KURZ INSTRUMENTS INC.

Model 455 Industrial Air Velocity Transducers User's Guide

(with 435-R1 Analog Linearizer)

June 1989

Attention: Manual User

Please note that there has been a product change. The 465R4 and 465R5 current transmitter boards have been upgraded to a 465R6 and 465R7.

Details on the operation, installation and tests procedures for these new components are outlined in the **Addendum: Product Change Notice** *found at the end of this manual just before the appendix.*

Unit Description Sheet

Unit shipped is: ____ 455-08

____ 455-16

Complete Model Number: _____

Serial Number: _____

Kurz Order Number: _____

Customer P. O. Number: _____

Gas Calibration: ____ Air

____ Other (specify): _____

Calibration Reference Temperature:

____ Standard (25° C, 77° F)

____ Other (specify): _____

Calibration Reference Pressure:

____ Standard (760 mm Hg, 29.92 in Hg)

____ Other (specify): _____

Velocity Range: ____ 0-100 SCFM

____ 0-300 SCFM

____ 0-1,250 SCFM

____ 0-2,500 SCFM

____ 0-6,000 SCFM

____ 0-12,000 SCFM

____ Other (specify): _____

Engineering Units: ____ SFPM

____ $SCFM/ft^2$

____ $lbs\ mass/min/ft^2$

____ SCFM

____ lbs/min

____ Other (specify): _____

Line or Duct Size (for SCFM and lbs/min only):_____

Power Supply:

____ Standard (110-115 Vac/50-60 Hz)

____ 220 Vac/50-60 Hz

____ Vdc (specify voltage): _____

Output Signal:

____ Standard (linear 0-5 Vdc)

____ 4-20 mA 4 mA = _____ 20 mA = _____

____ Other (specify): _____

OPTIONS:

____ Model 111 Dual Alarm Board

Sensor:

____ Teflon-Coated Sensor

____ Chrome Plated

____ Titanium

____ Sensor Safety Circuit

____ Other: _____

High Temperature Applications:

____ HT Rated to 250° C

____ HHT Rated to 500° C

____ Remote Current-Transmitter Electronics

Electronics Enclosures:

____ Rack-Module, 2.8"

____ Rack-Module, 4.2"

Displays:

____ Panel-Mounted LCD

____ Rack-Module LCD

____ Remote LCD

Totalizers:

____ Panel-Mounted Totalizer

____ Rack-Module Totalizer

____ Resettable Totalizer

Other Options (specify):

_____

_____

_____

2411 Garden Road

Monterey, CA 93940

(408) 646-5911

(800) 424-7356

Document Title: *Model 455 Industrial Air Velocity Transducers User's Guide*

Document Number: 360110 Rev. B

Publication Date: June 1989

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.

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.

Warranty Statement

The Kurz Model 455 Industrial Air Velocity Transducer 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.

Important Notice

The MetalClad sensor used in the Model 455 Industrial Air Velocity Transducer produces heat during normal operation. The sensor is designed for use in flows of air and other **NONEXPLOSIVE** gases. The sensor should not be used in flows of explosive gases unless it is equipped with the optional sensor safety circuit described in section 4.14 of this guide. Even when so equipped, the sensor can reach temperatures sufficient to ignite explosive gases unless the temperature of the gas flow itself is kept within established limits. **DO NOT USE THIS SENSOR IN FLOWS OF EXPLOSIVE GASES WITHOUT FIRST CONTACTING KURZ INSTRUMENTS FOR DETAILED SAFETY INFORMATION. FAILURE TO HEED THIS WARNING COULD RESULT IN EXPLOSION, DAMAGE TO FACILITIES, SERIOUS INJURY, OR DEATH.**

Table of Contents

Figures

Tables

About This Book

This book contains five sections and an appendix, each of which is briefly described below. The book also contains a Unit Description Sheet, a Quick Set-Up Guide, and an index. The book is not designed to be read cover to cover; rather, it is designed to present information to the 455 user in as accessible a manner as possible.

Organization

Unit Description Sheet

This sheet is found in the front of the book, immediately following the title page. It contains important identifying information about your Model 455 Industrial Air Velocity Transducer, including model number, serial number, Kurz order number, and customer purchase order number. It also lists any options you ordered with your 455. Check the options listed against your original order and against the actual contents of the shipping carton. Report any discrepancies immediately to Kurz Instruments Incorporated at (408) 646-5911.

Quick Set-Up Guide

The Quick Set-Up Guide consists primarily of a chart summarizing much of the information presented in the rest of the manual. You can use the chart to refresh your memory after you read the relevant sections of the manual. Or, if you feel that you do not need the more detailed information presented in the rest of the manual, you can attempt to install your 455 referring only to the Quick Set-Up chart. Kurz Instruments does **not**, however, recommend the latter approach.

Section 1: Product Overview

This section introduces you to the purpose, principles of operation, and features of the Model 455. You can safely skip this section if you are already familiar with that information.

Section 2: Installation

Section 2 explains, in necessarily general terms, how to install your 455. This section explains how to determine the correct location for installation, as well as how to perform the physical installation in pipes, stacks, and flat or round ductwork. You should read thoroughly the parts of this section that apply to your installation before you install the 455. **You may also want to read Section 5, "Testing," before you install the 455.**

Section 3: Operation and Maintenance

This section explains how to calculate actual velocities from the standard velocities reported by the 455, how to recalibrate the unit, and how and when to clean the sensor. Refer to this section as needed.

Section 4: Options

This section lists and explains most of the options available with the 455. Contact Kurz Instruments for a complete, up-to-date list of available options.

Section 5: Testing

This section explains two tests you can perform on the 455 to determine whether or not it is operating properly. Although the 455 is thoroughly tested before it leaves the factory, you may want to run the tests described in Section 5 to make sure that the unit has not been damaged in transit. Whether or not you do so depends largely on your judgment of the complexity of your installation: If installation and possible later removal are relatively easy, it probably makes more sense to go ahead and install the unit without extensive preinstallation testing. If your installation is a difficult one, and removing the unit later for testing would be more time consuming than the testing procedures themselves, you should probably test before you install.

Appendix A: Component Layout and Schematic Drawings

The appendix contains detailed component layout drawings and circuit diagrams of the various components of the 455. This information is not needed by most 455 users in routine operation of the unit. It is provided as an aid to those users who want to perform more detailed maintenance and testing operations than those described in sections 3 and 5.

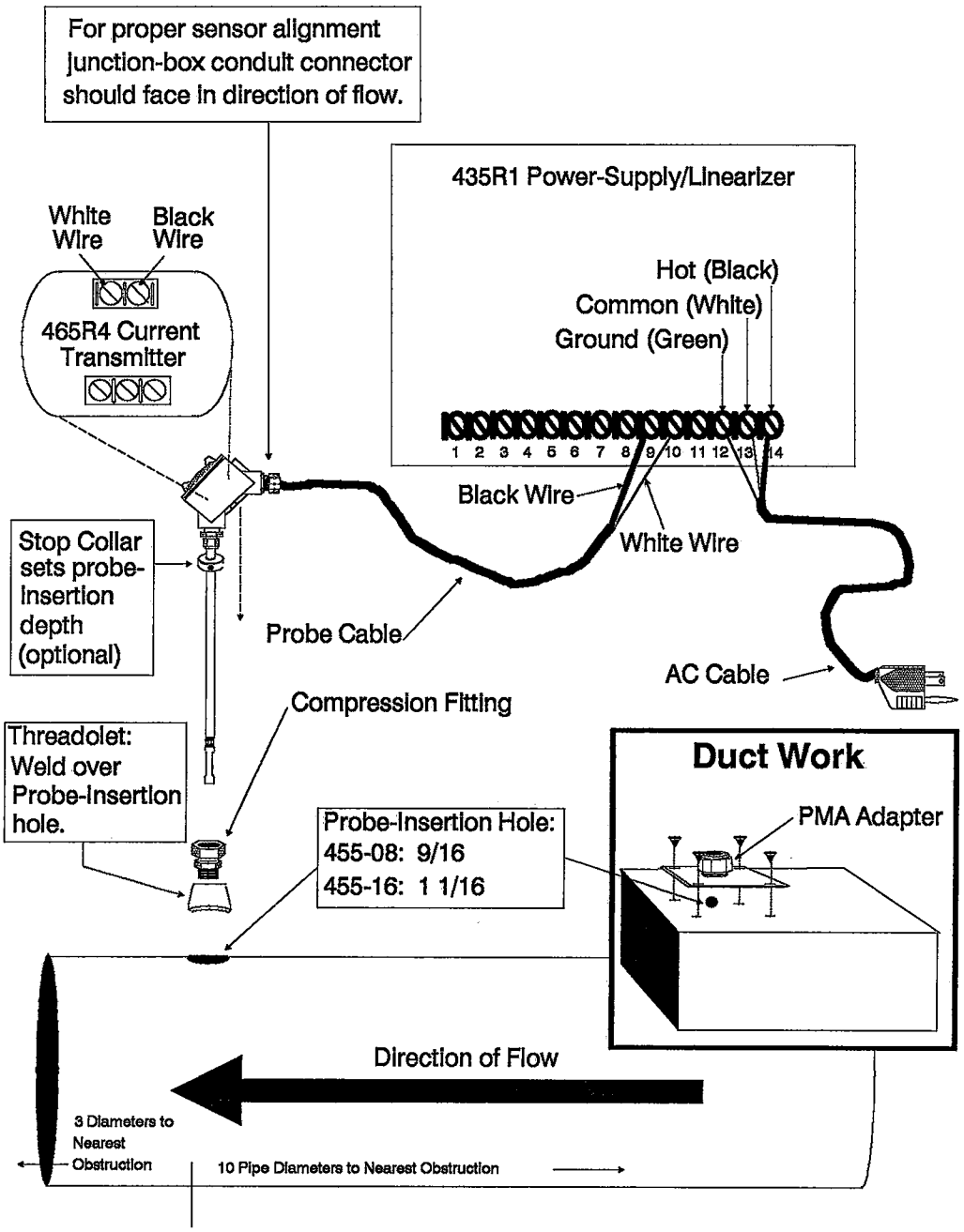
About the Art in This Book

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 Appendix A, which contains reproductions of actual engineering drawings.

Quick Set-Up Guide

The quick set-up chart below summarizes much of the information presented in this manual. It does not, however, contain all the information you may need for safe and satisfactory installation of your 455. Kurz Instruments recommends that you read the manual before attempting installation.

Important Note: Do NOT install the junction box close to a hot duct or stack. The ambient temperature around the junction box should not exceed 50° C.



Section 1: Product Overview

This section contains a general description of the Model 455-08 and 455-16 Industrial Air Velocity Transducers. It explains how the transducers work and lists their features and specifications.

1.1 Description

The Model 455 Industrial Air Velocity Transducer is designed to monitor the flow of air or other gases within pipes, stacks, flues, ductwork, and similar enclosed channels. It is extremely rugged and resistant to contamination, and is therefore particularly suitable for hot, dirty, or corrosive industrial environments.

The 455 is available in two sizes to suit a wide range of applications:

- The 455-08 is generally for monitoring velocity in lines from a minimum of four inches in diameter up to approximately 24 inches in diameter (or in ducts up to 24 inches across in their smaller dimension).

- The 455-16 is generally for lines from 24 to 72 inches in diameter (or ducts from 24 to 72 inches across), but can be used in lines down to a minimum of six inches. See Kurz EVA 4000 product information for larger multipoint applications.

Both the 455-08 and the 455-16 consist of the same basic components:

- MetalClad™ all-metal flow sensor mounted in a protective window at one end of the probe

  NOTE: The sensor shipped with your 455 was specifically matched to your unit's electronics during factory calibration. Sensors are **not** interchangeable between different 455s.

- 316 stainless steel probe support

- Two-wire current transmitter housed in a weatherproof aluminum junction box at the other end of the probe support

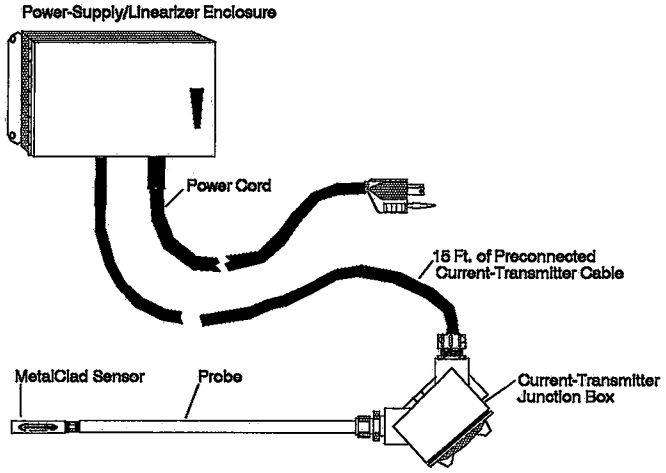
- Power-supply/linearizer unit housed in a steel enclosure with mounting brackets

The only significant difference between the 455-08 and the 455-16 is the size of the probe support. The 455-08 probe is 0.5 (8/16) inch in diameter and 24 inches long (24-inch probe length is standard; other lengths can be ordered). The 455-16 probe is 1.0 (16/16) inch in diameter and 60 inches long (60-inch probe is standard; other lengths can be ordered).

All information is this guide applies equally to the 455-08 and the 455-16 unless specifically identified as applying only to one or the other.

Figure 1-1 shows the basic components of the 455-08 with the standard probe.

Figure 1-1. *455 Basic Components*

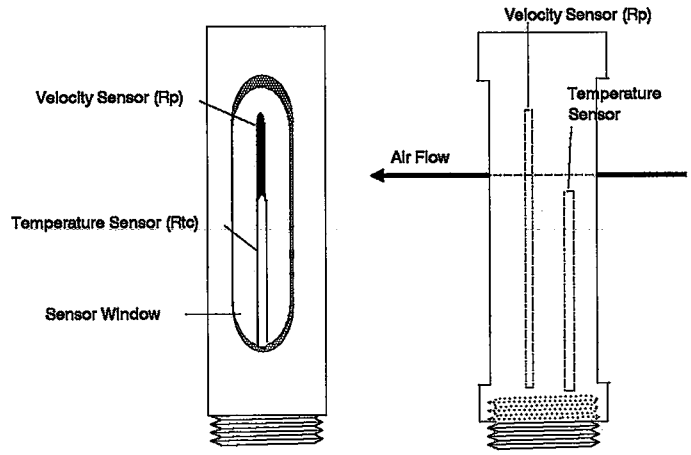


1.2 How the Sensor Works

The 455's MetalClad sensor is in fact two sensors in one: a temperature sensor and a velocity sensor. Both sensors consist of reference-grade platinum windings wound around a ceramic mandrel and enclosed in a single stainless steel sheath. The temperature sensor (R_{tc}) is the shorter of the MetalClad's two sensor elements. The velocity sensor (R_p) is the longer of the two elements.

Figure 1-2 shows a close-up view of the MetalClad sensor within its protective sensor window.

Figure 1-2. *MetalClad Sensor: Two Views*



The temperature sensor senses the ambient temperature of the air flow. The velocity sensor is then heated to approximately 75^{o} to 100^{o} F **above** the ambient temperature and is maintained at the same level of temperature differential (overheat) above the ambient temperature regardless of changes in ambient temperature or air velocity.

CAUTION: The MetalClad sensor's standard rating is for nonexplosive gases. If you plan to use it in flows of explosive gases, Kurz strongly recommends that you purchase the optional probe safety circuit (described in Section 4.14). That circuit prevents the velocity sensor from ever reaching the ignition temperature of a specified explosive gas, provided the temperature of the gas flow itself is kept within appropriate guidelines. Contact Kurz Instruments for more information on using the MetalClad sensor in explosive gas flows.

Because the temperature sensor compensates for fluctuations in ambient temperature, the amount of electrical power needed to maintain the velocity sensor's overheat is affected only by the flow of air or other gases over the sensor: The greater the velocity of the flow, the greater its cooling effect on the sensor and the greater the electrical power needed to maintain the sensor's overheat. It is this power or current draw that is measured by the 455.

Because the sensor is directly measuring mass flow (i.e., the number of molecules carrying heat away from the velocity sensor), it is calibrated in **standard** units, which are referenced to a temperature of 25° C and atmospheric pressure of 760 mm Hg. In other words, air at 25° C and 760 mm Hg, flowing at 100 feet per minute (FPM) will produce a reading of 100 **standard** feet per minute (SFPM)[1]. A 100 FPM flow at a different temperature or pressure produces a reading in SFPM that accurately compensates for the temperature or pressure differential.

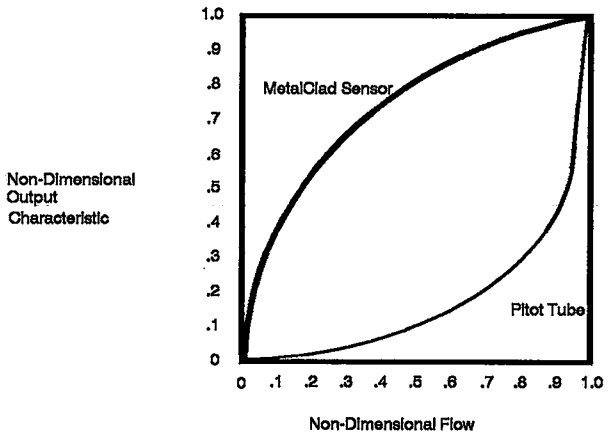
The temperature and velocity sensors form two legs of a balanced Wheatstone bridge. The bridge circuitry itself is contained in the current-transmitter junction box at one end of the probe.

The printed circuit board (PCB) housed in the power-supply/linearizer unit has two main functions: to supply direct-current (dc) power to the current transmitter and to transform the nonlinear current draw received from the MetalClad sensor into a linear 0-5 volt dc (Vdc) signal.

The signal received from the sensor is nonlinear in that the amount of power needed to maintain the velocity sensor's overheat is not directly proportionate to the velocity of the airflow. Instead, the power-consumption curve is fairly steep at low flow rates and relatively flatter at higher rates of flow. Figure 1-3 shows the MetalClad sensor's output curve as flow increases. Figure 1-3 also shows the corresponding curve for a pitot-tube type sensor. Note the greatly superior sensitivity of the MetalClad sensor at low flow rates.

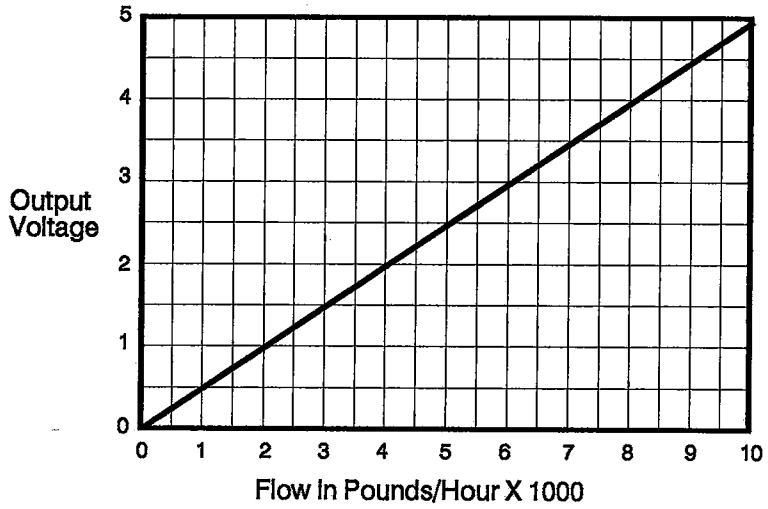
1 Standard 455 calibration is in SFPM. Other engineering units are also available--refer to Section 4, "Options".

Figure 1-3. *Sensor Output vs Flow*



The linearizer converts the nonlinear draw into a linear voltage that is directly proportionate to flow velocity: 0 Vdc indicates no flow, 5 Vdc indicates maximum measurable flow, and 2.5 Vdc indicates a flow exactly half of the maximum measurable flow, as shown in Figure 1-4.

Figure 1-4. *Linearized Output*



1.3 Features and Specifications

Some of the outstanding features of the 455 are summarized below:

Rugged Construction

The MetalClad sensor, with its 316 stainless steel sheath, is virtually indestructible in normal use. It is highly resistant to both dirt and corrosion; unlike pitot-tube and orifice-plate sensors, its performance is not degraded by operation in a dirty atmosphere.

Unsurpassed Accuracy

The 455's sensor windings are Resistor Temperature Detector (RTD)-type windings of reference-grade platinum 385.

Two-Wire Hookup

The 455's two-wire hookup between the current transmitter and the power-supply/linearizer unit allows for cable loop lengths of 1000 feet or more (refer to Section 2, "Installation"). The 455 also features reverse polarity protection for power input, making it almost impossible to hook the current transmitter to the power-supply/linearizer incorrectly.

Automatic Temperature and Pressure Compensation

The 455 directly measures mass flow. No computations are necessary to compensate for temperature and pressure changes.

Excellent Low-Speed Sensitivity

Unlike pitot-tube and orifice- plate sensors, the 455 can accurately measure flows down to 20 SFPM.

Convenient Linear Output

The 455's linear 0-5 Vdc output is convenient for digital panel meters, voltmeters, chart recorders, and computers. Other outputs are optionally available.

NBS-Traceable Calibration

Every 455 is factory-calibrated in a National Board of Standards (NBS) traceable wind tunnel. Packaged with your 455 is a Calibration Certificate showing output voltage vs air velocity. The factory calibration is for air at 25° C and 760 mm Hg. Calibration for other gases, temperatures, and pressures is available at an additional charge.

The specifications of the 455 are given in Table 1-1.

Table 1-1. *455 Specifications*

Sensor Construction:	Reference-grade 385 platinum RTD-type windings around a high-purity ceramic core, sheathed in 316 stainless steel
Accuracy:	+/-(2% of reading + 1/2% of full scale)
Repeatability:	+/- 0.25%
Response Time:	1 second
Calibration:	Factory calibrated in NBS-traceable wind tunnel for air at 25° C and 760 mm Hg. Includes Calibration Certificate showing output voltage vs air velocity for 11 data points, including zero flow.
Sensor Operating Temperature Range:	-55° C to +250° C standard HHT rated sensor optionally available for temperatures from -55° C to +500° C **NOTE:** Current-transmitter electronics not rated above 125° F. Specify remote-mounted electronics if the portion of the probe **outside** the pipe or duct to be monitored will be exposed to temperatures higher than 125° F. (See Section 2.5.2 for information on high-temperature installations.)
Probe Construction:	316 stainless steel

Table 1-1 (continued)

Probe Dimensions:	455-08: 1/2" outside diameter; 24" length standard; lengths from 3" to 48" optionally available 455-16: 1" outside diameter; 60" length standard; lengths from 12" to 72" optionally available
Current Transmitter Enclosure:	Weatherproof aluminum junction box. Rated for hazardous environments: Class I groups C & D; Class II groups E, F, & G.
Electronics Hookup:	Two-wire twisted pair. Reverse polarity protection.
Power-Supply/Linearizer Enclosure:	8" x 6" x 4" NEMA-type steel enclosure with mounting brackets; green hammertone enamel finish. (When optional modules such as digital displays or totalizers are included, a larger enclosure may be used.)
Output:	Linear 0-5 Vdc standard. Isolated and nonisolated 4-20 mA outputs optionally available. For other nonstandard outputs, consult factory.
Power Supply:	110 Vac/60 Hz standard. 220 Vac and dc powered models optionally available.

End of Section 1

Section 2: Installation

This section explains how to install your Model 455 Industrial Air Velocity Transducer. The instructions given in this section are necessarily general in nature; every installation is unique. If you need further assistance with your installation, contact Kurz Instruments, Inc. at (408) 646-5911.

2.1 Checking the Contents of the Shipping Carton

Open the shipping carton and remove the protective foam packaging material that covers the 455 and any options shipped with it. Check to see that the shipping carton contains everything you ordered.

Make sure the NBS traceable calibration certificate is included. Verify that the line size (if applicable) and pipe schedule shown on the calibration certificate are correct.

2.1.1 455 Without Options

If you ordered your 455 without any options, the contents of the shipping carton should be as shown in Figure 1-1, "455 Basic Components."

Check inside the power-supply/linearizer unit and remove any desiccant or other packaging material you find there.

If the contents of the shipping carton are correct, proceed with the installation. (If you prefer to test the unit before you install it, refer now to Section 5, "Testing.")

2.1.2 455 with Options

Any options you ordered should be specified on the Unit Description Sheet at the front of this manual. Available options are listed, described, and (where applicable) pictured in Section 4, "Options". If the options specified on the Unit Description Sheet do not match the options you ordered or the options actually shipped, contact Kurz immediately.

Unless you ordered your 455 with the rack-module electronics option, the contents of the shipping carton include a NEMA-type box housing the power-supply/linearizer unit. Check inside this unit and remove any desiccant or other packaging material you find there.

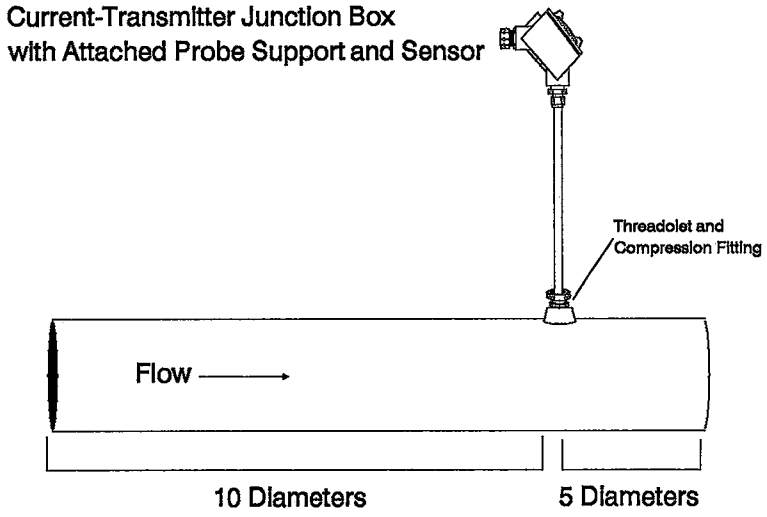
If the contents of the shipping carton are correct, proceed with the installation. (If you prefer to test the unit before you install it, refer now to Section 5, "Testing.")

2.2 Determining Probe Location

If possible, you should locate the probe at least three pipe or duct diameters upstream and ten diameters downstream from the nearest bend, elbow, or other obstruction in the pipe or duct to be monitored. The chosen location should also provide sufficient clearance for inserting and removing the 455 probe; that is, the clearance between the pipe or duct and any obstruction should equal at least the length of the probe, plus the current-transmitter junction box, plus two or three inches for maneuver. Correct probe location is illustrated in Figure 2-1.

Important Note: The electronic components on the 437 board are not warranted to operate above 70° C. Therefore we recommend that you do not place the junction box close to hot ducts or pipes. Provide sufficient clearance between the duct or stack and the junction box so that the ambient temperature around the junction box is less than 50° C.

Figure 2-1. *Probe Location*



2.3 Determining Probe Insertion Depth

Because the 455's MetalClad sensor can, at any one time, measure velocity at only one point within your pipe or ductwork, it is important that the sensor be mounted at a point where velocity closely approximates the average velocity within the pipe or duct. You can approach the problem of determining a point of average velocity in a variety of ways, depending primarily upon the accuracy your application requires.

2.3.1 Center Mounting

Under some circumstances, it may be appropriate to assume that the center point of the pipe or duct represents a point of average velocity. Such circumstances include the following:

- A high degree of accuracy is not critical to your application.
- The pipe or duct to be monitored is so small that it is impractical to mount the sensor anywhere other than at the center of the pipe or duct.
- Flow profile is known to be turbulent and of high velocity; many points of average velocity are likely.
- Flow profile is known to be very uniform.

Even under the circumstances listed above, however, you may want to perform at least a half traverse (described below at 2.3.2) before deciding on center mounting.

2.3.2 Half-Traverse Averaging

You can, with a fair degree of accuracy, determine the average velocity within a pipe or duct, and a specific point at which velocity closely approximates that average, by traversing the sensor once across the center line of the pipe or duct, from the far wall to the center[1]. The procedures for performing the traverse and obtaining an average are described below:

Step 1: Divide a cross section of the pipe or duct into a number of equal, concentric areas (see Figure 2-2). The number of areas you use depends on the the uniformity of flow within the pipe or duct and on the degree of accuracy you require: The more areas you use, the more accurate your computed average will be.

Step 2: Identify a point to monitor for each area (see Figure 2-2).

Step 3: Drill a hole in the pipe or duct 1/16-inch larger in diameter than the probe (9/16" for the 455-08; 1 1/16" for the 455-16).

Step 4: Insert the probe into the pipe or duct and take a velocity reading at each of the points selected at Step 2.

You can most easily determine the position of the sensor within the pipe or duct by using a pencil or other marker to mark off appropriate measurements on the probe before you insert it.

Be sure the window of the probe's protective shield is aligned with the direction of flow so that airflow over the MetalClad sensor is unobstructed.

Step 5: Compute an arithmetic average of the readings obtained at Step 4.

1 If the size of the pipe or duct is such that the probe will not reach all the way across it, you can perform the traverse from the center to the near wall. In that case, however, you should omit the reading nearest the wall of the pipe or duct (see Figure 2-2) because that reading may be influenced by turbulence or leakage caused by the probe-insertion hole.