NDT INTERNATIONAL, INC.

711 S. Creek Road
West Chester, PA 19382

(610) 793-1700
FAX (610) 793-1702
www.ndtint.com E-mail: ndtint@ndtint.com

Operating Instruction Manual

Revision 2

NDT-710 Ultrasonic Thickness Gauge

NDT- 710 Ultrasonic Thickness Gauge Operating Instructions

Rev. 2

Table of Contents **Page No.**

A Basic Introduction to Ultrasonic Thickness Gauging

Ultrasonic thickness gauging is a widely used technique for measuring the thickness of a material from one side. The first commercial ultrasonic gauges, using principles derived from sonar, were introduced in the late 1940's. Small portable instruments dedicated to a wide variety of applications became common in the 1970's.

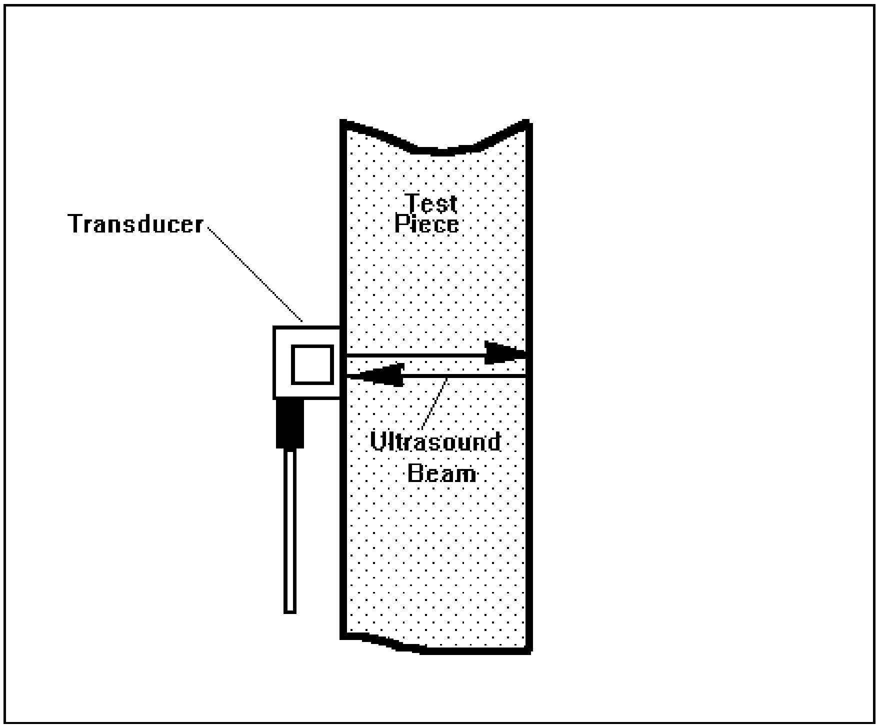
Sound energy can be generated over a broad frequency spectrum. Audible sound, for example, is restricted to a low frequency range with a typical upper limit of twenty thousand cycles per second (or 20 Kilohertz or KHz). Ultrasound is sound beyond the limit of human hearing; frequencies that are too high to be detected by the human ear. Thickness gauges for industrial use operate at frequencies in the Megahertz range, typically from 1 to 20 MHz.

Ultrasound at high frequencies, because of the very short wave-length, has the advantage that it can be used to make very accurate thickness measurements on most engineering materials. Even more important, measurements can be made from one side only as the ultrasound waves inside a material will bounce back from the opposite surface (like an echo). Thus thickness measurements can be made instantly and accurately when the other side of the test part is impossible or difficult to reach, with no need to cut parts for access. Ultrasonic thickness measurements will save material, time, and labor costs.

HOW DOES IT WORK?

All ultrasonic measurements require two components: an electronic device (the gauge itself) and an ultrasonic transducer. In order to make a thickness measurement the gauge transmits a pulse of electrical energy to the transducer, which then converts this energy into high frequency sound waves. This ultrasound enters the test material at the point of contact and propagates through the material until it reflects from the opposite surface. Some reflected sound will travel back to the point of entry, where it's detected by the same transducer. In essence, the transducer listens for the echo from the opposite side. In turn, the transducer converts sound energy into electrical energy. The electronic circuitry of the gauge then precisely measures the time interval between the initial pulse (or reference pulse) and the echo from the back wall. Typically, this time interval is a few millionths of a second. The gauge computes actual thickness of the test material by multiplying the time interval by the speed of sound in the material and then dividing this by two in order to compensate for the round-trip transit time.

It is important to note that the velocity of sound in the test material is an essential part of this computation. Different materials transmit sound at different velocities, and the sound velocity in some materials will change significantly with temperature or composition. Therefore it is always necessary to calibrate an ultrasonic instrument to the speed of sound of the test material at hand. Accuracy of a measurement will be only as good as this calibration.



It is practically impossible to efficiently transmit ultrasound from the transducer to the object to be measured without the aid of a suitable coupling medium, usually referred to simply as couplant. Couplants frequently used for thickness gauging are water, oil, gel, glycerin, and propylene glycol. In practice, a small amount of couplant is applied between the transmitting face of the transducer and the test surface.

WHAT MATERIALS CAN BE MEASURED?

Virtually any engineering material can be measured ultrasonically. Ultrasonic thickness gauges can be set up for metals, plastics, ceramics, composites, epoxies, and glass. Liquid levels and biological samples can also be measured. Materials generally not suited for conventional ultrasonic gauging include wood, paper, concrete, and foam products. Online or inprocess measurement of extruded plastics or rolled metal is often possible, as are layers or coatings in multi layer materials.

THINGS TO CONSIDER

For any ultrasonic gauging application, the choice of gauge and transducer will depend on the material to be measured, thickness range and accuracy requirements, geometry and temperature, and any special conditions that may be present. Listed below, in order of importance, are brief descriptions of some of the conditions that should be considered.

Materials

Material is the most important determinant in final selection of gauge and transducer. Certain materials, including most metals, glass, and ceramics, are excellent for sound propagation and lend themselves to a wide range of measurement modes and transducer frequencies.

Other materials, such as plastics, absorb ultrasound more quickly and have a limited measurable maximum thickness range. They are generally measured with gauges that utilize contact type transducers. Rubber, fiberglass, and composites are even more attenuating and often require gauges with special high penetration pulser/receivers and low frequency transducers.

Thickness

Thickness ranges will also dictate the type of gauge and transducer to be selected. In general, thin materials require high frequency transducers and thick or attenuating materials require lower frequencies. Very thin material may not be within the range of a gauge utilizing contact transducers; a delay line transducer may then be the answer. Similarly, gauges with delay line and immersion transducers have limited maximum thickness capabilities primarily due to potential interference from a multiple of the interface echo.

Geometry

A contract transducer is preferred for most ultrasonic measurements, unless sharp curvature or small part size makes contact measurements impractical. As the surface curvature of the test piece increases, the coupling efficiency from the transducer to the test piece is reduced. In general, as the surface curvature increases, the size of the contact transducer should be reduced. Extreme curvature or inaccessibility of the test surface requires a system with a delay line or an immersion transducer.

Temperature

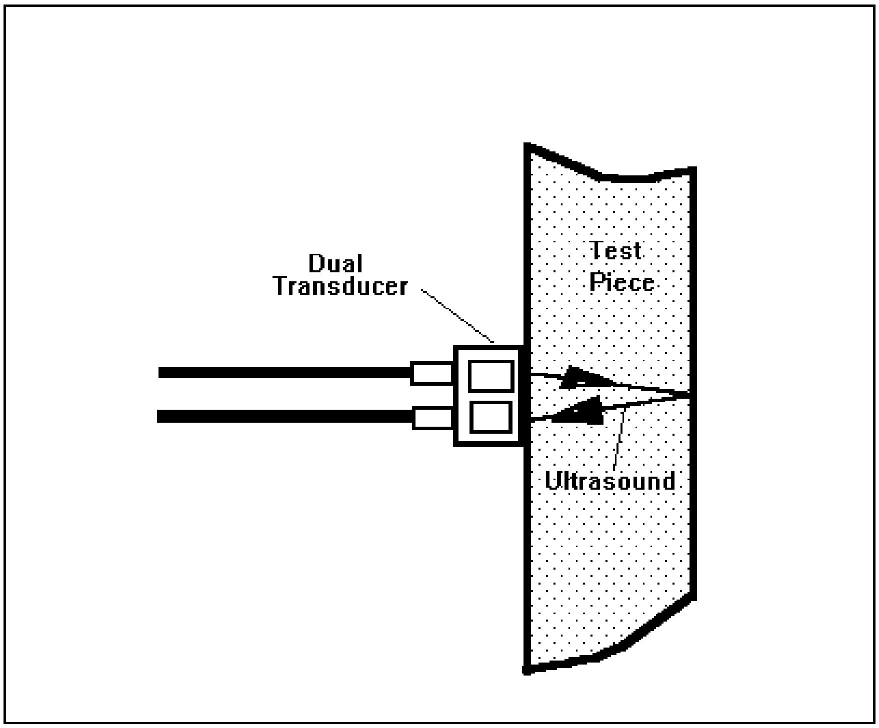
Contact transducers can be safely used on material surfaces up to 120 F (50 C). Thickness measurements with contact transducers on material surfaces in excess of these temperatures will result in transducer failure. Transducers with special heat resistant delay lines are recommended on hot or warm surfaces above +180 F.

Accuracy

It should be considered that many factors may affect accuracy: sound attenuation and scattering, sound velocity variations, poor coupling, surface roughness, non-parallelism, curvature, echo polarity, etc. Selection of the best possible combination of gauge and transducer should take into account all these factors. With proper calibration, measurements can usually be made to an accuracy of 0.001 inch or 0.01 mm.

Dual Transducers

The most common application for thickness measurements involves "dual" or "pitch-catch" transducers. This is the type used with the NDT-710 thickness gauge. These employ separate transmitter and receiver transducer elements mounted on a delay line. The two-transducer elements are slightly angled towards each other, creating a “V” shaped sound path beneath the surface of the part. Although measurement with dual transducers is not as accurate as with other types of measurements, they provide better performance on rough or corroded surfaces as found in pipelines, storage tanks, pressure vessels, structural support beams, and most other metal components exposed to the weather and extremes in temperature, pressure and humidity.



Specifications:

The NDT-710 Ultrasonic Thickness Gauge is a Pulse/Echo type ultrasonic instrument that uses a hand held dual element transducer to measure the thickness of metallic and nonmetallic materials.

Measurement Range:	0.030 to 19.999 inches in carbon steel. This is dependent upon the transducer used and the material measured. The standard kit transducer will read to a minimum of 0.040"
Resolution:	± 0.001" (± 0.01 mm) up to 1.000 inches (25.3 mm) ± 1% from 1.000 to 19.999 inches
Velocity:	0.0197 to 0.3936 *in/µ second* (500 to 10,000 *m/s*)
V-Path Correction:	The microprocessor automatically adjusts for linearity
Display:	4 ½ digit LCD display
Backlit Display:	Set to "AU" - will light when transducer is coupled to material, and will to shut off automatically after 10 seconds of non use. Set to "ON" - backlight will come on when gauge is turned on and remain on until gauge shuts off. Set to "OFF" - backlight will remain off.
Temperature Range:	+10 to +120F (-10 to +50C)
Size:	1.4" H. x 3.1" W. x 5.7" L.
Weight:	11 ounces

Features:

Automatic Zero adjust circuit for fast calibration
Automatic shut-Off 2 minutes last measurement or key pressed
Retains the last reading in memory
Battery life is approximately 75 hours continuous use from one 9 volt alkaline battery with backlight turned OFF
Low battery level indicator in display
Coupling indicator
The backlit display liquid crystal display (LCD) gives easy-to-see thickness readings in most lighting conditions
Keypad has built-in 0.250" thick calibration block

The standard kit includes the NDT-710 gauge, a 0.25" element diameter (.41" contact face diameter) x 5.0 MHz dual element transducer with comfort grip housing on 4-foot long top-exiting cable with LEMO #00 plug connectors, a 4 oz. bottle of top quality ultrasonic couplant, operation manual and a padded accessory bag.

Operation

1) Connect the dual element transducer to the connector sockets at the top of the gauge.

2) Turn the NDT-710 gauge on by pressing the ON/OFF key at the upper left of the keypad. If the gauge has already been calibrated it will display the last reading taken; otherwise the gauge will display "PROB" (problem). When this appears proceed with the Zero Calibration Procedure. The "PROB" indicator will also be displayed when the NDT-710 is turned on after installation of a new battery and may indicate a battery connection or a probe cable problem.

   Power will remain on for approximately two (2) minutes after the last thickness reading is taken of from the last key is pressed.

3) Couple the transducer to the calibration block using an acceptable couplant material. The coupling indicator **(:)** turns off when the transducer is properly coupled to the test piece.

4) Apply pressure to hold the transducer flat against the surface of the calibration block or test piece.

5) Observe the thickness reading at the point where the transducer is in contact with the calibration block or test piece.

6) Use the (INCH / MM) key to switch between inch (19.999 max) and millimeter (199.99 max) units.

Note: Always clean and apply couplant to all surfaces to be measured. Large deposits of couplant remaining on the transducer may cause an erratic display when the transducer is not coupled to the product.

Zero Calibration Procedure

This procedure must be performed every time the transducer is changed, whether the replacement is the same type or not. This Zero calibration will compensate for the varying thickness of the delay line built into every dual element transducer.

1) Connect the transducer to the NDT-710 Gauge and press the (ON / OFF) key.

2) Make sure the surface of the calibration disk on the panel is clean.

3) Apply a thin layer of ultrasonic couplant to the calibration disk.

4) Press the (CAL) key: **(CAL)** will appear on the LCD display.

5) Couple the transducer to the calibration disk with steady pressure, and hold until the LCD displays **(- - - -).** Once this display appears the gauge is calibrated and is ready to measure carbon steel material.

Calibration to a Known Thickness

To measure materials other than carbon steel follow this procedure. A calibration standard of the same material and of known thickness is required. For best results, the thickness should be equal to or slightly greater than the thickness of the part to be measured. The standard Zero Calibration step, explained previously, must be done prior to this calibration.

1) Apply a thin layer of couplant to the calibration standard. Place the transducer on the standard and make sure the reading is stable. The reading obtained will not necessarily match the known thickness of the calibration standard.

2) Uncouple the transducer from the same and use the UP **(▲)** or DOWN **(▼)** keys to adjust the LCD display until it shows the same thickness as the sample block.

3) You are now ready to measure. This adjustment is saved in memory and will not change until the Zero Calibration step is repeated.

Using A Special Application Transducer - Sensitivity Adjustment

When using other than the standard transducer provided with the NDT-710 gauge it may be necessary to make an adjustment to the sensitivity pot. This adjustment may be necessary when using these special application transducers:

Part No.	710-2HT	High Temperature Transducer
	710-3	Low Range Transducer
	710-4	High Power Transducer
	710-7	Small Diameter, Higher Resolution Transducer
	710-8	Pencil Type Transducer

It should not be necessary when using these transducers:

Part No.	710-1	Standard Transducer
	710-1HT	High Temperature Transducer
	710-5	Small Contact Diameter Transducer
	710-6	Low Profile Transducer

Sensitivity adjustment is performed as follows:

1) Connect the transducer to the gauge and turn gauge ON.

2) Remove the small black cap located to the right of the transducer connectors at the top of the gauge.

3) Locate the small slotted pot just inside the case.

4) Using a small screwdriver, turn the pot full Counter Clockwise (CCW).
NOTE: Full movement of this pot is about ¾ of a turn.

5) With the transducer on the gauge keypad 0.250" calibration block, push (CAL).

6) Observe that the display shows **(: CAL).**

7) Turn the sensitivity adjustment pot gradually, in a Clockwise (CW) direction, until the display changes to **(- - - -)**, which indicates proper calibration of the transducer to the gauge.

8) Place the transducer on various other known thickness samples to verify the transducer measurement range. It may be necessary to make a fine adjustment CCW or CW to obtain the maximum correct range.

9) Once set, replace the small black cap. The gauge will then be calibrated for optimum accuracy and range for that transducer.

LCD Display Backlight

1) To turn on the backlight press the **(CAL)** key and the up arrow key **(▲)** at the same time. **(OFF)** will appear in the display signifying that the backlight is off.

2) While holding **(CAL),** press **(▲)** again and **(ON)** will appear signifying that the backlight is on continuously.

3) Press **(▲)** again and **(AU)** will appear in the display signifying that the backlight in automatic mode. In this mode the backlight will come on when the transducer is coupled to material and will to shut off automatically after 10 seconds of non-use. This mode will extend battery life.

Battery Replacement

1) The Low Battery indicator is a small arrow **(←)** which will appear in the upper left of the display window, above the coupling indicator. This lights when the battery drops below the proper operating level.

2) The battery should be replaced within two hours after the indicator lights. If not, the readings can become unreliable.

3) Slide the battery cover on the bottom of the shell to the rear.

4) Remove battery holder from battery compartment and remove old battery.

5) Insert new 9VDC battery observing proper polarity. Reversed batteries may cause permanent damage.

   NOTE: Some older gauges used (4) "AAA" batteries.

6) Install the battery cover.

ALWAYS CARRY A SPARE BATTERY.

Maintenance

1) DO NOT WRAP THE TRANSDUCER AROUND THE GAUGE. This will damage the LEMO connector sockets.
2) Check the transducer cable regularly for cuts or abrasions and that connectors are securely attached.
3) The LCD is made of glass and may break if the gauge is dropped. Be careful.
4) Keep the gauge clean. DO NOT clean the gauge with any solvents or abrasives. Use a mild glass or window cleaner applied with a soft rag.

Optional Accessories:

Nylon Instrument Case with Neck and Wrist Straps — Part No. 710-IC
Replacement Padded Nylon Carry Bag — Part No. 710-CC

Transducers:

Standard 0.25" element diameter (.41" contact area) x 5.0 MHz provides a measurement range of 0.040" to 12.000" — Part No. 710-1

High Temperature 0.25" element diameter (7/16" contact diameter) x 5.0 MHZ transducer - for temperature use up to 500 ^{o}F (260 ^{o}C), provides a measurement range of 0.150" to 6.000" — Part No. 710-1HT

High Temperature 0.50" element diameter (0.63" contact diameter) x 2.25 MHz transducer - for temperature use up to 500 ^{o}F (260 ^{o}C), provides a measurement range of 0.150" to 6.000" — Part No. 710-2HT

Low Range 0.25" element diameter (0.38" contact diameter) x 7.5 MHz transducer provides a measurement range of 0.030" to 2.000" — Part No. 710-3

High Power 0.50" element diameter (0.62" contact diameter) x 2.25 MHz transducer provides a measurement range of 0.200" to 10.000" — Part No. 710-4

Small Diameter 0.18" element diameter (0.25" contact area) x 5.0 MHz transducer provides a measurement range of 0.040" to 2.000" — Part No. 710-5

Low Profile, same as P/N 710-1, but with side exiting cable — Part No. 710-6

Small Diameter/High Resolution 0.18" element diameter (0.25" contact area) x 7.5 MHz transducer (range of 0.030" to 2.000") — Part No. 710-7

Pencil Type, 0.25" element dia. x 5.0 MHz (0.38" contact diameter), 0.040" to 6.000" range, in 3" long housing — Part No. 710-8

Reference blocks (traceable to NIST), nickel-plated steel:

4-step (0.250" to 1.000") — Part No. 4SB
5-step (0.100" to 0.500") — Part No. 5SB
6-step (0.040", 0.100" to 0.500") — Part No. 6SB

Also available in 7075 aluminum or 304 stainless steel and in metric dimensions

Ultrasonic Couplant:

4 oz. or 12 oz. plastic squeeze bottles, ULTRAGEL-II (-10 to +210 F.) in cases of one dozen bottles per case or by the gallon in collapsible plastic container.

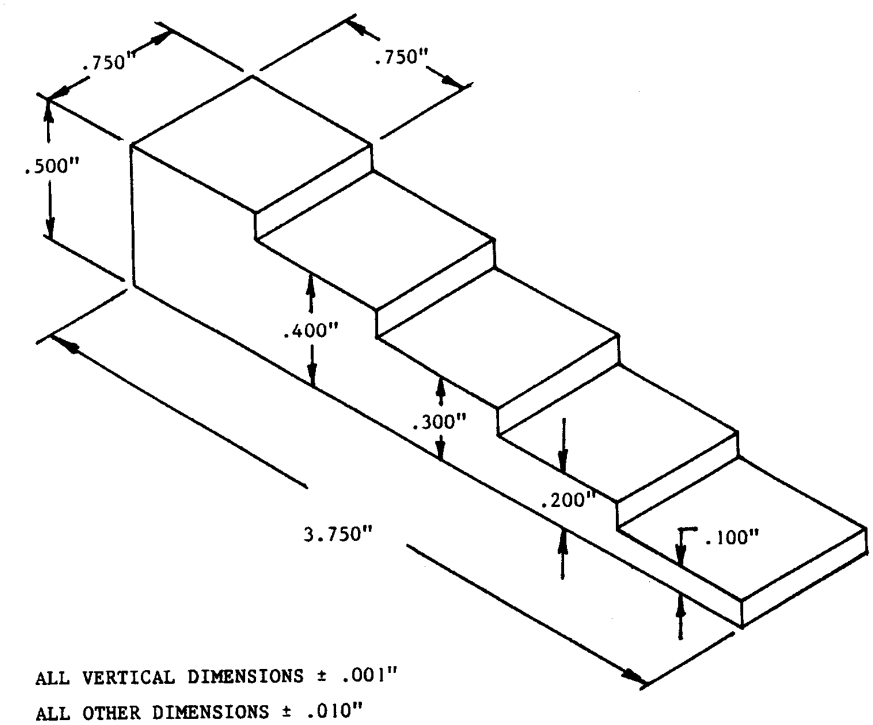
High temperature couplants (+600 and +900 F.) available in 4 oz. tubes only

VELOCITY and CONVERSION FACTOR TABLE

Material	Longitudinal Velocity Inch/µSec	mm./µsec	Conversion Factor from Mild Steel
ALUMINUM	.248	6.32	0.93
BERYLLIUM	.507	12.9	0.45
BRASS	.169	4.28	1.36
CADMIUM	.109	2.78	2.11
CAST IRON	.189	4.80	1.22
COPPER	.183	4.66	1.26
DIAMOND	.690	17.5	0.33
GLASS (Crown)	.207	5.26	1.11
GLASS (Window)	.267	6.79	0.86
GLYCERIN	.076	1.92	3.03
GOLD	.128	3.24	1.80
INCONEL	.225	5.72	1.02
IRON	.232	5.90	0.99
IRON (Cast)	.189	4.80	1.22
LEAD	.087	2.16	2.64
LUCITE	.106	2.68	2.17
MAGNESIUM	.248	6.31	0.93
MANGANESE	.183	4.66	1.26
MOLYBDENUM	.248	6.29	0.93
MONEL	.237	6.02	0.97
NEOPRENE	.063	1.60	3.65
NICKEL	.222	5.63	1.04
NYLON 6, 6	.066	1.68	3.48
OIL (SAE 30)	.685	1.74	0.34
PHENOLIC	.559	1.42	0.41
PLATINUM	.156	3.96	1.47
PLEXIGLAS (UVA)	.109	2.76	2.11
PLEXIGLAS (UVA II)	.107	2.73	2.15
POLYETHYLENE	.105	2.67	2.19
POLYSTYRENE	.105	2.67	2.19
POLYURETHANE	.070	1.90	3.28
PORCELAIN	.220	5.60	1.04
RUBBER (Butyl)	.073	1.85	3.15
RUBBER (Vulcanized)	.090	2.30	2.55
SILVER	.142	3.60	1.62
STEEL (Mild) 4340	.233	5.85	1.00 (Factory Standard)
STAINLESS STEEL	.225	5.80	1.02
TIN	.131	3.32	1.76
TITANIUM	.239	6.07	0.96
TUNGSTEN	.204	5.18	1.13
WATER	.584	1.48	0.39
ZINC	.164	4.17	1.40
ZIRCALOY 2	.187	4.65	1.23

EXAMPLE: At factory setting, the NDT-710 Thickness Gauge reads 0.630" when measuring a copper plate. Since the velocity of copper is less than that of steel, the actual thickness would be less than the gauge display reading. Finding the appropriate material in the above table and dividing the gauge reading by the conversion factor (1.26 for Copper) will convert the reading to the actual material thickness. 0.630” divided by 1.26 = 0.500" (the Actual Thickness)

5-Step Steel Thickness Calibration Block (Typical)



Note: The typical thickness reference block is supplied in Ni-plated C1018 steel and is also available in 7075 Aluminum and 304 Stainless Steel. A Metric version is also available in 2.5 mm steps in a thickness range of 2.5 mm to 12.5 mm.

Equipment Warranty

1. Electronic instrumentation manufactured by NDT International Inc. is warranted to be free from defects in workmanship and material under normal use and service for a period of one year from the date of shipment unless otherwise specified.

2. Instrumentation purchased from outside sources, to meet customer's special requirements, is guaranteed by the original manufacturer's warranty only.

3. Ultrasonic transducers and angle beam wedges (shoes) are not covered by the standard equipment warranty. Transducers are considered an expendable item, can be easily damaged through misuse or exposure to extreme temperatures and can be worn out through use on excessively rough surfaces. If transducers experience failure within the first thirty days, and have not been exposed to excessive use, replacement will be considered after examination by NDT International.

4. Warranty repairs are accomplished by NDT International or our authorized representative.

5. Goods or parts that are defective in workmanship and/or material will be repaired or replaced free of charge, FOB authorized repair station, provided that the goods or parts are returned, transportation charges prepaid, within the specified warranty period.

6. Materials returned for warranty repairs must have prior authorization. Obtain a Return Material Authorization (RMA) number from NDT International or our authorized representative prior to shipment. The RMA number must be used on all correspondence and packing lists.

7. Ship prepaid to the address below, ATTN: Quality Assurance Mgr. - Repairs

8. Warranty repairs include all parts and labor. The cost of any travel and/or subsistence to accomplish on-site warranty repairs, if requested by purchaser, is not a warranty item and will be charged to the purchaser in accordance with normal company procedure.

9. The cost of repairing goods damaged during shipment is not covered by this warranty unless specific allowances are made prior to shipment.

For service, repairs or calibration contact NDT at the following address:

NDT **INTERNATIONAL, INC.**
711 S. Creek Road
West Chester, PA 19382-8013 U.S.A.
Phone: (610) 793-1700 FAX: (610) 793-1702
E-Mail: ndtint@ndtint.com

NOTES and COMMENTS