

MODEL HCM 6000 CAPACITANCE MANOMETER TRANSDUCER



Contains Operating Information

MODEL HCM 6000
SERIES
CAPACITANCE
MANOMETER
TRANSDUCER

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Manual Print History

The print history shown below lists the printing dates of all revisions and addenda created for this manual. The revision level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new revision is created, all addenda associated with the previous revision of the manual are incorporated into the new revision of the manual. Each new revision includes a revised copy of this print history page.

Revision A (Document Number 144-1196) November 1996

Warranty

Hastings Instruments warrants this product, for a period of one year from the date of shipment, to be free from defects in material and workmanship. This warranty does not apply to defects or failures resulting from unauthorized modification, misuse or mishandling of the product. This warranty does not apply to batteries or other expendable parts, nor to damage caused by leaking batteries or any similar occurrence.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty as to fitness for a particular use. Hastings Instruments shall not be liable for any indirect or consequential damages.

Hastings Instruments will, at its option, repair, replace, or refund the selling price of the product if Hastings Instruments determines in good faith, that it is defective in materials or workmanship during the warranty period. Defective instruments should be returned to Hastings Instruments together with a written statement of the problem and a repair authorization number.

Table of Contents

1	General Information.....	1-2
	Introduction	1-2
	Features	1-2
	Specifications	1-3
2	Installation	2-2
	Receiving Inspection.....	2-2
	Mounting.....	2-2
	Cable Connections	2-4
	General Notes	2-5
3	Operating Information	3-2
	Warm Up	3-2
	Overpressure	3-2
	Zero Adjustment	3-2
	Theory of Operation	3-3
4	Maintenance and Repair	4-2
	Cleaning.....	4-2
	Internal Adjustments	4-2
	Return Information	4-3
	Warranty Repair	4-3
	Non-Warranty Repair	4-3

SECTION 1

General Information

Introduction

The Hastings Capacitance Manometer (HCM) transducer is an active sensor which makes direct (gas composition independent) vacuum/pressure measurements. Advanced design features, incorporating a capacitive diaphragm gauge, allow precision measurement over a wide input pressure range with long term stability and excellent repeatability of zero. Rugged construction permits low-range units (e.g. 100, 10 Torr) to accommodate overpressure to atmosphere without loss of accuracy.

In vacuum systems, the HCM is an excellent alternative to McLeod, Pirani, or thermocouple gauges and is best suited for applications where high accuracy is required.

The HCM is an absolute pressure transducer. In absolute transducers, an integral vacuum reference contains a getter pumped section which minimizes outgassing and ensures a long operating life. This eliminates the need for reference pumps. Since pressure is sensed by measuring pressure-induced displacement of a thin metal diaphragm, calibration accuracy is unaffected by chemical composition of input media.

Corrosive or radioactive gases such as tritium may be monitored without affecting accuracy because the electrically-active portion of the sensor is contained in the sealed vacuum reference.

The transducer's analog output is directly proportional to pressure, and may be recorded by data acquisition systems or read directly on a high-resolution digital voltmeter or a Hastings Capacitance Manometer Power Supply (HCM-300).

Features

- High Accuracy and Resolution
- True Total Pressure Reading
- 0-10 VDC Output
- Stable Zero Reference

Specifications

Ranges: 0-10, 0-100, 0-1000 Torr

Accuracy: $\pm 0.15\%$ of reading

Repeatability: $\pm 0.01\%$ of full scale

Output Signal: 0 to 10 VDC, linear with pressure

Material Exposed to Media: Inconel (Filter = Monel)

Operating Temperature: 0°C to 65°C

Temperature Coefficients zero: 0.005% full scale/ $^{\circ}\text{C}$
sensitivity: 0.02% reading/ $^{\circ}\text{C}$

Resolution: 1 part in 10^4 of sensor full range

Leak Rate to Ambient: less than 1×10^{-10} std cc/sec

Internal Volume: 8.3 cm^3 including $1/2''$ O.D. tube

Pressure Fittings: $1/2''$ O.D. tube standard, $1/2''$ VCR,
KF-16, $1.33''$ CF, (other fittings available)

Transient Response: 8 msec

Diaphragm Resonant Frequency: 2700 - 5500 Hz, depending on range

Power Requirements: $\pm 15 \text{ VDC}$ $\pm 5\%$, regulated
to $\pm 1\%$ at 30 mA

Weight: 1.5 lb. (0.7 kg)

SECTION 2

Installation

Receiving Inspection

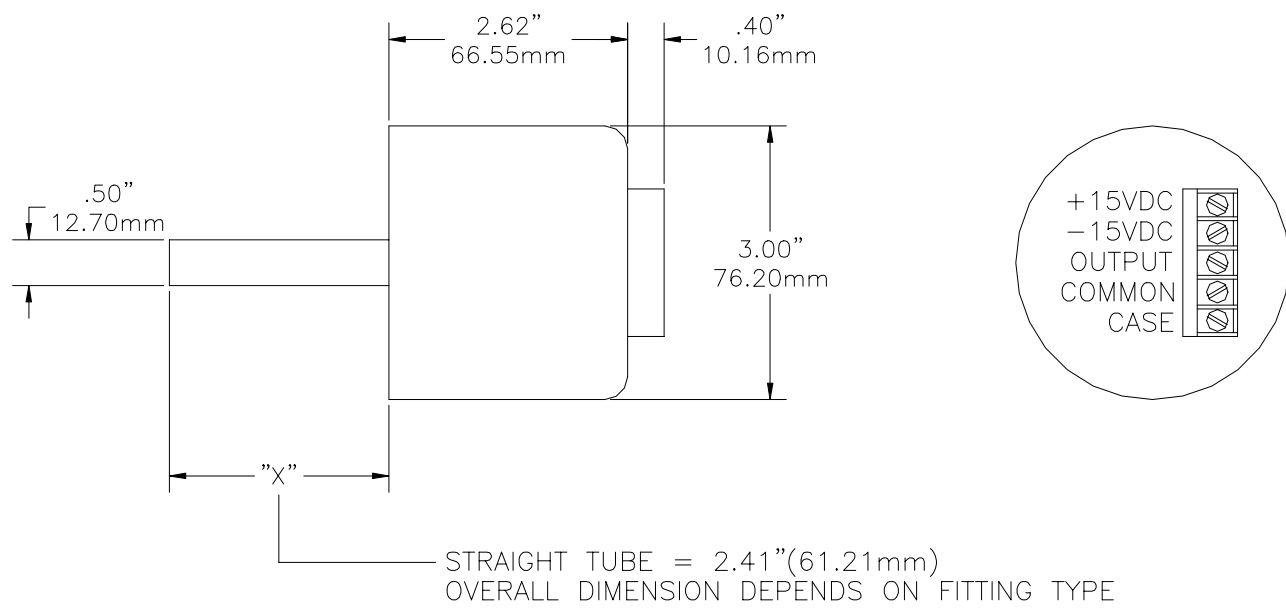
Carefully unpack the transducer. Inspect all items received at this time for any obvious damage that may have occurred during shipment. Immediately advise the shipping agent if there is any damage to items in your shipment. Identify each item and the quantity received with those listed on the packing list. Accessories will be listed separately.

Mounting

The following guidelines for mounting the transducer will improve utility and service.

1. The HCM transducer may be mounted in any position but it is recommended that the pressure port face downward to preclude particles from falling into the transducer. The transducer will easily support its own weight on the pressure fitting.
2. Insulate or protect the transducer from transient sources of heat or cold such as drafts, heaters, air conditioners etc.. Temperature changes can also be introduced by way of the pressure connection.
3. Mechanical vibration will cause noisy pressure readings particularly in low range absolute transducers where air damping of the diaphragm is absent. To minimize vibration problems, such as may occur from motor driven vacuum pumps, the transducer can be mounted to a padded support and a metal bellows inserted between the pressure port and the source of vibration.
4. Plastic or rubber pressure connections should be minimized at low absolute pressures to minimize outgassing and insure accurate readings.

The transducer is most sensitive to vibration along the axis perpendicular to the plane of the diaphragm.

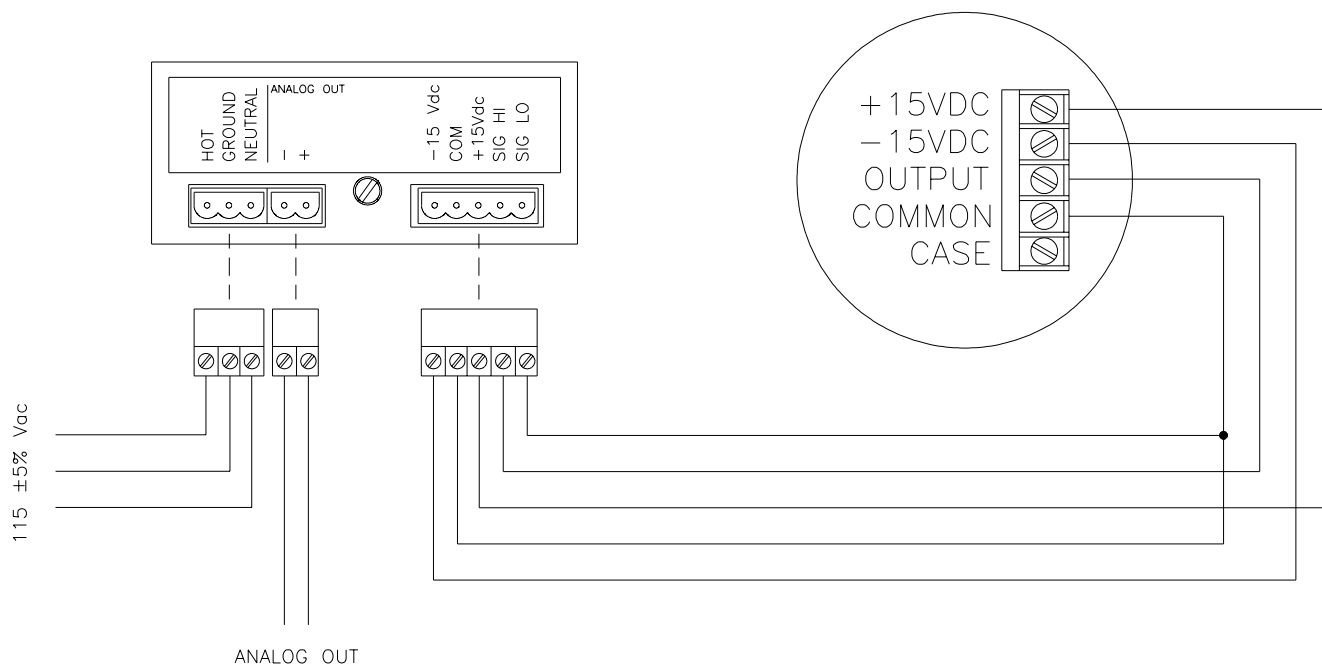


Outline Dimensions

Hastings Capacitance Manometer Power Supply Cable Connections

It is recommended that the HCM-6000 series transducer be powered by the HCM-300 power supply. The connections are shown in the figure below.

If a power supply other than the HCM-300 is used, make certain that it is capable of providing ± 15 VDC regulated to $\pm 1\%$ at 30 mA. In addition, the voltmeter used to measure the transducer's signal must be capable of displaying 10 VDC with a minimum input impedance of 10 k Ω .



General Notes on the Hastings Capacitance Manometer

The HCM transducers experience a small non-repeatability of zero which is caused by overpressure of the diaphragm. This non-repeatability is typically equal to 0.005% of the applied pressure. This zero shift can be eliminated by adjusting the zero control after evacuating the measuring inlet to a pressure whose value is insignificant compared to measurement accuracy (see Zero Adjustment in Section 3). This eliminates the error caused by the overpressure and also the error caused by variations in ambient temperature.

When working with low range (e.g. 10, 100 Torr) pressure transducers, it can be advantageous to mount a blanking valve in series with the pressure inlet so that before the vacuum system is open to the atmosphere the valve can be closed, thereby holding the vacuum at the transducer inlet to no more than 20% over full scale.

SECTION 3

Operating Information

Warm Up

Time for a complete warm up is three hours. The HCM transducer can be affected by temperature changes. See temperature coefficients specification on pg. 1-3. Operate the HCM transducer continuously to ensure optimum performance.

Overpressure

CAUTION: To avoid damage to the transducer, do not exceed 1.25 times full scale range or 35 psia, whichever is greater.

Zero Adjustment

After installation, the system should be checked for a zero pressure reading by first evacuating the transducer to a pressure lower than the digital display resolution (see table below). Adjust the zero pot.

Note: *The zero pot can be accessed with the transducer cover still attached by removing the round rubber boot.*

READOUT DIGITS	3-1/2	4-1/2
Transducer Full Range (Torr)	Zeroing Pressure (mTorr) must be less than:	
1000	100	10
100	10	1
10	1	0.1
1	0.1	0.01

Theory of Operation

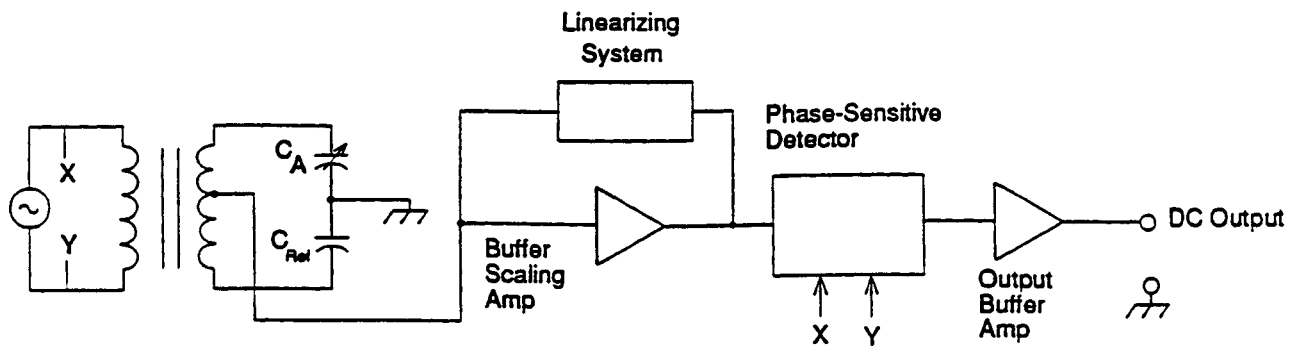
The HCM transducer has a thin, radially tensioned metal diaphragm which separates two volumes. One of these volumes is continuously pumped using getter material to maintain a reference vacuum. The other volume is exposed to the pressure to be measured. Electrodes in the reference vacuum along with the metal diaphragm comprise the capacitor. As the pressure changes, the diaphragm is proportionally deflected thus changing the capacitance between the diaphragm and the electrodes. By measuring the change in capacitance, a direct measurement of the pressure exerted by the gas on the diaphragm is obtained.

The transducer capacitor forms one element of a fixed frequency, constant amplitude bridge circuit. See schematic on page 3-4. As the capacitance changes due to pressure changes, the bridge becomes unbalanced and an ac signal related to the pressure is produced. This signal is fed into a buffer amplifier which uses a linearizer to vary the feedback to obtain a signal which is within 0.05% of the applied pressure.

The amplified signal then goes to a phase-sensitive detector. The AC signal is demodulated and a DC voltage is produced. A final stage output buffer amplifier generates a voltage level which can either be measured directly by the user or connected to the HCM-300 which in turn displays the result.

The reference capacitance electrode (C_{ref}) and the diaphragm motion sensing electrode (C_a) are made of “thick films” fired onto a massive one-piece ceramic substrate forming parallel-plate capacitors. The diaphragm and its support plate are also a one-piece construction. Dimensional changes in the spacing of the electrodes due to differential thermal coefficients of expansion of the structures (either motion parallel to the diaphragm or perpendicular to it) cause each of the capacitances to change by the same fractional amount, but produce no change in bridge output. During manufacture, the reference volume is pumped to high vacuum, baked out, and hermetically sealed. Getter material is activated during the sealing process so that degassing does not compromise the integrity of the vacuum reference.

The ceramic substrate is attached to the diaphragm tension plate by a fully-elastic system. This mounting absorbs stress induced by differential thermal expansion coefficients of the system (and transient temperature changes) eliminating thermal hysteresis and non-repeatability. Further, the strength of the substrate carries the forces from overpressure, and the elasticity of the mounting system eliminates overpressure non-repeatability effects.



SECTION 4

Maintenance and Repair

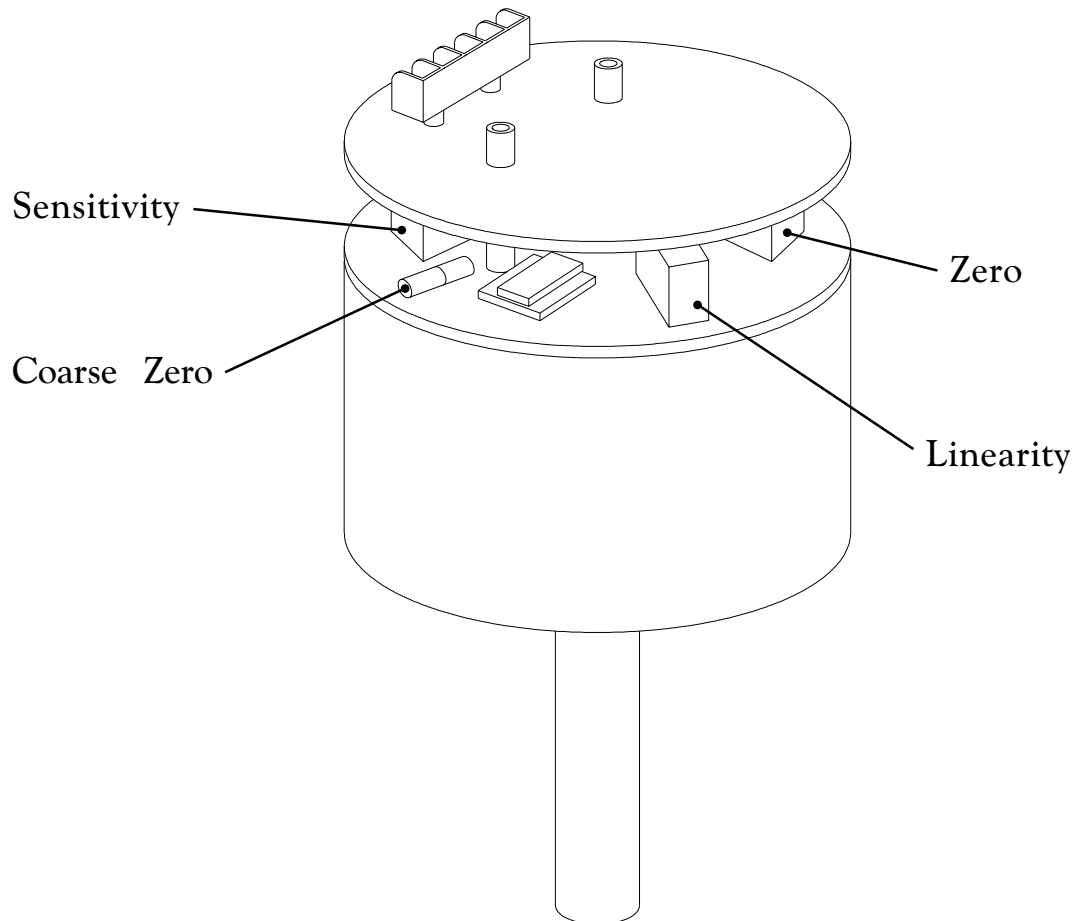
Cleaning

Hastings does not recommend that the customer attempt to clean the transducer. Units requiring cleaning should be returned to Hastings.

Internal Adjustments

If adequate pressure standards are available, the transducer may be recalibrated. The location of the adjustment pots is shown below. The cover must be removed to access these pots.

Note: Both the zero and the sensitivity may change with the cover removed.



CAUTION

Only qualified personnel should remove the cover and/or attempt adjustments.

Return Information

If you wish to return a transducer to Hastings, following these general procedures will ensure optimal service-return:

- 1) Call 1-800-950-2468 for a Return Material Authorization (RMA) number.
- 2) Read and fill out the Health and Safety Clearance Form in this section. It's suggested that you make a copy of the blank form to keep for future use.
- 3) If a transducer is to be returned, follow the transducer return instructions in this section.
- 4) Cover any ports to keep packing material out of the unit.
- 5) Pack the unit carefully with plenty of shock absorbing material. Preferably, use the original packing carton.
- 6) Enclose a description of the symptoms in as much detail as possible.
- 7) The package can be sent via Parcel Post, Air Freight, or any normal transportation, according to your requirements. Return to factory must be prepaid, as we cannot collect shipments.

HEALTH AND SAFETY FORM HS1 PROCEDURE FOR RETURNING CAPACITANCE MANOMETER EQUIPMENT TO HASTINGS INSTRUMENTS OR OUR AUTHORIZED DISTRIBUTORS

Our aim is to deal expediently with your product and we seek your co-operation in complying with both this form and Form HS2. Their purpose is to enhance health and safety and to minimize risk. Adherence to these forms will assist you in fulfilling your legal obligation.

When returning equipment to us or an authorized dealer, the following procedures must be followed:

1. Any fluid or lubricant or gases in the equipment or accessories must be drained or purged by yourselves and disposed of safely.
2. All accessories must be removed and, if contaminated and requiring our attention, sealed in heavy gauge polythene and secured with the other equipment.
3. All filter elements must be removed and disposed of by yourselves as contaminated waste, if applicable.
4. All outlets, including those resulting from the removal of accessories, must be sealed with suitable blanking covers or heavy gauge PVC tape.
5. All contaminated equipment must be sealed in heavy gauge polythene, preferably a bag. Large equipment should be securely strapped to a suitable pallet, preferably no larger than 510mm x 915mm (20" x 35"). If you have difficulty complying with these requirements please contact the service center prior to dispatch.
6. The pallet must be labeled in accordance with the appropriate regulations which cover the packaging, transportation, and labeling of dangerous substances.
7. You must notify the anticipated delivery date of the equipment in writing by completing form HS2. The HS2 form must be received in advance of the arrival of the equipment.
8. A copy of form HS2 must be handed to the carrier who must be informed if the consignment is hazardous. The original HS2 form must be securely fixed to the exterior of the consignment packaging in a suitable envelope.
9. It is recommended that contaminated equipment is transported only in vehicles where the driver is in a separate cab, not sharing the same air space as the load.
10. We want to deal with your equipment as quickly as possible, but failure to comply with these procedures will lead to delay. This could affect the repair, refurbishment, or the issue of credit where appropriate.

COMMUNICATION WITH HASTINGS INSTRUMENTS

Any communication relating to this instruction or the product should be directed to Hastings Instruments or to your supplier.

Please specify:

1. the model and serial number
2. the date of purchase
3. your order number and the supplier's invoice number

HEALTH AND SAFETY

Legislation requires employers to conduct their business so as not to expose persons outside of their employment to health and safety risks. When goods are returned to the supplier, warning must be given if their usage is likely to render the equipment hazardous in any way. Your attention is drawn to Form HS2.

Hastings Instruments and its distributors reserve the right to refuse any returned equipment which they have reason to believe may be hazardous.

DAMAGE IN TRANSIT

If any damage has occurred in transit, inform both the carrier and supplier within three days of delivery.

Advice regarding the return of Hastings products or the completion of Form HS2 can be obtained from the Warranty or Service Departments of the appropriate service center.

EQUIPMENT MUST NOT BE RETURNED WITHOUT PRIOR NOTIFICATION

Return of Equipment - Declaration (form HS2)

Return Authorization Number: _____

You must:

- Know about all of the substances which have been used and produced in the equipment before you complete this Declaration.
- Read the procedure (HS1) on the previous page before you attempt to complete this Declaration.
- Contact your supplier to obtain a Return Authorization Number and to obtain advice if you have any questions.
- Send this form to your supplier before you return your equipment.

SECTION 1 : EQUIPMENT

Equipment model _____

Serial number _____

Has the equipment been used, tested or operated? yes ☐ Go to section 2
no ☐ Go to section 4

SECTION 2 : SUBSTANCES IN CONTACT WITH THE EQUIPMENT

Are any of the substances used or produced in the equipment

- Radioactive yes ☐ no ☐
- Biologically active yes ☐ no ☐
- Dangerous to human health and safety? yes ☐ no ☐

If you have answered "no" to all of the above questions, go to Section 4.

Your supplier will not accept delivery of any equipment that is contaminated with radioactive substances unless you:

- Decontaminate the equipment
- Provide proof of decontamination

YOU MUST CONTACT YOUR SUPPLIER FOR ADVICE BEFORE YOU RETURN SUCH EQUIPMENT.

SECTION 3: LIST OF SUBSTANCES IN CONTACT WITH THE EQUIPMENT

Substance name	Chemical symbol	Precautions required (for example use protective gloves, etc.)	Action required after spillage or human contact

SECTION 4: RETURN INFORMATION

Reason for return and symptoms of malfunction: _____

If you have a warranty claim:

who did you buy the equipment from? _____

give the suppliers invoice number _____

SECTION 5: DECLARATION

Print your name: _____ Print your job title: _____

Print your organization: _____

Print your address: _____

Telephone number: _____ Date of equipment delivery: _____

Signed: _____ Date: _____

Warranty Repair

Hastings Instruments will repair or replace, at their option, any product covered under the warranty expressed in the front of this manual, that is returned transportation prepaid to their plant in Hampton, Virginia. All products returned must be accompanied by a Return Materials Authorization (RMA) form or a written description of the problem with the instrument. Please consult the factory for your RMA number before returning any product for repair.

Non-Warranty Repair

Any product returned for a non-warranty repair must be accompanied by a purchase order authorizing repair up to 1/3 the list cost of a new product and the RMA form or a written description of the problem with the instrument. If the repair cost is higher, you will be contacted for authorization before we proceed with any repairs. If you then choose not to have the product repaired, a minimum will be charged to cover the processing and inspection. Please consult the factory for RMA number before returning any product for repair.

**Teledyne Brown Engineering
Hastings Instruments
804 Newcombe Avenue
Hampton Virginia, 23669 U.S.A.
Attn: Repair Department**

Telephone	757-723-6531 800-950-2468
FAX	757-723-3925