW CONTROL the valve is controlled using the 4200's internal setpoint reference signal as set by the SET-POINT ADJ. potentiometer. When operated in this manner the sample is drawn at a constant rate and the system is **not** sampling isokinetically. To display the constant flow rate, as set by the SET-POINT ADJ. potentiometer, turn the DISPLAY switch to SET-POINT SCFM.

When the FUNCTION select switch is set to MANUAL VALVE the 730-Series Flow Control Valve can only be opened or closed manually using the MANUAL VALVE momentary toggle OPEN/CLOSE switch described in the next subsection.

3.5.3 The MANUAL VALVE OPEN/CLOSE Switch

This switch allows the operator to manually open or close the flow control valve to the degree proportional to how long the operator holds the switch to the open or closed position. Motor speed is typically 30 seconds from full open to full close although other speeds may have been specified on your order. The FUNCTION select switch must be set to MANUAL VALVE to use this switch. In most cases you will want to have the DISPLAY select switch set to SAMPLE SCFM so that you can monitor the changing sample rate when you are opening or closing the valve manually.

3.5.4 The SET-POINT ADJ. Locking Potentiometer

This locking potentiometer allows you to adjust the 4200's internal setpoint reference signal. This 10-turn potentiometer trims the supplied 0-5 Vdc (or optional 4-20 mA) setpoint signal to the level by which the 450's signal output signal will be compared. When adjusting the SET-POINT ADJ. potentiometer the DISPLAY switch should be set to SET-POINT SCFM to monitor the setpoint rate.

3.6 System Verification

The following procedures may also be used to verify operation.

1. Place the ADAM back into the executive state by pressing the C-key until the automatic display loop is executed. Press the D-key to see execute the display routine. Continue to press the D-key until all flow data about meter #1 has been displayed or press the C-key to select another meter. Verify the readings on a selection of meters.

2. If the system appears to be averaging correctly and the flow rate is what you would expect, turn the DISPLAY switch on the 710 module to STACK FLOW KSCFM. The reading on the 710 module should be equivalent to the flow rate displayed for the meter representing the average velocity in the duct or stack . Keep in mind that the 710 is displaying the velocity rate in KSCFM (SCFM X 1000) while the ADAM module may display the flow rates in SCFM or other engineering units

6. Next, turn the DISPLAY switch on the 710 module to SET-POINT SCFM and turn the FUNCTION switch to CONSTANT FLOW CONTROL. Make note of the setpoint flow rate displayed by the 710 module. Then turn the SET-POINT ADJ. potentiometer. Verify that the constant sample flow rate displayed by the 710 module varies up and down in response to the adjustments made to the SET-POINT ADJ. potentiometer.

   Return the SET-POINT ADJ. potentiometer to its original position so that the setpoint flow rate displayed by the 710 module is as originally set or adjust it to your system requirements. This is the constant rate at which the sample is drawn when the system is operated under constant flow control.

7. Next, turn the DISPLAY switch on the 710 module to SAMPLE SCFM and turn the FUNCTION switch to MANUAL VALVE. Open and close the valve using the MANUAL VALVE OPEN/CLOSE Switch. Verify that the sample flow rate displayed by the 710 module varies up and down in response to the manual opening and closing of the valve. Return the FUNCTION switch to ISOKINETIC.

8. If you have an optional temperature sensor in the system turn the DISPLAY switch on the 710 module to TEMPERATURE °F. Verify that the temperature is displayed.

9. To return the system back to normal isokinetic operation, return the DISPLAY switch on the 710 module to SAMPLE SCFM. The FUNCTION switch on the 710 module should be set to ISOKINETIC.

3.7 Calculating Actual Flow

For most air-flow monitoring applications, the **mass** of the flowing gas is the relevant variable. The Kurz sensors were designed with this fact in mind. Each sensor accurately registers mass flow at any temperature and pressure. Its output is therefore calibrated in standard units.

Those units are referenced to a standard temperature of 25° C (77° F) and standard atmospheric pressure of 760 mm (29.92 inches) of mercury. A flow reading obtained for air at a different temperature and/or pressure will not be the actual volumetric flow of that air.

Generally, standard flow is a much more useful measurement than actual flow. Sometimes, however, you may want to calculate the **actual** flow of an airflow whose temperature or pressure differs significantly from the standard temperature and pressure.

The formula for deriving actual flow from indicated flow is given below:

$$F_{act} = F_{ind} \frac{d_s}{d_a}$$

where:

d_s = Standard air density (25° C; 760 mm Hg).

d_a = Actual air density at local temperature and barometric pressure.

F_{act} = Actual air flow in cubic feet per minute.

F_{ind} = Indicated flow in standard cubic feet per minute.

Section 4: Programming the ADAM

4.1 Overview of the Program Mode

To enter the Program Mode, press the P-key when the system is in the Executive Mode. The system then prompts you for an access code. If you enter the access code correctly, the system enters the program mode and displays the first of a series of program menu choices. At this point, you can cycle through the program menu choices. Drawing 340268 (2 pages) provides a state diagram showing all the various program modes. These drawings can be found in Appendix A.

The following program menu choices are available:

1. Reset the stack flow totalizer to zero
2. Set the system time and date
3. Set log interval (time that meter data is logged to printer)
4. Set the meter data
5. Set the digital filter size
6. Set the analog out
7. Set the alarms
8. Set channel kickout
9. Read input volts
10. Calibrate the system (technician-level access only)
11. Linearize the system (technician-level access only)

Once the system is in program mode, you can cycle through these menu choices by pressing the P-key. When you reach the program menu choice you want, press the E-key. The key selections for the ADAM keypad and for the terminal and PC are repeated in Table 4-1.

Table 4-1. *Key Functions/Keypad and Keyboard Keys*

Key Function	ADAM Keys	Standard ASCII Keys
Program Key - Allows the operator (with proper access code) to program the ADAM. Section 4 provides information on programming the ADAM.	P	P
Display Key - Calls the ADAM's meter display routine. LCD displays the meter ID, time and date, flowrate, totalized flow and elapsed time, average velocity, calibration factor, flow area, and averaged channels.	D	D
Log Key - Sends data to a terminal port and the printer	L	L
Enter Key - Used in Program Mode to enter setup variables for the ADAM module	E	{CR}
Hold Key - Holds current display until the Clear Key is pressed	H	H
Up-Arrow/Yes Key - Used to access items within a list, from the first selection toward the last selection in the list	^ Yes	^
Down-Arrow/No Key - Used to access items within a list, from the last selection back toward the first selection in the list	V No	V
Clear Key - Returns the operator to the entry point of the routine just cleared	C	C
Hypen Key - Used for operator text entry	-	-
Period Key - Used for operator text entry	.	.
Number Keys 0-9 - Used for operator text entry	0-9	0-9

On the ADAM keyboard the "ENTER"-key is marked as "E". The key used as the "ENTER"-key on a terminal or PC may differ from one terminal or PC keyboard to another. Refer to the terminal or PC user's manual for the location of the terminal or PC key used for the "Carriage Return" {CR}. After you have pressed the appropriate "ENTER"-key, you can perform the appropriate action for that choice as described in the subsections below.

Note: When system variables are changed the message "NEW VALUE ACCEPTED" is displayed. At any time while you are cycling through the program menu choices, you can leave the program mode and return to the executive state by pressing "C" ("CLEAR").

4.2 Entering the Access Code

When you press the P-key to put the system into program mode, the system prompts you for an access code. Using the keypad, enter the 6-digit access code. Each digit you enter appears on the display as 'X.' If you make a mistake, you can press the C-key to start over.

If the access code entered is correct, the system enters the program mode and displays the first program menu choice. If the access code entered is not correct, the system displays the following error message for two seconds: "INVALID CODE." When the error message is no longer displayed, you can try to enter the access code again.

4.2.1 Levels of Access

There are two levels of customer access: user access and technician access. Those with user-access have access to all program choices except those that change the calibration and linearization variables. If the technician-level access code is entered, the user has access to all system variables, including access to calibration and linearization variables.

Figure 4-1a. *Program Mode State Diagram # 1*

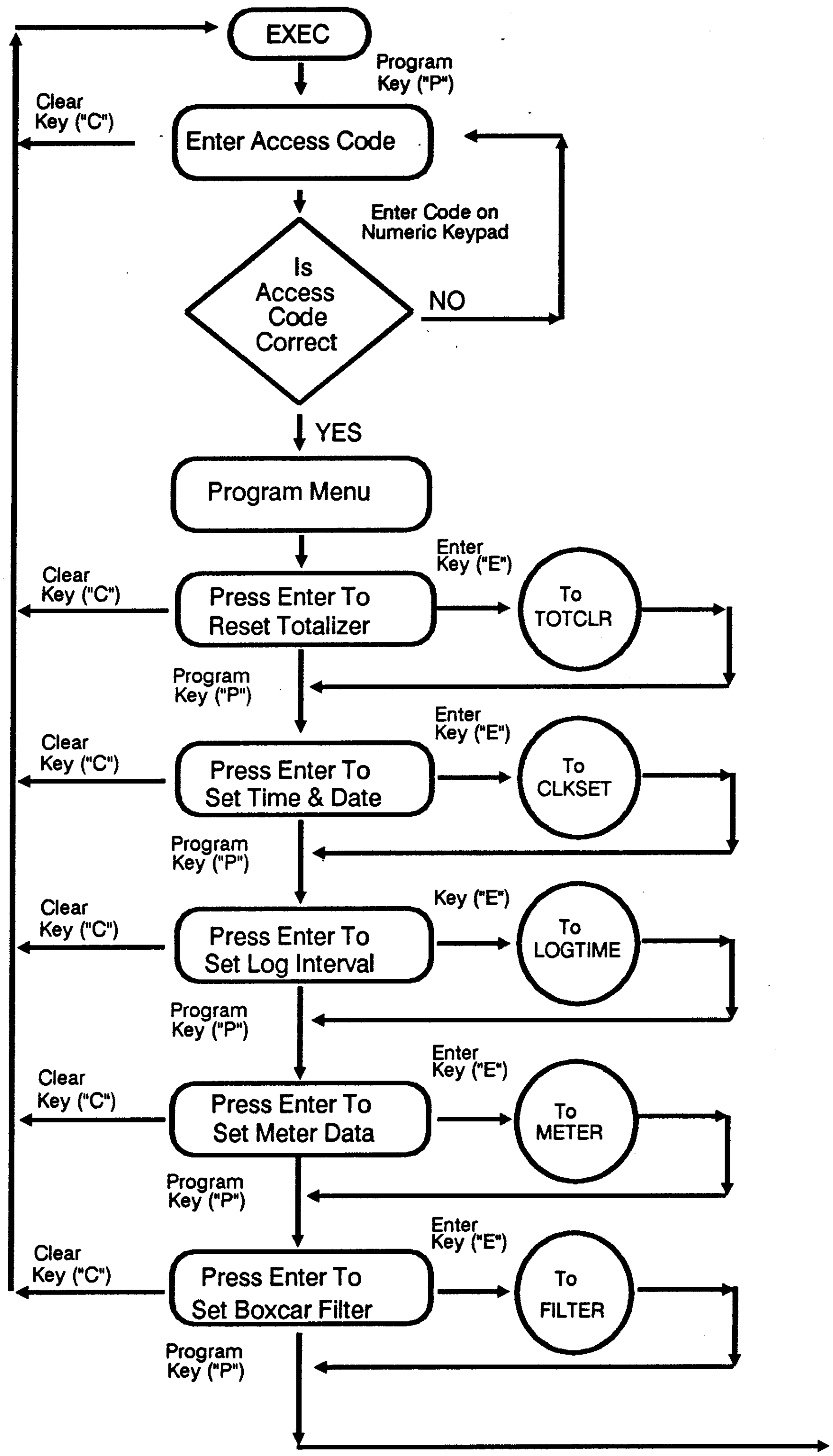
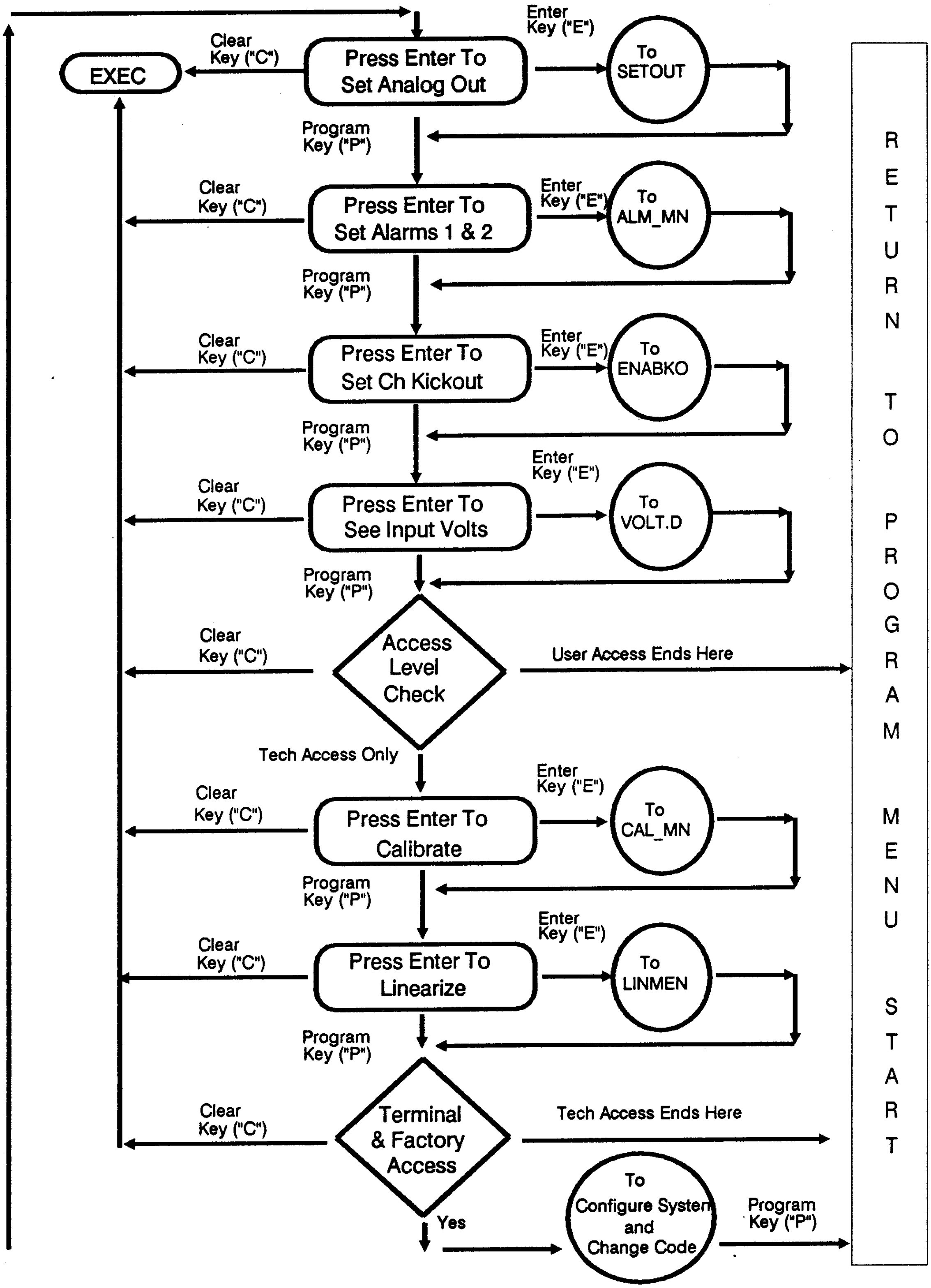


Figure 4-1b. *Program Mode State Diagram # 2*

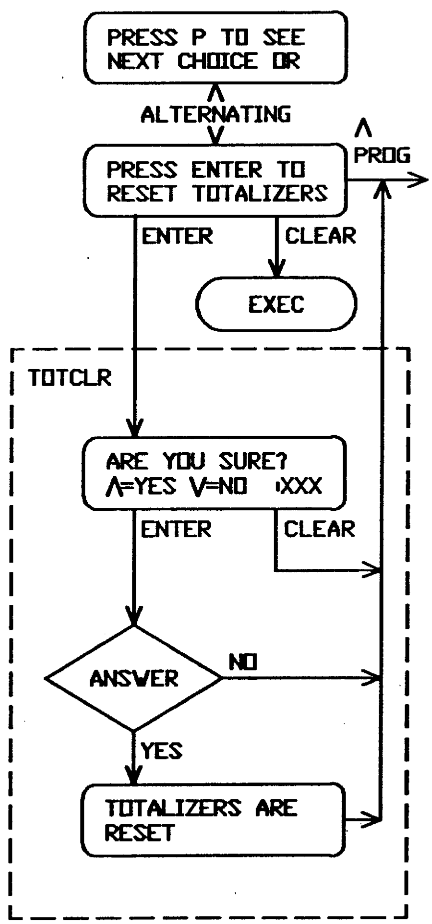


4.3 Resetting the Flow Totalizer

After you have pressed the P-key to enter the program mode and have entered a valid access code, the message "PRESS P TO SEE NEXT CHOICE OR PRESS ENTER TO RESET TOTALIZER" is displayed. If you press the E-key the message "ARE YOU SURE?" is displayed. To answer yes, press the YES/UP-ARROW-key, then press the E-key. The totalizer timer begins timing when the E-key has been pressed. If you do not want to reset the totalizer, press the NO/DOWN- ARROW-key, then press the E-key.

A state diagram of the program that resets the totalizer is provided in Figure 4-2.

Figure 4-2. *State Diagram of the Reset Totalizer Program*



4.4 Setting the System Time and Date

When you select this program menu choice, the system time of day is displayed in the following form: hh:mm mm/dd/yy. Although the time of day is displayed to the second, the system itself uses the time to the minute only. The system time of day is kept current with a battery-backed clock.

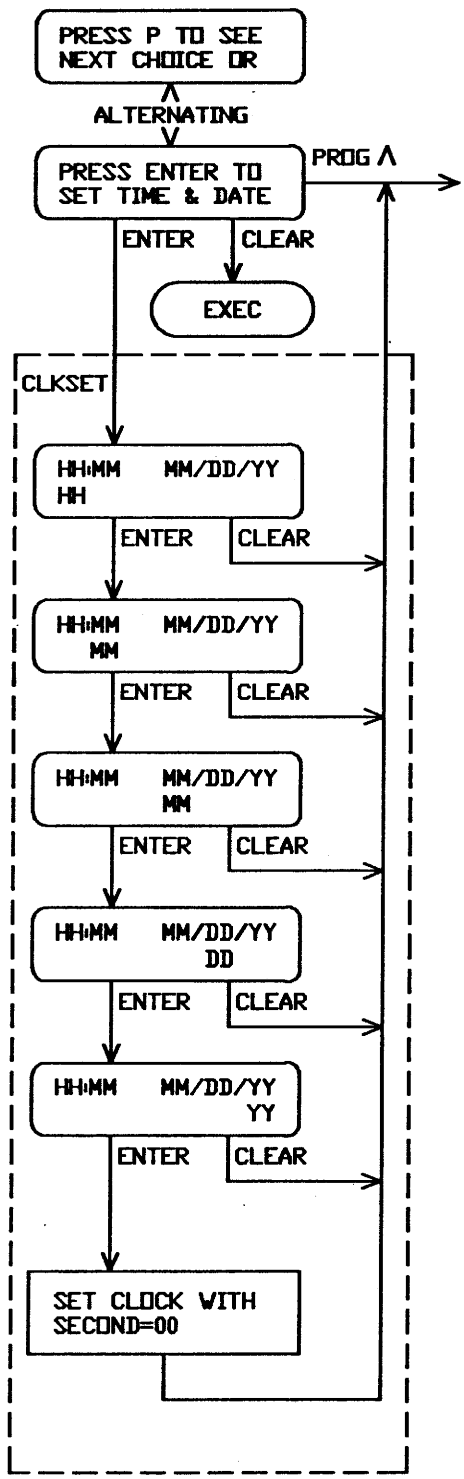
The state diagram of the program used to set the time and date is provided in Figure 4-3. To set any of the time and/or date values, you must set all time and date values, in the order in which they are displayed. Before any values have been changed; the top line will show the current value for time and date, and the bottom line will show the first digit of the current time being displayed.

Begin by entering a new value for the hours, or, if you do not want to change the value for the hours, press the E-key to go on to minutes. If you do change the hours value, the digits you key in are displayed below the old hours value. Press the E-key to enter the new hours value; this also updates the top line of the display.

Each time you press the E-key, you proceed to the next value in the time and date series. You can either keep the old value by pressing "E" or key in a new value and enter the change by pressing the E-key. The top line is not updated to reflect the change until you enter the new value.

Note: When the clock is reset, the seconds are set to 00. Therefore, if the time of day is critical down to the seconds in your application, be sure to press the E-key to enter the value for the year at precisely the beginning of the minute.

Figure 4-3. *State Diagram of the Set Time and Date Program*



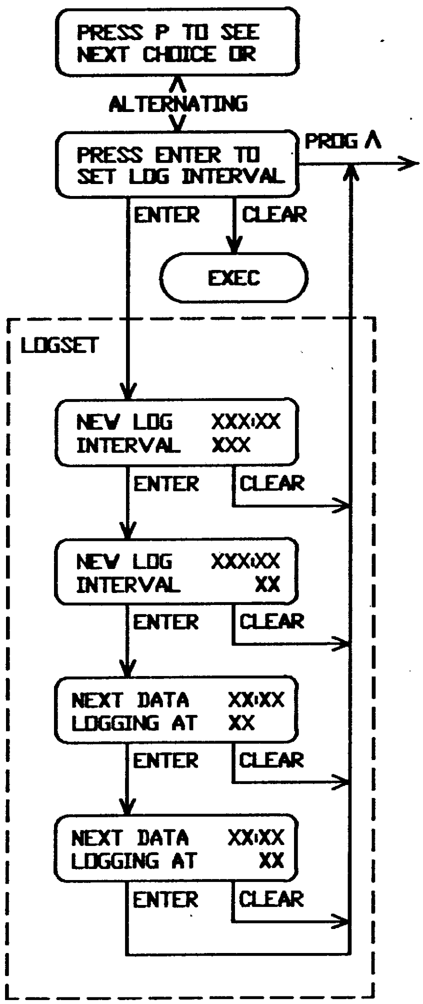
4.5 Setting the Log Intervals

The ADAM can be programmed to print the meter data to the printer at specified time intervals. The meter data is also output to a terminal or PC through the RS-232 port on the ADAM module. A state diagram of the program used to set the logging interval is shown in Figure 4-4.

To set the log interval, press the P-key until the display prompts you to "PRESS ENTER TO SET LOG INTERVAL". Press the ENTER key. The first display will show the current interval setting in hours and minutes. The time interval is set in two different entries, first the number of hours is entered then the number of minutes is entered. Type in the number of hours between each log interval then press the ENTER key. If you do not want to change the number of hours just press the ENTER-key without pressing any other keys. The display will show the current interval setting (including the new hour setting). Type in the number of minutes between each log interval (if you want a different setting) then press the ENTER key.

After you have entered the new log interval, the display will prompt you to set the hour and minute that the next data logging should occur. As with the time interval, the next data logging hour is entered first, then the logging time is set in minutes.

Figure 4-4. *State Diagram of the Set Log Interval Program*



4.6 Setting the Meter Data

Selecting this program menu allows you to generate or change the meter data in the display mode. The system will prompt you to select one of 12 meters. Use the YES/UP-ARROW-key and NO/DOWN-ARROW-key to cycle through the list of meters or enter a meter number with the numerical keys.

The state diagram for this program is provided in Figure 4-5.

4.6.1 Setting the Meter ID

Press the E-key for ENTER and the system will prompt you to assign a meter identification number. If there is no change, press the E-key. If there is a change; after inputing the new meter identification number; press the E-key.

4.6.2 Meter Assignment

After you have reviewed the meter ID, press the P-key. The system will enter a meter function list which allows you to assign the function of the meter. Use the YES/UP-ARROW-key and NO/DOWN -ARROW-key to cycle through the following four choices.

1. Insertion Flow Meter (Velocity)
2. In Line Flow Meter (Mass)
3. Temperature Meter
4. Sum Flow Meter

The ADAM can calculate flow measurements based on the sensor output from a 450 Insertion Flow Meter, a 505 In-Line Flow Meter, or from the outputs of the sensors in the K-BARs (Multiple-Array Insertion Flow Meter). Each sensor in the 4200 system is represented as an individual channel in the ADAM. Each of the 12 meters in the ADAM can represent the measurements of an individual sensor, the measurements of selected channels, or the sum of selected meters.

You can only display the following data input screens in sequence. To proceed from one display to the next, press the E-key.

IF you assign the meter as an Insertion Flow Meter, an In Line Flow Meter, or a Sum Flow Meter, the system will display a data input listing that will request the following:

1. Assign channels (for Insertion & In Line) or meters (Sum Flow).

   Press the E-key to advance through the list of channels or meters.

   If you have assigned the meter as an insertion or in-line flow meter, the channels in the system will be displayed

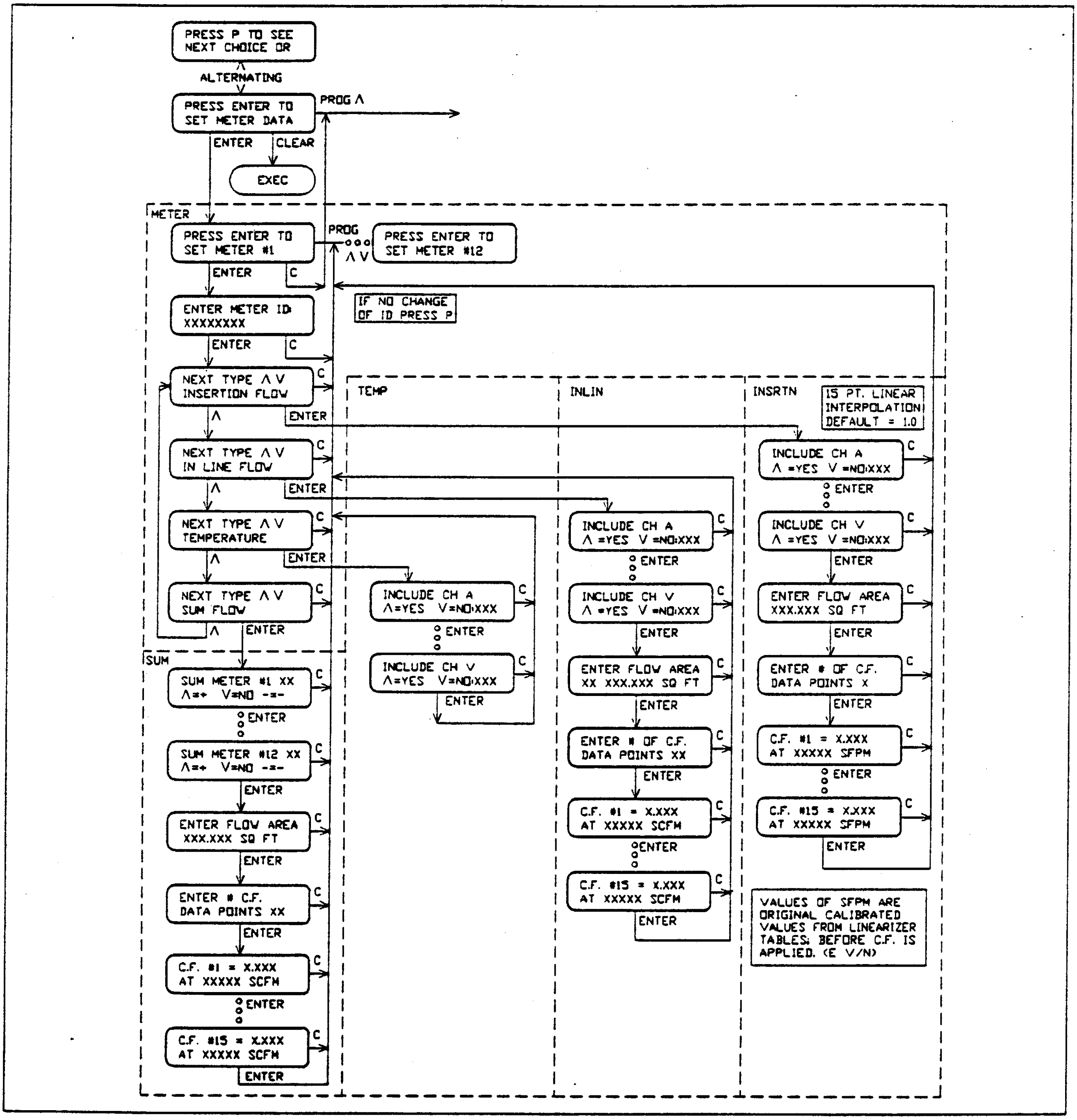
   Note: -For Insertion & In Line: your answer of "YES" or "NO" to channel will be displayed on the screen.
   -For Sum Flow: your answer of add (" + "), subtract ("-") or do not use this meter ("NO") will be displayed on the screen.
   Use the corresponding keys:
   " + " = YES\UP-ARROW-Key
   "-" = HYPEN-Key
   "NO" = NO\DOWN-ARROW-Key

2. Flow area in square feet.

3. Number of Calibration Factors used to adjust the meter's readings at various flow rates. There are up to 15 points possible for digital linearization using second order Lagrangian interpolations. Valid inputs are 1-15; the default is 1.

4. Calibration Factor (correction factor) at a given SCFM or SFPM (standard cubic feet per minute or standard feet per minute). Valid entries are values ranging from 0.001 to 9.999; the default value is 1.000 at 0 flow. Press the ENTER-key to advance or utilize the needed number of configuration factor screens.

Figure 4-5. *State Diagram of the Set Meter Data Program*



IF you assign the meter as a Temperature Meter, the system will display a screen requesting which channels are to be assigned to this meter. **Note:** Press the E-key to advance through the list of channels. Your answer of "YES" or "NO" to each channel will be displayed on the screen.

Reminder: for all data inputed, press the E-key to enter the data before pressing the C-key to exit the display. If the E-key is not pressed, the value will not be changed.

After exiting a display by pressing "C", the system will return to the meter list. Press "C" again to exit the program.

4.7 Setting the Digital Boxcar Filter Size

The analog inputs to the ADAM are filtered using a digital filtering algorithm known as a "boxcar filter." This algorithm works by taking the average of the last several readings. The size of the digital filter is equal to the number of readings to be averaged. Thus, when you set the digital filter size, you are determining how many readings will be averaged for each channel.

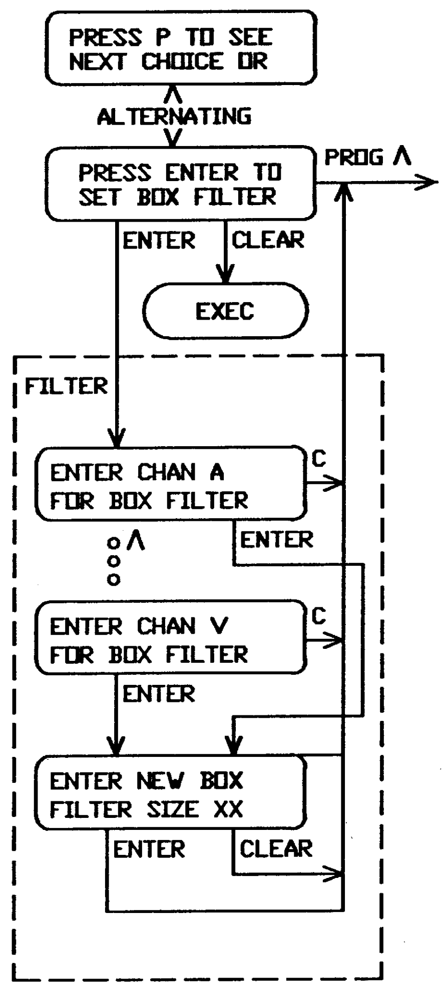
Averaging over a large number of readings is analogous to putting a large filter capacitor on the input. Averaging over a large number of readings slows down the system response because there is a 2.2 second time period between the reads of each channel. Averaging over a small number of readings can make the system susceptible to transient pulses.

The state diagram for this routine is shown in Figure 4-6. When you select this program menu choice, the system prompts you to select a channel. The channel listing can only be displayed in sequence. Use the YES/UP-ARROW-key and the NO/DOWN-ARROW-key to cycle through the channel list.

Press the E-key to enter the selected channel. The system will then prompt you to enter the boxcar filter size (i.e., the number of readings from a filtered input that will be averaged; allowable range 1 to 16). Key in the value, then press "E" to enter the value. (The value most commonly set to is 4, which is also the default condition.)

Note: After entering the boxcar filter size and pressing "E", the system will return you to the channel listing except after entering the last channel's boxcar filter size. Pressing "E" will then return you to the program menu.

Figure 4-6. *State Diagram of the Set Boxcar Filter Program*



4.8 Selecting the Analog Output

The ADAM has eight analog output channels. Each one can output a linear 0-5 Vdc signal which can be programmed to represent one of the following choices:

1. average velocity
2. flow rate
3. temperature

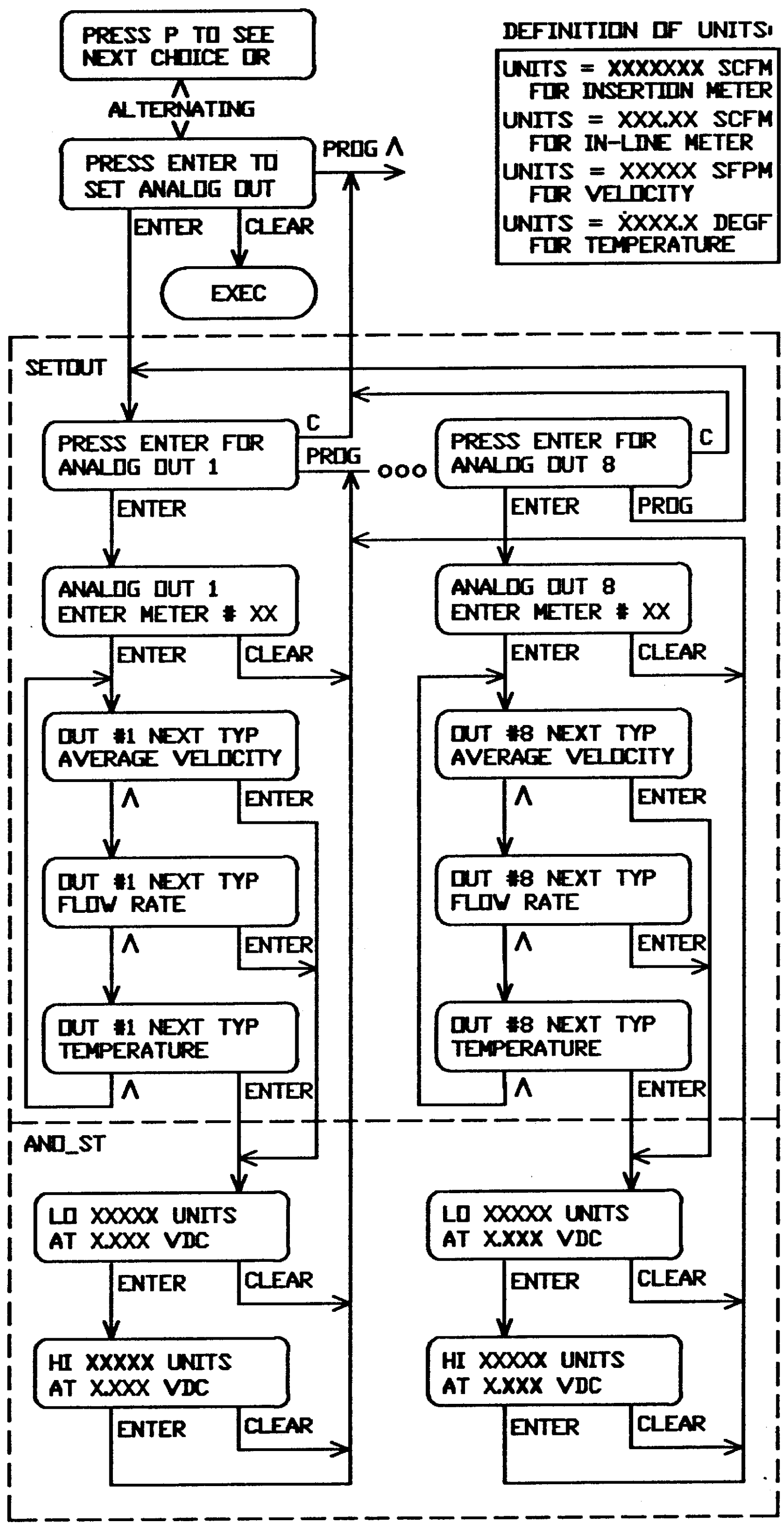
The state diagram for this routine is shown on the next page in Figure 4-7.

Upon selecting this program, the system will put you in an analog out listing. Select one of the eight analog outputs and press "E". The system will now prompt you to assign a meter to your selected analog. Key in the desired meter and the screen will display the value. Press "E" to enter. The system will prompt you to assign the analog a function to represent (the three choices are listed above). Press the YES/UP-ARROW-key to cycle through the list. When the selection shown on the display is the one you want converted to the analog output signal, press the E-key.

Next, the program will then prompt you to set the low and high limits and the corresponding voltages for these limits. After typing the value, press the "E" key. For example, if the average velocity through a stack will be in the range of 200 to 12,000 SFPM you might set the low limit at 200 SFPM ("ENTER") with a voltage representation of 1.000 Vdc ("ENTER") and a high limit of 12,000 SFPM ("ENTER") with a voltage representation of 5.000 Vdc ("ENTER").

If the system is programmed this way, the output signal will be a 1.000 to 5.000 Vdc linear representation of the average velocity representing a flow range of 200 to 12,000 SFPM. When the average velocity measured by the ADAM is 200 SFPM, a 1.000 Vdc signal will be output. When the average velocity is 5900 SFPM (half way in the range of 200-12,000 SFPM) the output signal will be 3.000 Vdc (half way between 1.000 and 5.000 Vdc). If the flow is 12,000, a 5.000 Vdc signal will be output.

Figure 4-7. *State Diagram of the Set Analog Output Program*



4.9 Setting the Alarms

There are 16 alarms, but alarm #1 is assigned as the alarm for Global Kickout, leaving 15 independent alarms to be activated by specified flow conditions. You can set each alarm to be activated by:

1. a flow rate that is higher or lower than a high or low setpoint
2. a velocity reading that is higher or lower than a high or low setpoint
3 a temperature that is higher or lower than a high or low setpoint
4. a channel kickout (the occurance of any channel being removed from the average because it is higher or lower than a specified range)
5. a non-isokinetic condition

The state diagram for the set alarms program is shown in Figure 4-8.

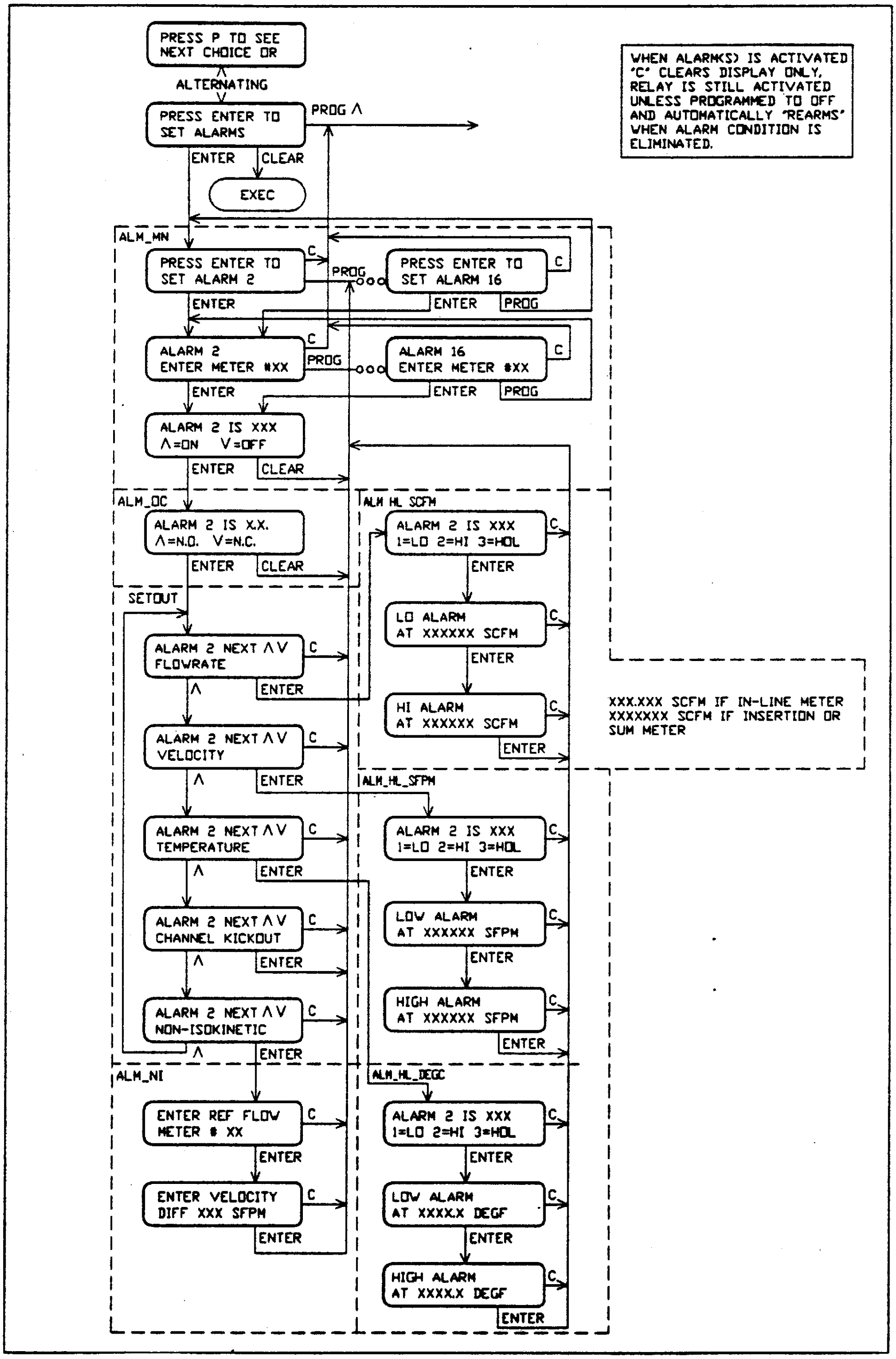
The alarms may have been preset at the factory before shipment. If so the alarm conditions have been indicated on the Unit Description Sheet in the front of this manual.

After entering this program, the system will prompt you to select an alarm (#2 to 16). Select your alarm and press the E-key. Your next system prompt will be to assign a meter to the alarm. Key in the desired meter. The screen will display the entered meter number and ask if you wish the alarm to be turned on or off. Key in your choice and press "E".

You will now be prompted to set the alarm relay as normally open (N.O.) or closed (N.C.). Each alarm can be independently used as a normally open (NO) or normally closed (NC) relay. Refer to the field wiring diagrams in Appendix A for the location of the output terminals used to connect external devices to the alarm relay contacts.

After you have keyed in and entered your relay choice, the system will display a list of flow conditions (see listing above) for you to assign to the alarm. Use the YES/UP-ARROW-key and NO/DOWN -ARROW- key to cycle through the list. Select the condition in which the alarm is to be activated by pressing the E-key when the appropriate selection is displayed.

Figure 4-8. *State Diagram of the Set Alarms Program*



IF you select "flowrate", "velocity" or "temperature" and entered your choice by pressing "E"; you will now be prompted to assign values to the alarm (High, Low or High Or Low alarm). Key in your choice and press "E".

Now set the alarm's threshold. If set as a Low alarm, the alarm will be activated when flow equals or is less than the alarm setpoint. If set as a High alarm, the alarm will be activated when flow equals or is greater than the alarm setpoint. For a High or Low alarm, the alarm will be activated when flow is greater than or less than the alarm setpoint.

IF you select "channel kickout", press "E" to enter and the system will return you to the alarm selection list (#2 to 16). You would be designating an alarm for a meter versas Global Kickout as described in next subsection. For more information on channel kickout, refer to next subsection 4.9.

IF you select "non-isokinetic", press "E" and you will be prompted to enter a reference flow meter and a velocity difference for the two meters.

Note: When an alarm is activiated, pressing "C" will clear the display, but not the alarm. The alarm will be "rearmed" when the fault condition is corrected. The alarm can also be programmed "off" until the fault is corrected.

4.10 Setting the Channel Kickout

Setting the channel kickout allows you to remove from the average any sensor reading that may be out of range because of a bad sensor. If the readings from a channel are higher or lower than a selected percentage of full scale, the reading(s) from the channel(s) will be removed from the averaging procedure.

A state diagram of this program is provided in Figure 4-9.

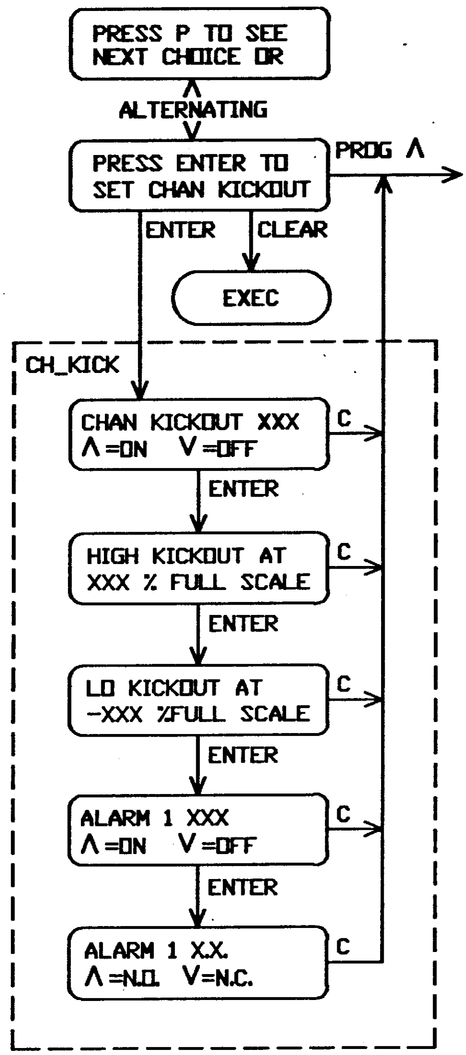
Upon entering this program, the system will prompt you to turn the channel kickout "on" or "off". After entering your choice by pressing "E", the system will ask for the value for the high kickout (percentage of full scale). Key in the value and enter. Next, the system will prompt you for the value of the low kickout. Again key in the value and enter.

The full scale to which your system has been calibrated in SFPM, SCFM or DEGF is indicated on the Unit Description Sheet in the front of this manual.

Alarm #1 has been pre-designated as Global Kickout which "kicks out" any of possible 22 sensors, who's readings are higher or lower than the selected percentage of full scale.

Now the system will prompt you to select the alarm to be turned on or off. Key in your selection and press "E". A display will ask if you want the alarm relay to be normally open (N.O.) or normally closed (N.C.). Key in your selection and at this point press "C" to return to the program menu.

Figure 4-9. *State Diagram of the Set Channel Kickout Program*



4.11 Displaying the Input Volts of Each Channel

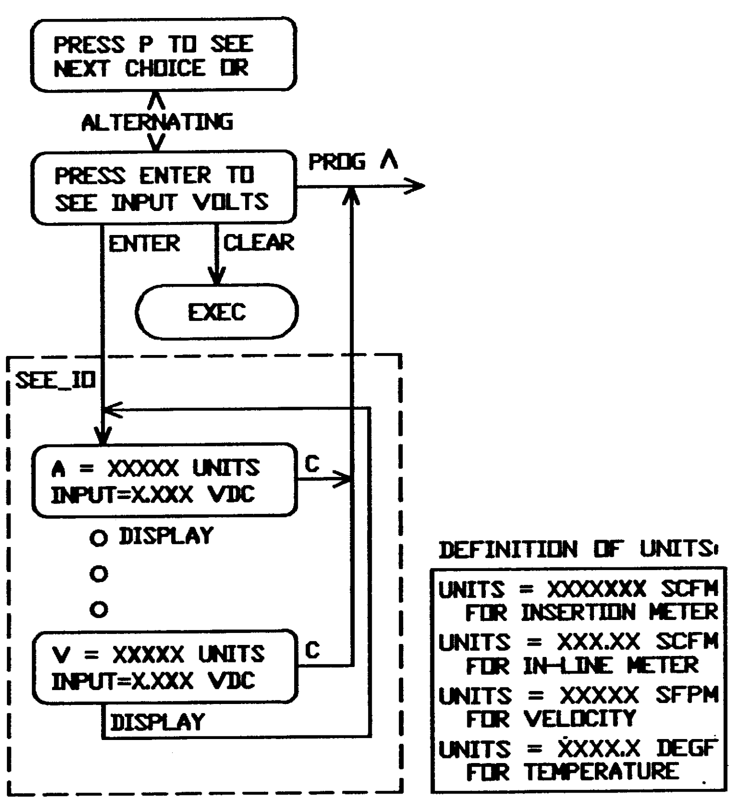
When you select this program menu choice, the system displays the input voltage for each of the 22 channels . This input voltage is derived from the return signal transmitted from the sensor's corresponding current-transmitter board. Typical values range from 0.6 to 2.6 Vdc.

The state diagram of the *See Input Volts* program is provided in Figure 4-10 below.

The screen will display the actual units (SCFM, SFPM or DEGF) for each channel as set by linearization and each channel's input in Vdc.

Press the D-key repeatedly or use the YES/UP-ARROW and NO/DOWN-ARROW keys to cycle through the sequential input voltage display for each channel. After all the channels are displayed, press "C" to exit back to the program menu.

Figure 4-10. *State Diagram of the See Input Volts Program*



When you exit from the see input volts program:

If you entered a user-level access code, the system will return you to the first program menu choice and prompt you to press "P" or press "E" to reset the totalizer.

If you entered a technician-level or factory-level access code, the system proceeds to the calibrate and linearize programs. The procedures are described in the Series 155 ADAM Calibration and Linearization Manual.

End of Section 4

Section 5: Routine Maintenance and Testing

5.1 Routine Maintenance

The MetalClad sensor is virtually maintenance free. Experience has demonstrated the long-term stability of the calibrations performed on the system before shipment. However, in order to maintain NBS traceability on the instrument calibration, annual recalibrations are recommended.

- Cleaning of the sensors in the IK-BAR(s), as needed.
- Cleaning of the 450 or 505 sensor and flow body or splitter, as needed.
- Cleaning of the 730 valve, as needed.
- Verifying the output signals

5.1.1 Cleaning the Sensors and the Sample Flow Body

The relatively large size of the sensors used in the IK-BARs and 450 or 505 Sample Flow Meter render them resistant to particulate contamination in most applications. However, continuous use under extreme conditions may necessitate periodic cleaning of the sensors and the internal parts of the 505 flow body (or flow splitter). The sensors and flow body (or flow splitter) should be periodically examined every 90 days for typical applications. When the sensor is operating in particularly dirty or particle-laden environments, they should be checked every 30 days. If the system is operating in clean-air applications an inspection of the sensor every 180 days may be sufficient.

If the sensors and/or the flow body do need cleaning, flush the flow body and sensor with a any solvent you believe is effective in removing the contaminants. Make sure that power is off during cleaning. While the MetalClad sensor is rugged, it can be bent or broken by careless treatment. A bent sensor may develop a short and need to be replaced.

Some MetalClad sensors may have small specs of excess metal adhering to their stainless steel sheaths. This is normal and in no way degrades the performance of the system. Do not attempt to remove such specs; doing so may change the system's calibration.

5.1.2 Cleaning the Series 730 Valve

The 730 valve might require disassembly at some time to allow for cleaning, primarily the orifices from which the flow enters and exits. Smaller valves with smaller orifices will require cleaning sooner than larger valves. Also gas or air flows with some degree of contamination will cause the valve to be cleaned more frequently than a pure gas.

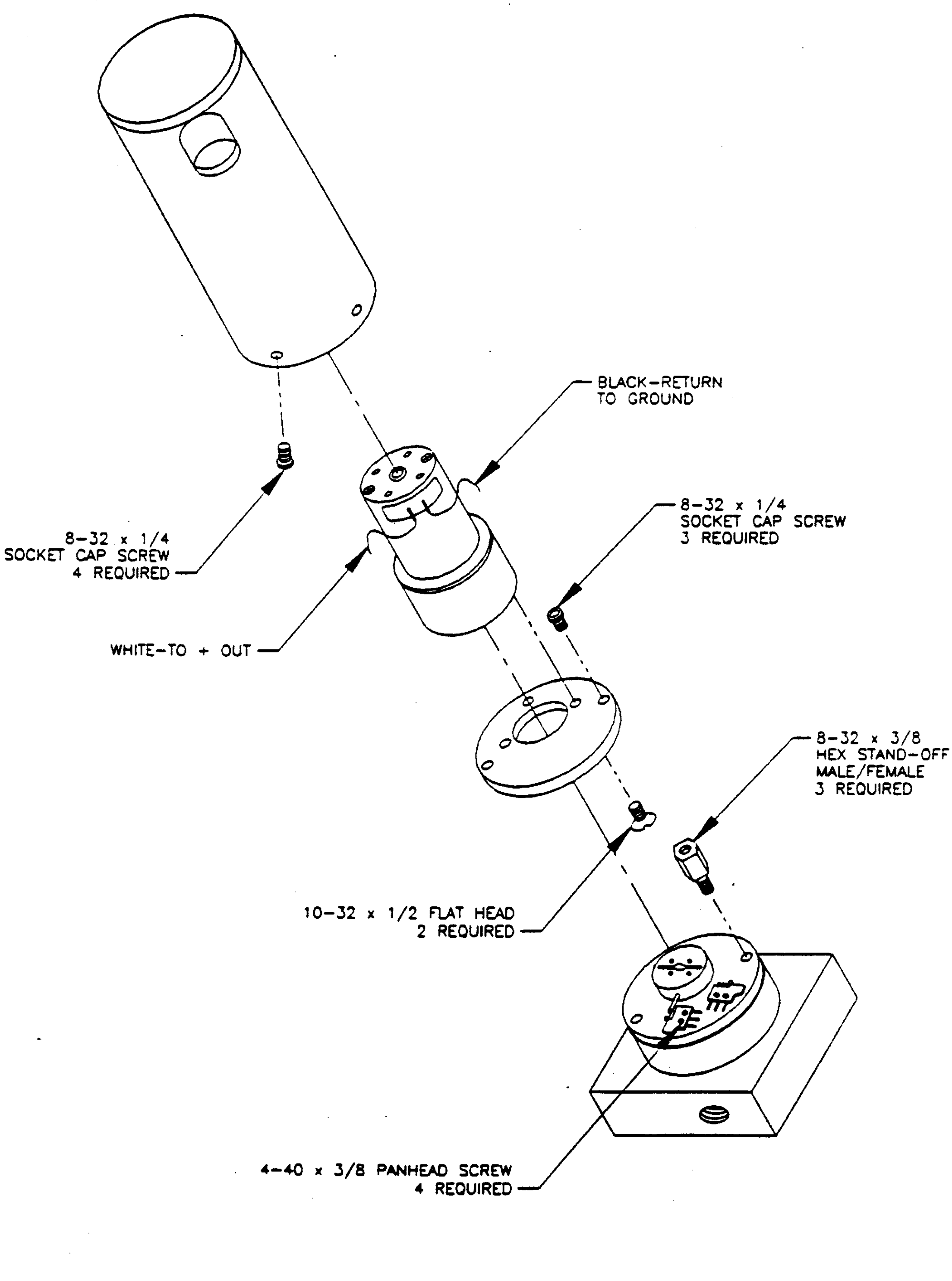
The valve orifices may be cleaned with any solvent indicated for used with the contaminant. After cleaning the valve, reassemble in the reverse order as described below.

Larger valves can be disassembled by removing the socket head cap screws that are placed around the largest diameter of the valve. This allows the valve rotor housing halves to be separated. With these type valves this should normally be the only disassembly required to allow access for maintenance and cleaning. If the 730 valve does not have an alignment mark or internal alignment pin, make sure to mark the position before disassembly in order that the valve rotor halves may be properly realigned upon reassembly.

To disassemble smaller valves refer to Figure 5-1. First remove the motor cover housing by removing the 4 socket cap screws placed around the base of the valve's motor cover housing. Before you remove the motor you will need to remove the motor lead wires. It may be helpful to mark the leads with a + or - to indicate how the wires should be reinstalled.

The motor can be removed by unscrewing 3 socket cap screws that mount the motor mounting base plate to the valve body. Next remove the 4 or more socket cap screws that hold the motor coupling/limit switch/bearing block and rotary disk assembly. Be careful not to lose the pressure assisted shutoff plug that fits into a machined opening in the face of the rotary ramp disk.

Figure 5-1. *Disassembly of the Series 730 Vlave*



5.2 Test Procedures - An Overview

If the data acquired by the ADAM does not look accurate to you we recommend that you perform the following checks. Most of the checks can be done using a portable digital voltmeter (DVM) accurate to 1/1000 and a watch accurate to the second. You may also need an ohmmeter to check switch contacts and other connections.

However, if the flow rates measured by the system do not appear accurate, the Kurz 4440 Portable Air Velocity Meter is also an excellent in-situ calibration tool. The 4440 is easy to use when comparing readings and verifying functionality of an IK-EVA sensor because the length of the probe extender allows the 4440 sensor to be positioned close to an IK-EVA sensor.

1. Review the installation procedures in Section 2 and verify that all interconnections have been made correctly.

2. Check the power supply outputs, described in subsection 5.3 below.

3. Check the test points on the 465 Current Transmitter Board as described in subsection 5.4.

4. Check the input voltage read for each channel using the Model 40 Field Calibrator and the *See Input Volts* program in the ADAM.

5.3 Power Supply Voltage Checks

Using a DVM, check the power supply ground bus and the +24 Vdc power supply.

5.3.1 Check the +24 Vdc

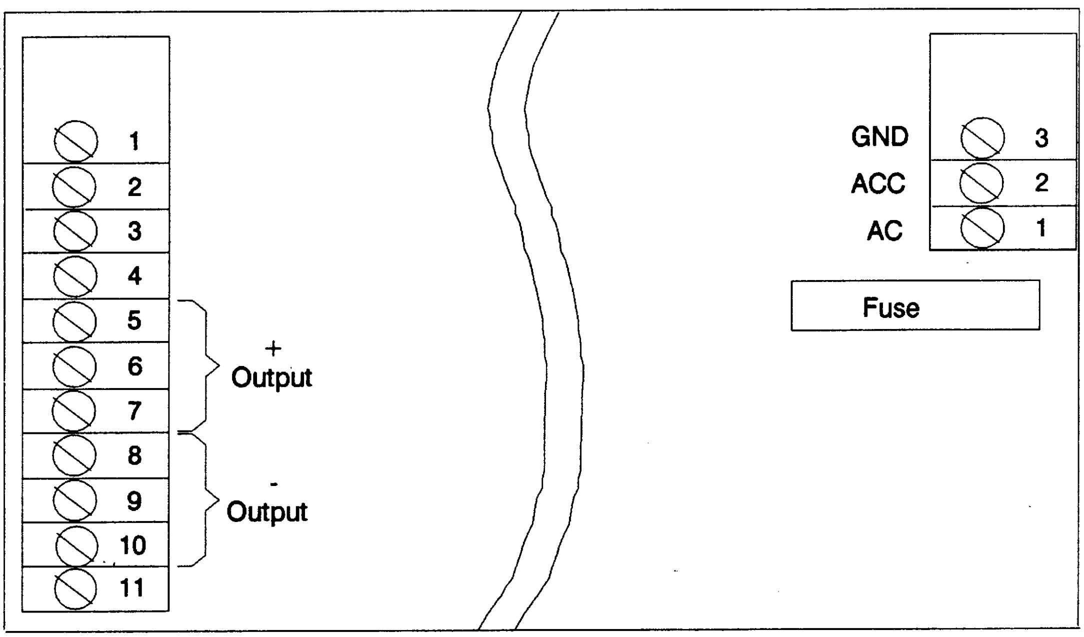
Step 1: With the power switch turned-on (up), check the voltage between a (+) terminal for any channel input and the 0-5 Vdc output ground (-) terminal in the 193 system enclosure. The meter should be measuring a voltage of +24 Vdc. In these signal are available on field terminal blocks in the 193 system enclosure. Refer to the interconnect wiring diagrams in Appendix A. Any terminal with a (+) next to the terminal represents a +24 Vdc connection.

Step 2: If the +24 Vdc is present, proceed to subsection 5.4

If the +24 Vdc supply is not present at any of the terminals, check the power supply as described in Step 3.

Step 3: Verify that a black wire is attached to the AC terminal on the power supply board and that a white wire is attached to the ACC terminal on the power supply board. Check for a +24 Vdc voltage between the (+) and (-) output terminals on the power supply board. The (+) output terminals are 5-7. The (-) output terminals are 8-10, as shown in Figure 5-2. Check the fuse on the board if these voltages are not present.

Figure 5-2. *Power Supply AC Terminals*



If the fuse is good, check the interconnections between the Series 191 AC terminal block and the AC terminal block in the 193 enclosure. Refer to the Field Wiring Diagram for the location of the AC terminal. Verify that power is present at these AC terminals.

5.4 Testing the Current-Transmitter Boards

The following procedures allow you to verify the operation of the 465R7 Current-Transmitter boards in the current-tranmitter enclosure. Before you perform the test, check to make sure that the following conditions are met:

- The five wires from each of the sensors are correctly connected to the correct field wiring terminals in the junction box associated with each KBAR and the 450. Refer to the wiring diagrams in Appendix A for information regarding the connections.

  Caution: The sensor wire connections to the 195 enclosure or to the terminal blocks inside the 193 System Enclosure should never be removed with power on. If you must remove these connections, make sure that the power is off.

  Because each sensor has been calibrated with the sensor cable attached to a specific current-transmitter board, the sensor cable wires should be wired as shown in the field wiring diagrams supplied with your system. If you have to remove these connections for any reason, each wire of the sensor cable should be labeled before removal to ensure that each wire can be reconnected to the same terminal.

- The wires exiting the terminal blocks in the junction box are properly connected to the correct terminals in Series 193 system enclosure. Refer to the field wiring diagrams in Appendix A for information regarding the connections.

- No flow is moving past the sensors.

- AC power is supplied to the system electronics enclosure.

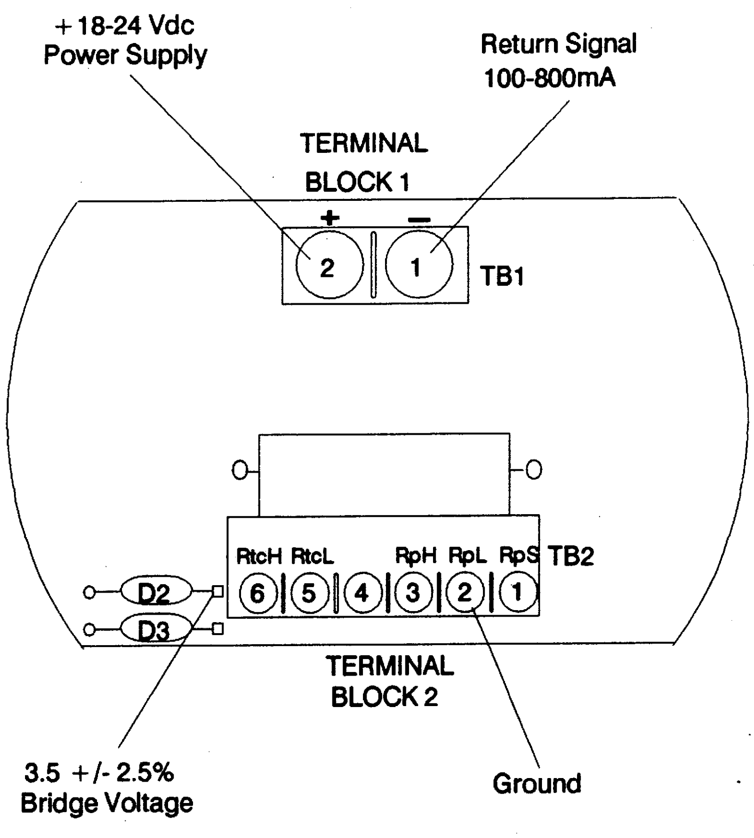
The 465R7 Current-Transmitter Boards does not have test points labeled on the board. You can, however, do some checks for proper supply voltages and sensor current. Refer to Figure 5-3 for the location of the points where the voltages and current can be measured.

Step 1. Check the Ground. Place the ground lead of a DVM to chassis ground. Place the positive lead on the DVM to terminal 2 on Terminal Block 2 (TB2-2, Gnd.). There should be no voltage measured between chassis ground the ground at TB2-2.

Step 2. Check the +24 Vdc Input. Place the negative or ground lead of the DVM on terminal 2 on TB2 (TB2-2, Gnd.). Place the positive lead of the DVM on terminal 2 of TB1 (TB1-2, +24 Vdc). The voltage should be +18-24 Vdc.

Step 3. Check the Bridge Voltage. Place the negative or ground lead of the DVM on terminal 2 on TB2 (TB2-2, Gnd.). Place the positive lead of the DVM on the leg of diode D2 closest to Terminal Block 2 (TB2). The voltage should be a minimum of 2.0 Vdc, typically +3.5 Vdc +/- 2.5%, and a maximum of 8 Vdc.

Figure 5-3. *Voltage and Current Check Points on the 465R7 Board*



CAUTION: If the bridge voltage is +5 Vdc or more (with no flow moving past the sensor), and the voltage does not start to drop below five volts within five to ten seconds, turn power off **immediately**. Supplying power for more than five to ten seconds under these conditions may result in damage to the probe.

Step 4. Check the Return Signal. Using a meter that can measure current, measure the amount of current at Terminal 1 of Terminal Block 1 (TB1-1, RET.). The current should be in the 100-600mA range, dependent on the amount of flow measured by the sensor.

5.5 Using the Model 40 Field Calibrator to Check the Input Voltages

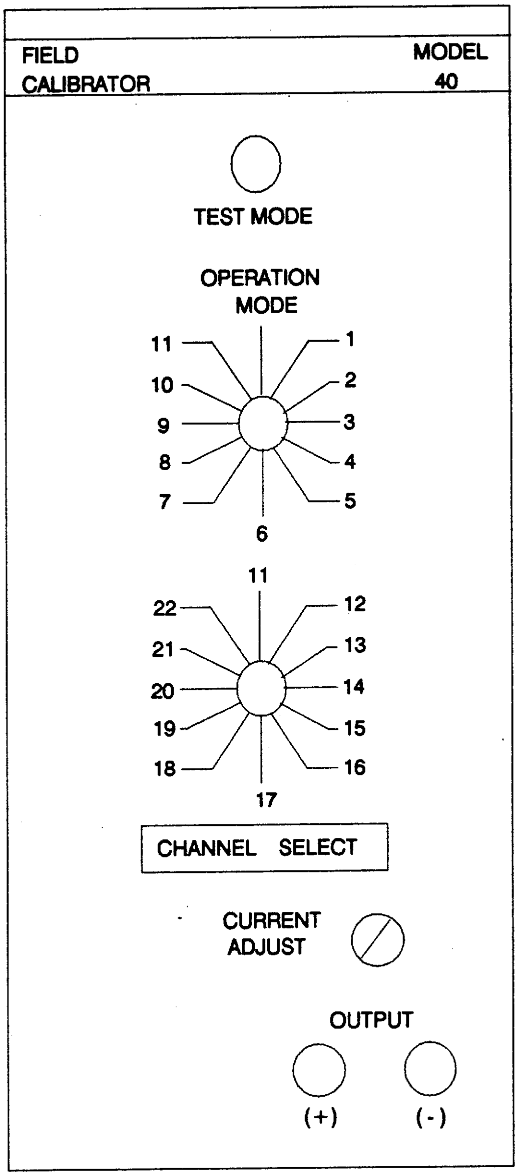
The ADAM runs a self-test when power to the IK-EVA system has been powered on. However, if the results displayed do not match the data you expect, the following procedures can help to identify certain potential problems.

NOTE: When the 4200 system is in operation, the top CHANNEL SELECT Switch on the front panel of Model 40 is set to OPERATION MODE. When this switch is turned from the OPERATION MODE selection, the 4200 is no longer functioning as an isokinetic sampling system.

The Model 40 can simulate the sensor signal for each of the 22 input channels in the ADAM. The CURRENT ADJUST potentiometer allows you to simulate and verify the readings for a wide range of flow conditions. To check channel A, you will need a digital multimeter or digital voltmeter (DMM or DVM) and the calibration sheets supplied with your system.

An illustration of the front panel of the Model 40 Field Calibrator is shown in Figure 5-4.

Figure 5-4. *Front Panel of the Model 40 Field Calibrator*



1. Turn the top SELECT Switch on the front panel of Model 40 to position 1.

2. Connect the leads of a digital multimeter (DMM) to the output jacks on the front panel of Model 40.

3. Adjust the CURRENT SENSE potentiometer on the front panel of the Model 40 so that the DMM indicates a voltage approximately equal to the first voltage listed in DC Voltage Crnt Sense column of the calibration sheet for channel A (#1). The voltages listed in the DC Voltage Crnt Sense column are the input voltages to the ADAM, derived from the electrical output from the 465 Current-Transmitter Board. The calibration sheet also indicates the velocity and mass flow measurements corresponding to the voltage inputs for the 14 calibration breakpoints. The first breakpoint is always at no flow.

   The calibration sheets are provided for each channel, according to the serial number of the sensor. Refer to Appendix D for a cross reference for the serial number to each channel number.

4. If the ADAM is in the executive mode, enter the program mode and execute the *See Input Volts* program. To do this press the P-key, enter your access code, and continue to press the P-key until the message "PRESS ENTER TO SEE INPUT VOLTS" is diplayed. Press the ENTER-key to see the input voltage for channel A.

5. Use the calibration sheets provided with the systems to verify the voltages and flow ranges for each of the calibration points. Make sure that you have adjusted the CURRENT SENSE potentiometer until the multimeter readout displays the voltage listed in the DC Voltage Current Sense column for 0 flow.

   The voltage displayed in the see input volts program should match that measured by the digital multimeter. There should be no flow at this first breakpoint.

6. Repeat this procedure for each breakpoint on each channel. Adjust the Model 40 potentiometer to the DC voltages listed on the calibration sheets. Compare the voltages and the flow measurements listed on the calibration sheet against the voltages and flow rate indicated by the *See Input Volts* program.

7. Turn the Model 40 channel selection swith to position 2 and press the D-key on the ADAM to see the input voltage on channel B (#2). Refer to the calibration sheet for the channel B sensor. Continue to check the breakpoint vlaues for channel B, then repeat the procedure for the nect channel.

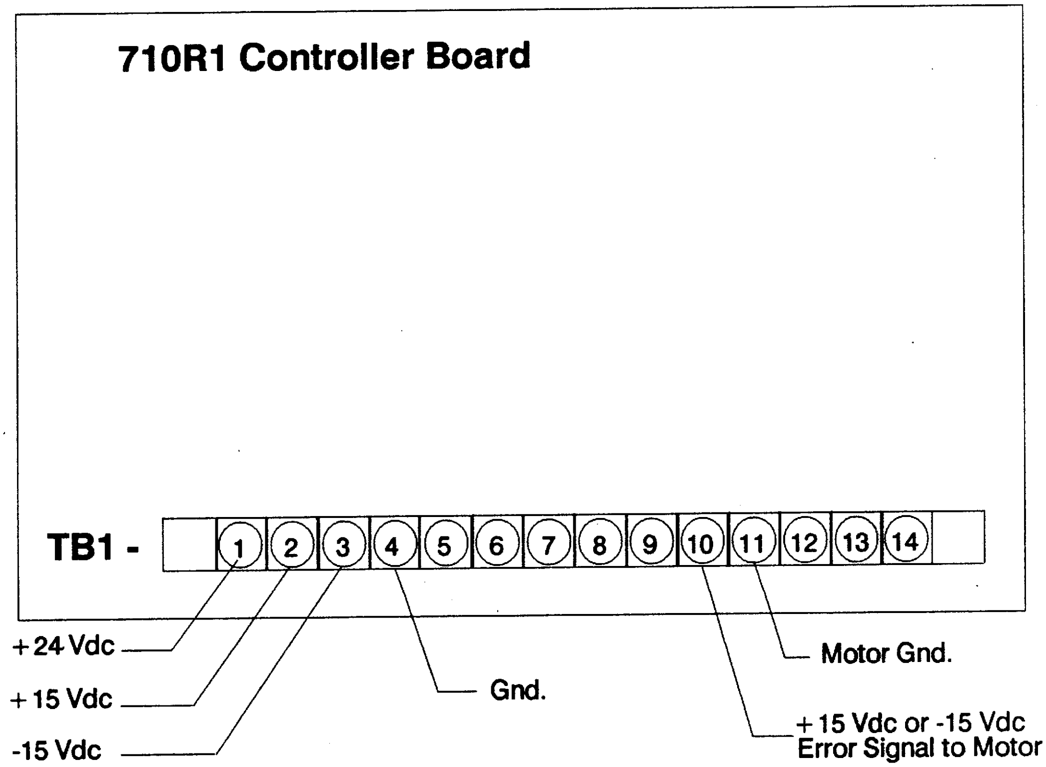
8. If the voltages and/or flow rates are not close to those listed on the calibration sheets, the ADAM may need to be recalibrated.

5.6 Testing the 710R1 Board

To perform the tests for the 710R1 board, you will need an ohmmeter and a digital voltage meter accurate to within +/-.001 Vdc.

To test the 710R1 board measure the voltage between the specified terminals on Terminal Block 1 (TB1) of the 710R1 board. These test points are indicated in the illustration shown in Figure 5-5.

Figure 5-5. *Test Points on 710R1 Board*



The correct voltage for each test point is provided in the following list.

+24 Vdc Unregulated Supply:

Measure the voltage between terminal 4 and terminal 1 of the 710 board's terminal block. The voltage should measure +24 Vdc.

+15 Vdc Regulated Supply:

Measure the voltage between terminal 4 and terminal 2 of the 710 board's terminal block. The voltage should measure +15 Vdc.

-15 Vdc Regulated Supply:

Measure the voltage between terminal 4 and terminal 3 of the 710 board's terminal block. The voltage should measure -15 Vdc.

Error Signal:

Measure the voltage between terminals 11 (motor ground) and 10 (error signal). With the FUNCTION select switch set to CONSTANT FLOW CONTROL and the DISPLAY select switch set to SET-POINT, make note of the flow rate. Next, turn the DISPLAY select switch set to SET-POINT, make note of the current setpoint.

Vary the setpoint by adjusting the SET-POINT ADJ. potentiometer. As you adjust the SET-POINT ADJ. locking potentiometer to a higher setpoint, a +15 Vdc motor error signal should be output from the 710 board. As you adjust the SET-POINT ADJ. potentiometer to a lower setpoint, a -15 Vdc motor error signal should be output from the 710 board. Return the setpoint to the original setting.

End of Section 5

Appendix A: Drawings

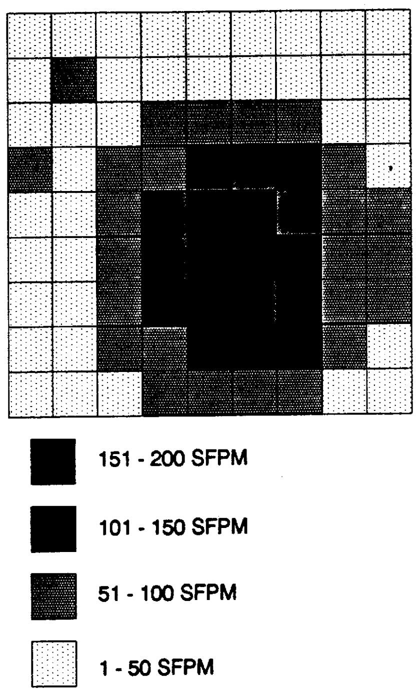
This appendix contains drawings that are helpful when you're installing your IK-EVA system. Other drawings, required for trouble-shooting an IK-EVA system, are included in the back of the installation drawings.

NOTE: If you want to perform your own warranty service, you must first obtain written authorization from Kurz Instruments. **Unauthorized service performed during the warranty period voids your warranty.** Please read the warranty statement at the front of this guide before performing any service.

Appendix B: Sensor Placement Examples

Figure B-1 shows the same sample velocity profile shown in Figure 3-3 in Section 3. The examples in this appendix are based on that profile.

Figure B-1. *Sample Velocity Profile*

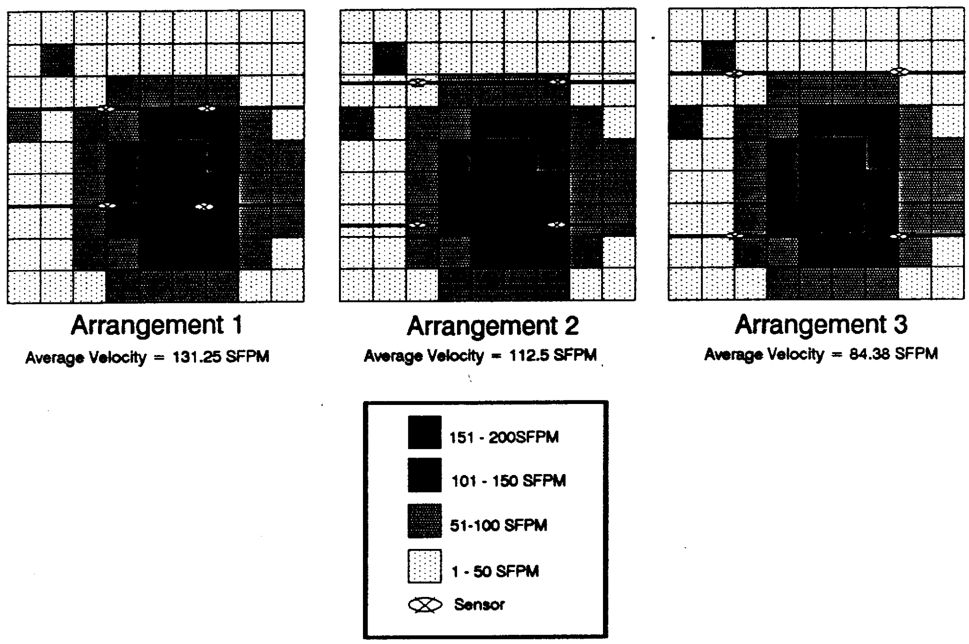


B.1 Method 1: Evenly Spaced Sensor Placement

To calculate the actual average velocity shown in the profile in Figure B-1, assign to each square in the profile the highest number in its range (i.e., each light square = 50), total the squares, and divide by 81. This yields an averaged velocity of just over 91 (91.36) SFPM. You would try to find an evenly spaced arrangement of sensors that would most closely approximate that average.

Three possible arrangements of four sensors are shown in Figure B-2.

Figure B-2. *Evenly Spaced Sensor Arrangements*



Note that, of the three arrangements considered, Arrangement 3 yields the average closest to that computed above.

B.2 Method 2: Equally Weighted Area Placement

To decide on the number of sensors in an equally weighted area placement scheme, consider the number and relative extent of the ranges shown on the velocity profile. The velocity profile shown in Figure B-1 contains four distinct ranges. Table B-1 shows the relative extents of each of those ranges.

Table B-1. *Relative Extents of Sample Velocity Ranges*

Range No.	No. of Units/Range	Approximate % of Total
1	38	47%
2	25	31%
3	12	15%
4	6	7%

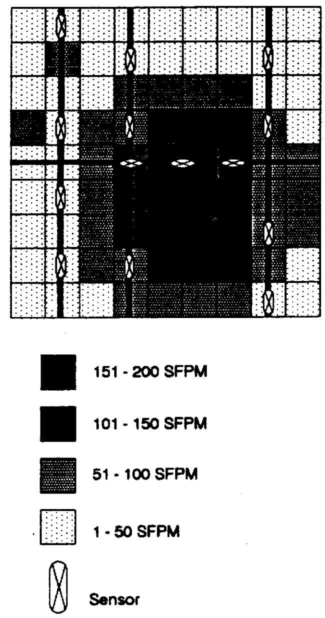
Since every sensor in an EVA is weighted equally with every other sensor, each sensor should ideally be monitoring an equal proportion of the total flow in the duct. Since Velocity Range 4 covers the smallest area, roughly 7% of the cross-sectional area, we could consider that area (7% of the cross section) the smallest significant area to monitor. Since 100% ÷ 7% = 14.29, 14 sensors would be required to monitor flow in the duct shown in Figure B-1. The sensors would then be distributed within the ranges as shown in Table B-2.

Table B-2. *Sample Sensor Distribution by Range*

Range No.	No. of Sensors	Calculation
1	7	14 x 47% ≈ 7
2	4	14 x 31% ≈ 4
3	2	14 x 15% ≈ 2
4	1	14 x 7% ≈ 1

Figure B-3 shows one possible arrangement of 14 sensors in the sample velocity profile.

Figure B-3. *Sample Velocity Profile Monitored by 14 Sensors*



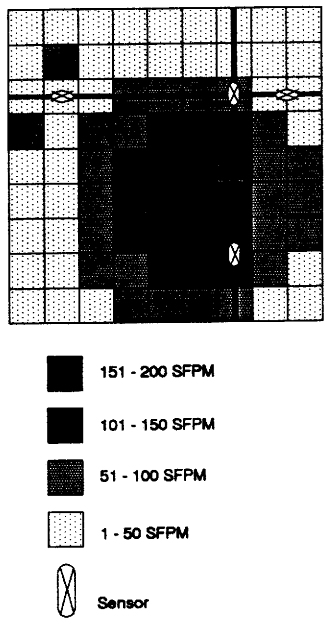
The arrangement show in Figure B-3 yields an average reading of 89.28 – significantly closer to the computed average than any of the four-sensor, evenly spaced arrangements show in Figure B-2.

A total of 14 sensors is reasonable if the duct shown is, in fact, fairly large[1]. If, however, the duct is fairly small, say 2' x 2', you might want to use as few as four sensors[2]. Figure B-4 shows one possible arrangement of four sensors in the sample velocity profile.

1 If the duct is 9' x 9' or 81 ft^2, each of 14 sensors would be monitoring about 5.79 square feet of cross-sectional area, a little more than the maximum given as a rule of thumb at Step 6 in Section 2. In that case, you might want to go to 17, or even 18 sensors.

2 The number of sensors used should always be at least as large as the number of distinct velocity ranges shown in the velocity profile. Therefore, a duct with a velocity profile like the one shown should be monitored by at least four sensors, regardless of its size.

Figure B-4. *Sample Velocity Profile Monitored by Four Sensors*

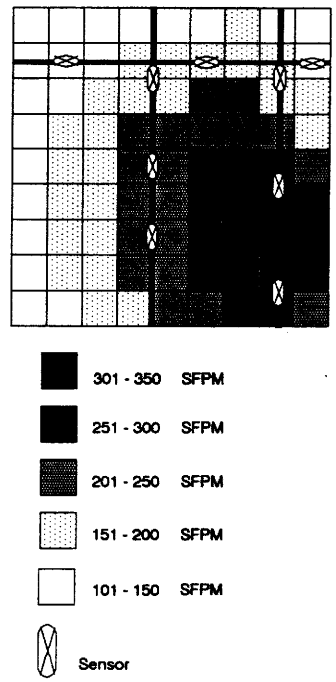


Note that, when only four sensors are used, Range 1, at 47% of the total cross-sectional area, accounts for two of the sensors, leaving only two additional sensors to monitor ranges 2, 3, and 4. In the arrangement shown, one sensor is used to monitor Range 2, and one sensor is placed at a point where ranges 3 and 4 meet. Clearly, the velocity picture this arrangement will yield is much "grainier" than the one obtained with 14 sensors arranged as shown in Figure B-3. Still, it is likely to be somewhat more accurate than an arrangement based on Method 1.

In fact, the arrangement shown in Figure B-4 yields an average reading of 93.75 SFPM. This is significantly better than any of the four-sensor arrangements shown in Figure B-2, and only very slightly less accurate than the 14-sensor arrangement shown in Figure B-3.

Figure B-5 shows the same velocity profile monitored by nine sensors. The figure nine was arrived at more or less arbitrarily; it represents a midpoint between the high of fourteen and the low of four already illustrated.

Figure B-5. *Sample Velocity Profile Monitored by Nine Sensors*



This particular arrangement of nine sensors yields an average reading of 91.66 – even more accurate than the 14-sensor arrangement shown in Figure B-3. It should be borne in mind, however, that a larger number of sensors will better handle changes in profile as overall velocity changes. And it is, of course, changes in profile that make a multipoint system necessary.

B.3 EPA Method 1

Applicability: EPA Method 1 is specifically applicable to particulate-sampling applications and applications where velocity rather than volumetric flow is desired. Although EVA sensors do, in fact measure volumetric flow, EPA Method 1 can still be an aid in determining their placement. EPA Method 1 is applicable to gas streams in ducts, stacks, and flues, provided that:

1. The flow in the line is not cyclonic or swirling.

2. The line is at least 12 inches in diameter or 113 square inches in cross-sectional area.

3. The measurement site is at least two line diameters downstream and at least one half line diameter upstream from the nearest flow disturbance.

   (In fact, the standard Method 1 procedure requires that the measurement site be at least eight diameters downstream and two diameters upstream from any flow disturbance. The EPA does, however, provide an alternative method when the measurement site meets the minimum criteria but not the more desirable eight and two criteria—refer to the full text of EPA Method 1.)

Equivalent Diameters: The EPA Method 1 procedure for determining the number of monitoring points in a line depends on the diameter of the line to be monitored. In the case of square or rectangular lines, Method 1 provides a formula for calculating an *equivalent diameter*:

$$D_e = \frac{2\,LW}{(L + W)}$$

where

D_e = equivalent diameter

L = length of line cross section

W = width of line cross section

Determining the Number of Monitoring Points: Table B-3 specifies the number of monitoring points required by EPA Method 1, according to the diameter or equivalent diameter of the line to be monitored.

Table B-3. *Minimum Number of EPA Method 1 Monitoring Points*

Line Diameter (or Equivalent)	Number of Monitoring Points
12 - 24 in	8 (circular lines)
12 - 24 in	9 (rectangular lines)
over 24 in	12 (circular or rectangular)

Appendix C: Kurz Equipment Storage Requirements

The Kurz specification for equipment storage requirements provides general storage criteria and specifies the minimum storage and maintenance requirements for the supplied equipment for periods up to five years at the manufacturer's facilities, the plant sites, or other storage facilities.

1. PURPOSE

1.1 This specification provides general storage criteria and specifies the minimum storage and maintenance requirements for the supplied equipment for periods up to five years at the manufacturer's facilities, the plant sites, or other storage facilities.

1.2 The storage and maintenance requirements herein are to be implemented by the Owner or Contractor wherever the equipment is assigned to storage, either at the sites or at other facilities. Since these requirements identify the final storage environments, they are also to be utilized by Kurz Instruments Projects, Design Engineering and Quality Assurance-Engineering Equipment and Installation to develop proper Vendor packaging.

1.3 The requirements herein and additional or maintenance requirements given in Kurz Instruments approved Vendor instruction manuals or storage conditions may require additional special considerations. In the case of conflicts between this specification and Kurz Instruments approved Vendor manual or special instructions, the more stringent requirements shall apply.

2. APPLICABLE DOCUMENTS, CODES, AND STANDARDS

2.1 The equipment storage requirements described by this specification shall be designed in accordance with the following documents to the extent specified herein.

2.2 Codes and Standards

2.2.1 Military Standards and Specifications

a. Desiccants, Activated, Bagged, Packaging Use and Static Dehumidification.

MIL-D-3464

MIL-B-131

b. Barrier Material, Water Vaporproof, Flexible

2.2.2 American National Standards Institute (ANSI)

a. Packaging, Shipping, Receiving, Storage and Handling of items for Nuclear Power Plants, ANSI N45.2.9 - 1974.

3. DESCRIPTION

3.1 The preservation of equipment during all warehousing or inplant storage consists primarily of keeping the equipment CLEAN AND DRY and protecting it from physical damage. This is best assured through planning and implementation of a storage program, inspection and maintenance of all equipment. Accordingly, this document provides equipment and material storage requirements for use in development of a storage program.

The storage, maintenance, and environmental requirements in Section 4 and Table 1, plus Kurz Instruments approved Vendor manuals or approved Vendor program to be formulated. However, it should be recognized that the actual storage conditions may require additional precautions, and good judgement must be exercised on the part of the personnel responsible for the storage. Basic responsibility for storage at the plant sites belongs to the Owner.

3.2 The maintenance of clean and dry storage via a temperature controlled heated warehouse for as much of the equipment as possible is emphasized. Such storage conditions limit equipment and air temperature changes in the warehouse, thereby reducing the possibility of condensation on the equipment. Condensation occurs when the equipment temperature is allowed to drop below the dewpoint of the surrounding air.

If the equipment and air temperature limitations do not control condensation, as might occur under very humid conditions, it may be advisable to reduce the relative humidity of the air of dehumidification, thus the relative humidity of the air bay dehumidification, thus reducing the dewpoint temperature. For example, under 90 percent relative humidity and 80° F air temperature the dewpoint is 76.5° F, whereas at 40 percent relative humidity and 80° F air temperature the dewpoint is 32.5° F.

3.3 To establish storage criteria, three environmental categories of storage are defined as they relate to the general types of areas normally available for storage. Equipment is then assigned to one of the categories. These categories are: Inside Heated (IH), Inside Unheated (IU), and Outside (O). Another type of storage occurs at the plant sites when equipment is moved into the plant buildings for installation and is defined as in-plant storage.

3.4 Definitions of terms used herein as follows:

a. CONTRACTOR -- The agency under contract for storage of the equipment.

b. OWNER -- The customer, i.e. the power company.

c. SHALL and SHOULD--This document contains both mandatory and guidance information. "Shall" or "must" indicates mandatory requirements, while "should" or "may" indicates recommendations as good practice. Deviations or substitutions for mandatory requirements shall require approval by Kurz Instruments Design Engineering. Recommendations are not mandatory.

3.5 The specifications herein are divided into General Storage and Maintenance Requirements (Section 4.1), Special Considerations for Storage (Section 4.2), and a listing of Kurz Instruments supplied equipment (Table 1). 4. REQUIREMENTS

4.1 General Storage and Maintenance Requirements

4.1.1 Storage and Maintenance Program

4.1.1.1 A most important part of equipment warranty protection is a planned, periodic inspection and maintenance program including documented results, This is to ensure that storage is provided in a proper manner without degradation of the equipment.

A storage program shall be developed by the responsible Contractor or Owner for all equipment. At the plant site the program shall include receipt inspection through in-plant storage at the equipment's final location and continue until the start of pre-Operational testing. Basic responsibility for the site program and storage rests with the Owner.

4.1.1.2 The storage program shall fulfil the following requirements for control of items while in storage.

a. Inspections and examinations shall be performed on a periodic basis. Minimum quarterly inspections are recommended with monthly inspections as appropriate. Any deficiencies shall be corrected and documented. Some characteristics to be verified during these inspections are:

   Identification and marking
   Protective covers and seals
   Coating and preservatives
   Lubrication
   Desiccants or nitrogen atmosphere
   Physical damage
   Cleanliness

   Kurz Instruments should be notified as soon as possible (not to exceed 30 days) concerning any physical damage or need for repairs.

b. The care of items in storage shall be established by developing written procedures of instructions in accordance with requirements herein and the Kurz Instruments approved vendor instruction manuals or storage instructions.

c. Written records shall be prepared to document the inspections performed, the performance of maintenance, and the disposition of nonconformances and repairs.

4.1.1.3 Receipt inspection shall be performed on all incoming equipment to be stored. As part of the inspection, the packaging and components shall be inspected for damage and be inventoried for completeness. The appropriate damage or shortage reports shall be prepared promptly.

4.1.1.4 Receipt inspection should be performed without destroying the shipping/storage protection provided by the manufacturer. If it is necessary to remove seals such as tank covers, pipe caps, polyethylene wrappings, these shall be replaced prior to storage. The receipt inspection shall also determine or verify that the packaging is sufficient protection for the type storage instructions/manuals.

4.1.1.5 The equipment storage is subject to audit in conformance with this specification, Kurz Instruments approved Vendor storage instructions/manuals, and the Contractor's program.

4.1.2 Storage Facilities Requirements

4.1.2.1 Inside Heated (comparable to Level B of ANSI 45.2.2)

4.1.2.1.1 Inside heated (IH) category is defined as storage in a clean, fire resistant, weathertight, well ventilated building (warehouse). The temperature of the warehouse is to be controlled with heating and ventilating systems to ensure that condensation of moisture does not occur on stored parts. This is the optimum storage condition for all equipment, except for special equipment such as electronic devices which may require humidity control within specified limits.

4.1.2.1.2 Other requirements for IH storage are as follows:

a. Internal cleanliness of equipment and flow elements shall be maintained by closing openings where possible by plugging, capping and/or sealing with tape (approved types). But weld preps on valves and spool pieces shall be reinstalled over plywood to better protect the weld preparation.

b. All equipment shall be protected against rodent and insect damage. Electrical equipment, and motors in particular, shall be provided with screens, shields, etc., to preclude entry.

c. Equipment shall be protected form mechanical damage. The proper use of racks, pallets, and handling equipment so arranged as to minimize damage to the stored equipment during handling.

d. All equipment shall be protected from dust and dirt. Large equipment should be covered with polyethylene if it is not adequately protected in its as-shipped condition. Small equipment should be bagged in polyethylene or stored in clean, closed boxes. Note that small parts are generally listed for warehouse that small parts are generally listed for warehouse storage where they can be under inventory control to reduce risk of loss.

4.1.2.2 Inside Unheated (comparable to Level C of ANSI 45.2.2)

4.1.2.2.1 Inside unheated (IU) category applies to storage within a building as defined in storage but is not heated. IU also applies to individual housing made only for a large component such as the shroud or steam dryer. Any building provided as an individual housing made only for large components shall meet the same requirements as for any other IU building. A wood or other framed shelter with only polyethylene walls does not afford complete weather protection and does not meet IU requirements.

4.1.2.2.2 Other requirements for IU storage are:

a. All those listed under IH storage, 4.1.2.1.2, items a through d.

b. The equipment shall be stored off the floor on suitable skids, pallets or racks.

c. All water or other liquid capable of freezing at outside temperatures shall be drained from the equipment prior to storage and/or such verification obtained. This is particularly applicable to head exchangers, equipment having cooling water coils, gages, etc.d which may have been test operated or hydrostatically tested.

d. Preservative coating applied to the equipment or added shall be maintained, i.e., paint, oils and contact preservatives.

4.1.2.2.3 In addition, a subcategory, inside unheated controlled (IUC) is utilized in Table 1 to identify the need for special protection against condensation for a component or part thereof. IUC also applies to condensate protection for the entire component if it is equipped with electrical or air operated devices. Listed below are four methods by such condensate protection may be provided, and all require periodic inspection and maintenance.

a. Bagged desiccant within a sealed enclosure. The desiccant may be inside the component for internal protections, and/or the entire component may be sealed in a container or warp with a desiccant enclosed. A means of checking the relative humidity with the enclosure/container shall be provided and the desiccant changed when indicated. A vapor barrier wrap other than polyethylene must be used to reduce frequency of desiccant change.

b. Local heating by strip heaters, light bulbs, etc., inside a tent-like structure to maintain the equipment surfaces degrees above the ambient air temperature.

c. Local heating by strip heaters, light bulbs, etc.d, inside a tent-like structure to maintain the equipment surfaces degrees above the ambient air temperature.

d. Pressurized nitrogen atmosphere to minimize condensation and oxidation on internal surfaces.

e. Approved preservatives to protect unpainted carbon steel surfaces. Such preservatives shall be in accordance with the Kurz Instruments approved Vendor instructions or approved Kurz Instruments Engineering.

The selection of an IUC method for a particular component shall be by the Contractor or Owner, unless specifically designated herein or in the Kurz Instruments approved Vendor's instructions.

4.1.2.3 Outside Storage (comparable to Level D of ANSI 45.2.2)

4.1.2.3.1 Outside Storage (O) is subject to the site location considerations given in Section 4.2.2 and the requirements listed below:

a. Items c and d as listed under 4.1.2.2.2.

b. On equipment where internal cleanliness or operation could be adversely affected by dirt or contamination, openings shall be plugged, capped, or otherwise sealed. Al plugs and caps shall be securely attached to the equipment to prevent their inadvertent removal. Large items such as tanks and heat exchangers, with all openings tightly covered, need not be crated, but the established preservatives shall be maintained.

c. All equipment and equipment containers shall be stored off the ground on suitable skids or cribbing and covered to protect the equipment surfaces from direct exposure to the weather. Canvas cloth or other weather resistant material must be used. The covering shall be lashed down and provide drainage of precipitation without formation of water pools.

CLEARANCE BETWEEN THE COVERED EQUIPMENT AND THE GROUND LEVEL SHALL BE SUFFICIENT TO PERMIT AIR CIRCULATION, THUS MINIMIZING CONDENSATION ON THE EQUIPMENT.

4.1.2.4 In-Plant Storage

4.1.2.4.1 In-Plant storage at the site is storage of the equipment in the plant usually at or near its final installed location while it is being installed and/or readied for operation. Because of the surrounding construction work, it is during these storage periods that the equipment is often least protected form dust, dirt, and moisture. Careful planning surveillance is required in-plant to assure that the equipment is adequately protected.

In-plant storage shall meet the minimum environmental requirements specified Table 1 for up to one year of storage, including all other general area requirements and considerations herein. Planning for such storage may require utilization of special procedures to keep the equipment clean and dry. Temporary covering, heating facilities, and routine storage shall be employed. Construction operation is to be planned so that dust-producing operations or unusual conditions of dampness are minimized where the equipment is located.

TABLE 1

Equipment Type	Storage Requirement	Reference Section
Electronic or Electrical	(IH)	4.1.2 - 4.1.2.2
Carbon Steel Parts, Painted or Unpainted	(IUC) or better	4.1.2.2.3, a-d
Flow Sensor Assembly	(IUC) or better	4.1.2.2.3, a-d
Stainless Steel Assembly, Parts or Hardware	(0) or better	4.1.2.3.1, a-c

Note: Where equipment types are mixed, as in assembled goods, the more stringent storage requirements shall be employed.

For example:

a. Clean the area before the equipment is introduced and establish routine housekeeping inspections.

b. Minimize water that is allowed in the lower drywell areas. Prevent flooding of equipment by providing operable sump pumps and alarm systems before the equipment is placed in the area.

c. Energize electric motor space heaters as soon as the motor is moved out of the warehouse to the installed position.

d. Plan to have the control room enclosed and heated, and a humidity indicator in operation before installing control and instrumentation equipment.

e. Provide temporary heat and coverings to keep the equipment protected from dirt and above the dew-point of the surrounding air.

4.1.2.4.2 Note that control panels, racks, vertical boards, and instrumentation are most vulnerable to plant construction conditions. Covering/protective measures per (e) above are required to assure that cleanliness and dryness is maintained.

4.2 Special Considerations

4.2.1 This section provides recommendations and requirements to assist in the development of storage areas and in the selection of protective materials at all storage sites.

4.2.2 The storage location and the compatibility of materials with the equipment must be considered when providing on-site packaging or repackaging of equipment. The storage location affects the degree of protection required against atmosphere constituents such as halides, sulfides, industrial fumes, etc. The nearer the sea coast of heavy industrial areas are to the storage area, the more protection from the atmosphere is required.

It is most important the stainless steels or nickel based alloys be protected from contamination by halides or low melting point elements. The Contractor or Owner should factor in any unique storage conditions such as high chloride soils and/or industrial fumes, and apply and additional requirements above the Kurz Instruments minimum requirements when the storage program is established.

4.2.3 Some equipment parts such as O-rings, shaft packing, insulation, contact switches, and gasket material may deteriorate in long-term storage despite optimum conditions. Therefore, the Owner's pre-operational maintenance program should identify and schedule procurement for the replacement of these parts.

4.2.4 In some cases insurance underwriters require warehouse sprinkler systems and may limit package storage for more effective sprinkler protection; therefore, insurance requirements should be factored into the storage program.

4.2.5 Spare Parts

4.2.5.1 The Owner shall establish a program for spare parts receipt inspection, storage, maintenance, and control of issue. The program shall provide IH storage for all parts with packaging to keep the equipment clean and dry.

4.2.6 Identification

4.2.6.1 The identity of all equipment shall be verified and so identified while in storage by marking or tagging. This applies whether the equipment is crated, boxed, or stored inside without covering, and shall be accomplished so that the equipment is identifiable without opening or disturbing its storage condition. The following identification/marking is required:

a. Equipment part number
b. Purchase order number, item serial numbers, and quantity.
c. Equipment name or description
d. Project name and unit number

4.2.6.2 It is recommended that the above markings appear on two sides of each outer container, in letters at least 1/2 inches high in weatherproof ink or paint.

4.2.6.3 Where applicable, shipping skids or crates should be stenciled with handling instruction such as "fork lift here only use no hook", etc.

4.2.6.4 Direct marking on stainless steel, nickel alloys, and other metallic materials are permitted with the following materials, providing they are completely removed prior to any system cleaning or plant heating operations. Kurz Instruments engineering approval is required for use of any other materials.

a. Black tip markers and ball point pens
b. Common lead pencils
c. Dyken steel blue, DX-100, Dykem Company, layout fluid
d. Sprayon No. 603, Sprayon Products, layout fluid
e. Nissen "no chloride" white metal marker
f. Carter's "marks-a-lot" black pen

4.2.6.4.1 Colloidal graphite is alcohol mixture, Dispersion #156, or Kurz Instruments approved equal, may be used for marking without the necessity for removal prior to heating.

4.2.6.4.2 Crayon and chalk marking materials are NOT PERMITTED on stainless steels or nickel based alloys unless the material has been Kurz Instruments approved for use.

4.2.7 Preservatives (Corrosion Inhibitors)

4.2.7.1 Preservatives are used primarily on carbon steel surfaces and include paints, oils, greases, and a number of tradename compounds such as Colomoline, Tectal, Immunol, etc. Preservatives applied at a Vendor's plant shall be left intact during storage.

Should the reapplication of preservatives be required at the site, only those already approved for use through instruction manuals, Kurz Instruments approved Vendor storage instructions, or specified in the ordering data for the equipment involved may be used without Kurz Instruments Engineering approval.

4.2.7.1.1 If the preservative is to be used on inside surfaces that will be wetted during plant operation, the preservative shall meet two criteria: (1) be completely removable by cold water flushing, and (2) be low is sulfur and halogens so that it will not contaminate stainless or nickel alloys. Approved preservatives for carbon steel which met these requirements are:

a. Solution of 1/2 percent sodium nitrate, 1/4 percent disodium phosphate and 1/4 percent monosodium phosphate (commercially supplied as Kemtron #485, Chemical Supply Co.,), or Immunol GE, Harry Miller Corporation.

b. Immunol #1722, or Immunol NF, Harry Miller Corporation.

c. Hydrin-X, Daubert Chemical Co.

4.2.7.2 Preservatives used to protect carbon steel weld preparation shall also meet the above requirements and not be detrimental to the weld quality. One such product is Dexalulminite, Special Chemicals Corp.

4.2.7.3 Kurz Instruments Engineering approval is required for use of any preservative on stainless steel surfaces or any other surfaces directly exposed to reactor water.

4.2.8 Desiccants

4.2.8.1 The use of desiccants with austenitic stainless steel requires prior Kurz Instruments approval. Desiccants which may be used upon approval are limited to a non-halogenated type such as silica gel. The desiccant must meet MIL-D-3464 Type II non-dusting type and be contained (bags) and installed with the containers supported so that they will not be in direct contact with the component surfaces.

Desiccant placed inside of equipment must be accounted for by marking/tagging the outside of the equipment Desiccant may be used with carbon steel components without Kurz Instruments approval providing the particular desiccant used is one of those listed below

a. Protec - Sorb 121, X1591 (selica gel) - W.R. Grace and Co.

b. Eagle Silical Gel 12867 - Eagle Chemical Co.

c. Desiccate No. 25 Filtrol, Corporation

4.2.9 Tapes (Pressure-Sensitive)

4.2.9.1 Pressure-sensitive tapes are normally used for sealing polyethylene film wrappings, flange covers, small openings, containers, etc. Only Kurz Instruments approved tapes shall be used on stainless steel, nickel base alloys, and other materials exposed to the reactor primary system. Wherever tape contact with metal occurs, remove all adhesive with acetone or toluene immediately after tape removal. The tapes approved for use are as follows:

a. Clothbacked (Not PVC treated)

(1) Polyken #222, Kendal Company (silver color)
(2) Polyken #224, Kendall Company (silver color)
(3) Ditch Brand #357, Nashua Corporation (silver color)
(4) Permacel P69, Johnson & Johnson

b. Polyethylene

(1) #480, 3M Company
(2) Ex-Cor-Pe-12, Nashua Corp.

c. Polyester (Mylar)

(1) #850, Black 3M Company

4.2.10 Wrapping Material and Tarpaulins

4.2.10.1 Flexible materials used to wrap or cover components made of stainless steel or nickel base alloys shall be limited to the following:

a. Clear polyethylene film

b. Clear polyethylene film with thread reinforcement - equal to Type 55 manufactured by Griffolyn Company, Houston, Texas

c. Canvas cloth (fire retardant types)

d. Green colored polyethylene film: #01797, Plicose Mfg. Corporation or Polyfluff #1056 from Shott International Incorporated

e. Fire retardant polyethylene, white, visqueen, Ethyl Corporation

f. Vapor proof barrier materials for use with desiccant shall beet Mil-B-131; Marvelseal 1311, 360 and B-117-E from Marvellum Company

Polyvinyl chloride (PVC) plastic films shall not be used due to their high chloride content.

4.2.10.2 Polyethylene film is a good wrap or tarp to keep items clean, but is not a vaporproof barrier and permits passage of water vapor. When polyethylene is used to wrap an item for storage, the film should be left open and allowed to "breathe" freely so that the air inside the package is allowed to change readily, thus minimizing condensation.

4.2.10.3 If asbestos is used on stainless steel it shall be kept dry. If wetting does occur, the asbestos shall be removed and the stainless area rinsed with tap or demineralized water to remove the potential harmful effects of leached out chlorides.

4.2.11 Lubrication. Lubrication oils/greases shall be applied in accordance with Kurz Instruments approved Vendor manual or special storage procedure instructions.

4.2.12 Stainless Steel Storage

4.2.12.1 Stainless Steel is not subject to harmful oxidation in the presence of moisture; therefore equipment constructed entirely of stainless steel may be stored Outside or Inside Unheated, subject to protection from dirt and mechanical damage as desired herein.

If stainless steel becomes discolored with rust, it may be cause by surface iron contamination. A light rust film on the steel is not considered detrimental. However, to minimize rust it is recommended that stainless steel be stored where iron or carbon steel material cannot come in direct contact with its surfaces. Check carbon steel banding of packaging to assure that it is not in direct contact with stainless steel.

4.2.12.2 Components composed entirely of stainless steel should not be kept tightly wrapped and sealed, but be loosely packaged with provisions for ample circulation of air. This is particularly true of polyethylene wrapping which is porous and will trap moisture inside the package and generally degrade the entire package.

4.2.13 Carbon Steel Storage

4.2.13.1 Rusting of carbon steel surfaces is of primary concern in carbon steel equipment storage. A light film of soft rust is not considered detrimental, but pitting and heavy rust and scale formation must be avoided. The preservatives which meet cleaning requirements are only effective for a short period of time in the presence of moisture (1-3) months); therefore, if such preservatives are utilized for any unheated storage, the equipment must be periodically inspected to insure satisfactory condition.

End of Appendix C