ELECTRONICS FOR INDUSTRY, INC.

DETECTION TOOLS

Model EI-500 Leak Detector

Model EI-300 Stethoscope

Pistol Style Detector
Used in:
Model W-7
Model EI-701L
Model EI-701S

Electronics For Industry, Inc.
6850 SW 79 Terrace
South Miami, Florida 33143-4440

305-233-1640 voice
305-666-4185 fax

sales@e4i.com e-mail
www.e4i.com web site

Version NOV2010
User manual

Introduction to and Applications For: Ultrasonic Testing Ultrasonic Tools Their Uses and Applications

Everything you always wanted to know about ultrasound and ultrasonic detection and probably a lot of stuff you really did not want to know.

INDEX

SECTION 1 - QUICK START

This section is for those who are familiar with Ultrasound characteristics and have some familiarity with Ultrasonic Testing Tools.

If you are new to Ultrasound and Ultrasonic Testing Tools please first read the information on Ultrasound and Ultrasonic tools which can be found in later sections.

It is suggested that you read the detailed information sections before continuing and then return to the quick start instructions.

SECTION 1 - QUICK START

OPERATION AS A LEAK DETECTOR

Pistol Style Detector

Insert the Leak Detection Module (the one with the grill opening at the front) into the recessed front of the Detector body. Be sure that both connector pins line up with the receptacles and that the Module seats fully in the recess. Plug the headset cord connector into the receptacle in the bottom of the "grip" of the gun. You are now ready to search for leaks of any gas or vapor that is under pressure or vacuum.

To remove the Leak Detector module, pull it straight out from the pistol body and store it in the storage slot in the die cut foam.

To search for leaks

1) **Turn the Volume-Sensitivity control located on the underside of the pistol just forward of the trigger all the way up. (a reading of 10 on the dial)**
2) **Hold the unit as you would any gun.**
3) **Depress and hold the trigger to turn on the detector.**
4) **Scan the area of possible leaks with the "muzzle" of the gun.**

A leak sounds like a rushing sound in the headset accompanied by an increase in the meter reading. As you approach a leak, the rushing sound becomes louder and the meter reading continues to increase. A scanning or sweeping back and forth motion of the muzzle helps pinpoint exact location of the leak. As you approach the leak continuously reduce the sensitivity using the knob just forward of the trigger to enable exact pinpointing of the leak.

To demonstrate the approximate sound of a leak and the reaction of the meter to it, hold your free hand in front of the detector and briskly rub your fingers and thumb together, the resulting noise heard in the headset is from the ultrasonic noise generated by the friction at your finger tips.

If the meter jumps too rapidly and bangs against the full-scale side of the meter it may be desirable to reduce the meter sensitivity. Meter sensitivity is adjusted by inserting the adjusting tool (small red screwdriver which came with the kit) into the hole on the left side of the pistol body and setting the desired meter sensitivity. This adjustment does not affect the detection ability of the unit, only the meter sensitivity.

The leak detector is directional and you can follow it directly to a leak. As you approach a leak point the meter may remain at full scale and/or you will not be able to hear a difference in the sound level. When this occurs, start reducing the sensitivity to keep the meter on scale. Continually reduce the sensitivity until the leak point is pinpointed. If it is still too sensitive you can additionally reduce the sensitivity by turning the module sensitivity adjustment located on the top of the black module itself counterclockwise using the black plastic screwdriver which came with the detector kit.

At times it may be desirable to restrict outside interfering ultrasonic noises or to increase the directivity of the unit. To do this, slip the Rubber Focusing Extension onto the front of the Leak Detection module. This also assists in picking up sounds of a small leak in inaccessible locations such as on the rear side of pipe fittings. It also allows one to drag the rubber font end opening along seams and seals without creating a lot of interfering ultrasonic noise.

As a reminder, the knob controls overall sensitivity of the detector, both headset volume and the meter circuitry. To obtain near repeatability of readings, both the knob and the meter sensitivity settings must be the same as during previous tests. As a general rule, once the detector has been in use for a short period of time, the meter sensitivity is seldom touched. You will very quickly find a setting that is satisfactory for almost all your uses.

If when using your leak detector you find the unit is too sensitive, (the meter remains at full scale), when the volume sensitivity knob is all the way down, sensitivity can be reduced further by reducing the sensitivity of the Leak Detector Module itself by adjusting the potentiometer located in the module itself. Use the black plastic screwdriver supplied with your kit to turn down the control through the hole on the top side of the module just forward of the red housing until the meter remains on scale or until the desired sensitivity is set.

Tubular Style Detector

Finding leaks with the Tubular Style detector is the same as when using the Pistol Style detectors. The difference is that the tubular units do not have a meter nor do they have plug in front end units, they are complete and self contained. The rotary control on the top of the unit is the on off and sensitivity control. After plugging a headset into the receptacle on the rear of the detector you then rotate the control forward to turn it on and set the sensitivity and volume level. Now the search is the same as described above. Be sure to turn the unit off when not in use to conserve battery power. The 9-Volt battery is located under the cover toward the rear of the detector unit. Unscrew the two slotted head machine screws to access the battery.

TONE GENERATOR USE

To locate openings or leaks in systems not under pressure or vacuum, such as wind or water leaks in vehicles, leaks around doors, windows, or roofs of buildings, or leaks in vessels, chambers, containers or volumes, use the Tone Generator.

The Tone Generator produces high intensity ultrasonic energy, which is heard as a tone by your ultrasonic detector. Ultrasonic sound, like all sound, will not penetrate a solid but will find its way through openings, cracks and crevices.

The Tone Generator should be placed inside the enclosure. The interior becomes "filled" with high frequency sound, which will leak through any openings. Scan the surface, seams and seals with the detector, using the leak detector module. Anywhere there is a leak the tone will be heard. As stated before the leak source is the loudest point and as you approach the source you may need to reduce sensitivity in order to pinpoint the exact spot.

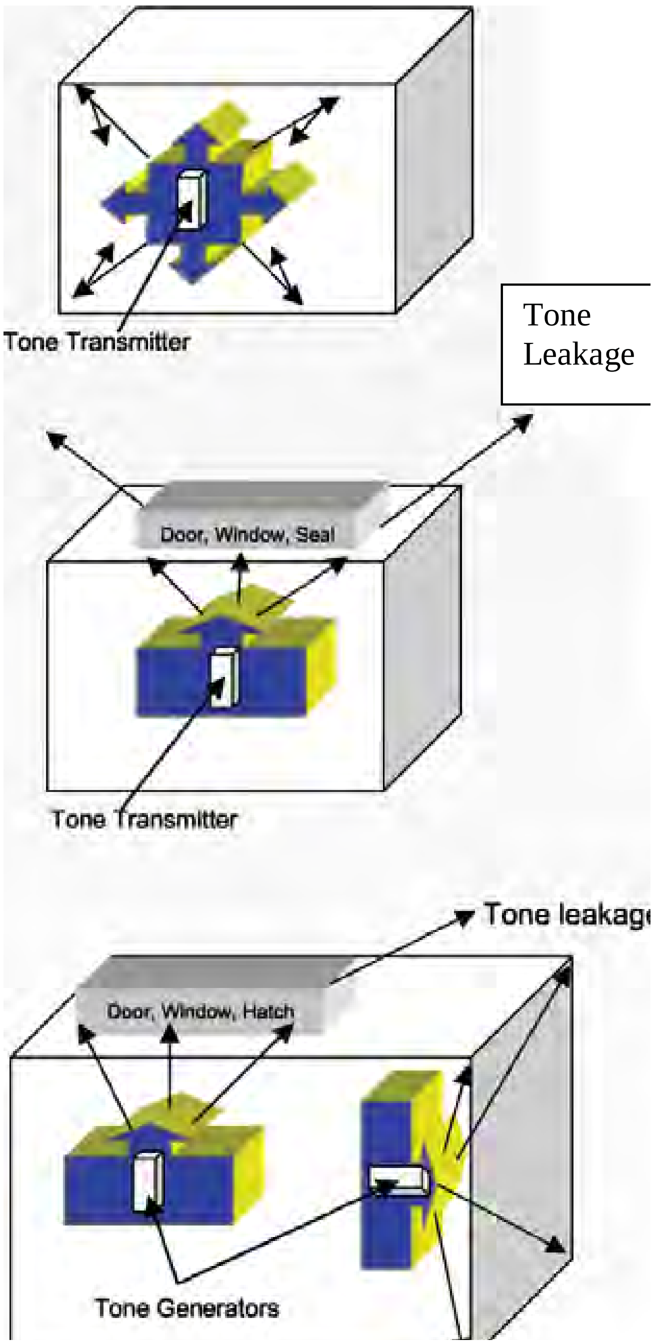
Do not point the detector directly at the tone generator as the energy is so intense it my block the detector, it will not harm the detector but you will not hear any tone.

To test the Tone Generator, turn it on and point the detector away from the Tone Generator when pulling the trigger on the detector.

The ultrasound produced by the Tone Generator is quite intense and can cause a "Drum Head" type of transmission of energy if the enclosure is a thin material, you can dampen this with a rag pressed lightly against the outer side of the "can" being sure not to cover seams or seals.

Ultrasound will not pass through a solid so the "leak channel" must be dry as water in the air path appears as a solid to the ultrasound. This is especially true when looking for leaks in automobile windshields or roof leaks.

The following diagrams are examples of how the tone generator is used to find leaks in various types of volumes but is by no means a complete list of its uses.



Tone generator capacity for a closed volume with hard reflective surfaces and no blocking obstructions such as baffles is approximately 1500 cubic feet and is omni directional.

Note: Additional transmitters can be added to extend coverage.

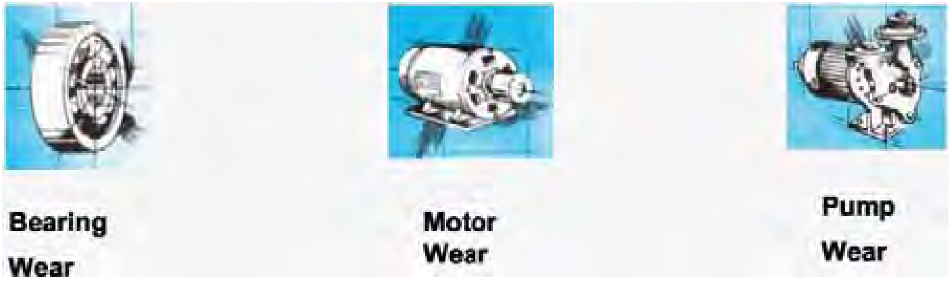
<u>Directional Application:</u>

When a tone generator is placed with emissions directed towards a surface area to be tested the total volume is not a consideration but you should aim the generator at the general area being inspected.

Multiple tone generators can be placed so as to cover a larger area or multiple areas.

One use here is for seams, seals, gaskets, doors or window openings.

OPERATION AS A MICROSONIC STETHOSCOPE



Pistol Style Stethoscope Detector

Insert the Stethoscope Module (the one with the metal probe extending from the front) into the recessed front of the Detector body. Be sure that both connector pins line up with the receptacles and that the Module seats fully in the recess. Be sure the metal probe is screwed into the front of the module only "finger tight". Over tightening could result in internal damage to the Stethoscope Module.

Sensitivity adjustments and calibration are essentially the same as described above for Leak Detector use with the following added stethoscope only adjustment.

If when using your stethoscope you find the unit is too sensitive, (the meter remains at full scale), when the volume sensitivity knob is all the way down, sensitivity can be reduced further by reducing the sensitivity of the Stethoscope Module itself by adjusting the potentiometer located in the module itself. Use the screwdriver supplied with your kit to turn down the control through the hole on the side of the module until the meter remains on scale.

The Microsonic Stethoscope will detect internal sounds in the ultrasonic range. It does not detect the sounds that the ear can hear, or other low frequency sounds, such as a heartbeat. The friction between moving parts of machinery generates ultrasonic sound. As a general rule, the ultrasonic sound is very similar to the low frequency sound heard by your ears, a mirror image but displaced in frequency. If you touch the probe to the case of a mechanical watch, for example, the ticking sound is similar to that heard with the unaided ear. The sound from the stethoscope, however, has much better "definition". Minute sounds are present that was not noticed before.

The stethoscope is detecting sound generated by the friction of the parts rubbing together, and not just the clicking sounds of the escapement, or gear wheels meshing.

As wear begins in machinery, ultrasonic sound from increasing friction is building up long before the unaided ear can hear it. The Stethoscope is valuable because of this. It forewarns you. The repair or maintenance can be carried out at a more convenient time; rather than waiting for failure that always occurs at the most inopportune time. Furthermore, damage is often more severe during later stages of failure.
Since high frequency vibrations do not radiate as much as low frequency vibrations, use of the Microsonic Stethoscope allows you to more readily screen out some sounds and pay particular attention to others.

Internal flow can be heard with the Stethoscope to detect turbulence or blockage in lines or process flow. It is easy to tell if a valve has shut completely, is leaking, or bypassing. You can hear the action of the valve and the flow. As the valve closes completely, flow ceases. If the valve stops moving as if closed, and flow is still heard, the valve has not seated and sealed properly.

The Ultrasonic Stethoscope is the tool of choice for detecting bad or malfunctioning steam traps.

When using a grease gun to lubricate bearings, the stethoscope should be placed on the housing in the vicinity of the bearing as the grease is added. As you add grease the sound will continuously diminish until the optimum grease point is reached, adding more grease will cause the sound to increase and should be avoided as over greasing is as destructive as not greasing a bearing. The Magnetic Stethoscope Module in combination with the Holster makes this operation easier for a person working alone.

Tubular Style Stethoscope

Finding mechanical troubles with the Tubular Style Stethoscope is the same as when using the Pistol Style Stethoscope. The difference is that the tubular units do not have a meter nor do they have plug in front end units, they are complete and self contained. The rotary control on the top of the unit is the on off and sensitivity control. After plugging a headset into the receptacle on the rear of the detector you then rotate the control forward to turn it on and set the sensitivity and volume level. Now the search is the same as described above for the Pistol Style Stethoscope. Be sure to turn the unit off when not in use to conserve battery power. The 9-Volt battery is located under the cover toward the rear of the detector unit. Unscrew the two slotted head machine screws to access the battery. An additional sensitivity control us located under the battery to further reduce sensitivity of you find the unit too sensitive.

SECTION 2 - EFI DETECTION KITS

GENERAL DESCRIPTION OF THE KITS

DESCRIPTION (pictures follow the description pages)

In general an EFI pistol type detection kit is comprised of the EI-701 detector body, a plug in probe (either LM-1 or SM-1) and a headset, either a lightweight headset or deluxe headset (customers' choice). The tubular detectors (shown below) consist of the detector body and headset.

DELUXE HEADSET: The deluxe headset is designed to aid in reduction of outside noises. The headband is usually worn over the top of the head but may be worn at the back of the head to help accommodate a hardhat. The earmuffs cover the ear and fit snugly against the head to block interfering sound leakage.

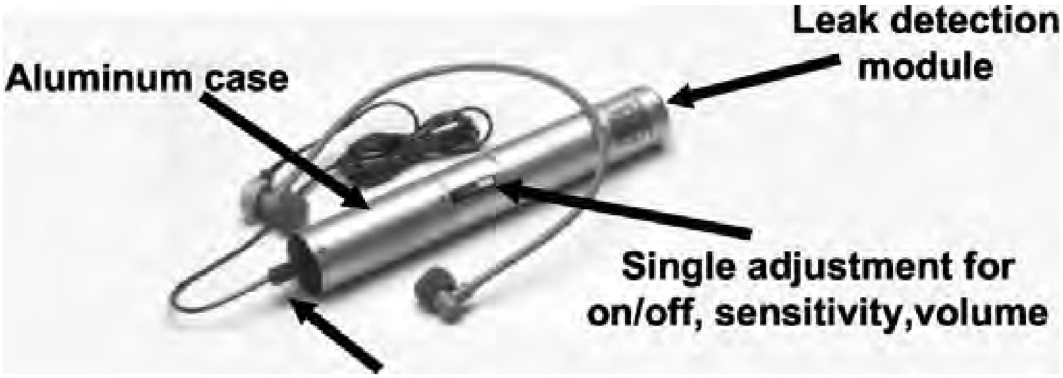
LIGHTWEIGHT HEADSET: The lightweight headset (shown with tubular detectors) is designed to be worn with the tubular band under the chin, this allows for the wearing of a hard hat if necessary. Firmly placing the ear elements in the ear will also provide for reduction of outside noises.

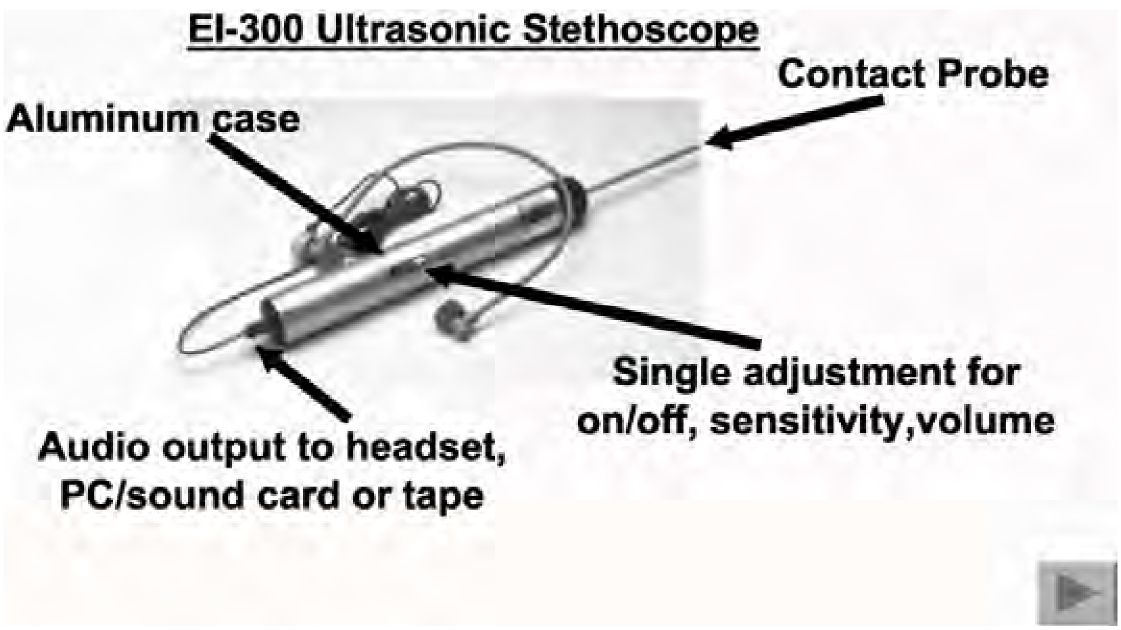
It is highly recommended that you use the headset when using your detector. Listening as well as keeping your eyes on the meter, as much as is safe, makes a search easier. The additional information you get, frequency, repetition rate, and sound discrimination makes locating and pinpointing problem areas much quicker. The meter displays only the sum of all the sounds. However, use of the headset is not absolutely necessary; the headset does not even have to be plugged in for operation of the pistol style detector.

PISTOL STYLE DETECTORS

TUBULAR STYLE DETECTORS

EI-500 Leak Detector





KIT CONTENTS

MODEL W-7 **"Microsonic Detection Kit" consists of the Pistol Style Detector, Leak Detection Plug in Module, Stethoscope Plug in Module, Rubber Focusing Extension, Tone Generator, Deluxe Headset, Carrying Case, Stethoscope Sensitivity & Meter Adjust tools, This manual on a CD and batteries.**

MODEL W-5 **"Wind Noise Test Set" consists of the EI-500 Tubular Style Detector, Tone Generator, Rubber Focusing Extension, Headset (Specify Light-Weight or Deluxe), and carrying case or carrying pouch depending on which headset option is selected.**

INDIVIDUAL DETECTOR UNITS

MODEL EI-701L **"Microsonic Leak Detector" consists of the Pistol Style Detector with a Leak Detector Plug In Module and Deluxe Headset.**

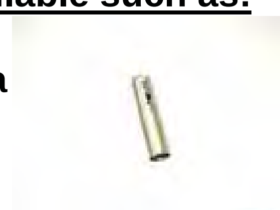
MODEL EI-701S **"Microsonic Stethoscope " consists of the Pistol Style Detector with a Stethoscope Plug In Module and Deluxe Headset.**

MODEL EI-500 " **Microsonic Leak Detector" consists of the Tubular Style Leak Detector, a Headset (Choice of Light-Weight or Deluxe), and a carrying case if the Deluxe Headset is chosen or pouch if the Light-Weight headset is chosen.**

MODEL EI-300 **"Microsonic Stethoscope" consists of the Tubular Style Stethoscope unit, a Headset (Choice of Light-Weight or Deluxe), and a carrying case if the Deluxe Headset is chosen or pouch if the Light-Weight headset is chosen.**

There are several accessory items that are available such as:

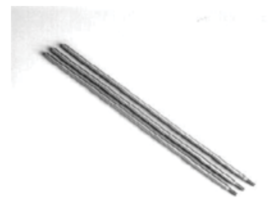
TTG-2 'Tubular Tone Generator" for inserting a tone into pipes or other such small opening spaces.



H-1 "Pistol Holster" which allows the pistol detectors to be worn on a belt. The holster has an additional pouch so that a second module may be stored in it.

MSM-1 "Magnetic Stethoscope Module". A module that plugs into the front end of the Pistol Style Detector with a five foot cord leading to the actual Stethoscope Module which has a rare-earth magnet assembly on the front to allow it to be magnetically attached to the piece of machinery being listened to. This is especially useful when the operator needs both hands free such as when using a grease gun to inject grease in a bearing and listening for the lowest sound point which indicates the optimal grease point.

PK-1 "Probe Extension Kit". Three 12 inch extension rods to extend the reach of the Stethoscope units.



Technical Specifications

Item	Weight	Housing	Length	Width	Power
Pistol Style Detector	1.5 Lbs.	Plastic	8"	2.75"	(1) 9V
Leak Detector Module LDM-1	1.2 oz	Molded Nylon	2.5"	1.5"	N/A
Stethoscope Module SM-1	1.5 oz	Molded Nylon	6.35"	1.5"	N/A
TG-2 Tone Generator	6.3 oz	ABS-T1000 Plastic	5.5"	2.5"	(4) 1.5V AA
Rubber Focusing Extension RFE-1	2.1 oz	Rubber Polymer Mix	8.5"	1.5"	N/A
Probe Extension Kit PK-1	2.5 oz	Aluminum	12" to 36"	-	-
Tubular Style Detector	6.1 oz	Aluminum	8.5"	1.25"	(1) 9V
Deluxe Headset DH-1	9.2 oz	Molded Plastic	-	-	-
Light Weight Headset SH-1	0.7 oz	Molded Plastic	-	-	-
Large Carrying Case CC-800	1.5 Lbs.	Cordura Case	14"	-	-

Operating frequency	**35 KHz to 45 KHz**
Operating Range	**40 + Feet**
Sensitivity:	**"Hear" pressure leaks of .001 @ 3 psi**
Intrinsically Safe:	**Class 1, Division 1, Groups B, C & D**
Output:	**Audio/Visual**

Safety Ratings

The EI-300, EI-500 and TG-2 have been rated intrinsically safe, and designed to meet FM approval for Class 1, Division 1, Groups B, C & D when used with standard carbon zinc batteries. The 701 (Pistol style) has been rated intrinsically safe, and designed to meet FM approval for Class 1, Division 1, Groups C & D when used with standard carbon zinc batteries.

EFI Detectors have been in the market over 45 years and are designed to withstand a rigorous Industrial environment.

Warranty and Repair Service

Your Microsonic Detection Kit is manufactured with high quality components and workmanship and is warranted to be free from failure for a period of one year from date of purchase, battery excluded. This warranty shall not cover or apply (1) to any failure caused by abuse, (2) if it has been tampered with, or (3) if repairs have been attempted by anyone other than Electronics For Industry, Inc. trained service personnel.

Many units returned to the factory for repair have only needed a fresh battery, be sure to replace the battery with a fresh battery before sending your unit for repair.

The pistol unit uses a standard 9 volt battery located in the battery compartment on the left side of the pistol housing grip area. The TG-2 Tone Generator uses four standard AA size batteries located under the battery compartment cover on the left side of the tone generator.

The tubular units use a standard 9 volt battery which is located under the battery cover toward the rear of the unit and is accessed by removing the two slotted head screws.

If a fresh battery does not cure a failure, carefully pack the kit and ship it to:

Service Department
Electronics For Industry, Inc.
6850 SW 79 Terrace
South Miami, Florida 33143-4440

Phone: 305-233-1640
Fax: 305-666-4185

Please include a short note describing your problem or troubles. Your unit will be serviced promptly and returned to you. If it is a warranty repair please include proof of purchase.

For your records, record the date of your purchase:___________________

For more information please visit our web site at: http://www.e4i.com

Our e-mail address is: efi@e4i.com or service@e4i.com

(Sample)

Electronics For Industry Inc.

CERTIFICATE OF CALIBRATION

This certificate attests to the manufacturing standards and equipment calibration relating to the Electronics For Industry, Inc. line of Ultrasonic Detection equipment.

The equipment meets all existing standards as required.

It is certified that these instruments meet or exceed the Electronics For Industry, Inc. standards as outlined in the Electronics For Industry, Inc. standard test and calibration procedures and all applicable ISO 9000 and CE requirements.

All leak detection equipment meet the requirements of ASTME E1002-96 as currently published.

All equipment used to calibrate the ultrasonic equipment is traceable to NBS and is traceable to QEC Standard Meter QE-579 s/n 5225.

Prepared and attested to this date by:

George A. Harris
President

SECTION 3 - INTRODUCTION TO ULTRASOUND

What is Ultrasound?

Sound has been defined as vibration of an air column to which a human ear would respond. Ultrasound is those frequencies that are above human hearing. Humans can usually begin to hear low frequency sound at about 30 Hertz (cycles per second). This is comparable to the low bass frequencies in a good music system. The upper range for high frequency hearing is usually in the neighborhood of 15,000-20,000 Hertz or 15 to 20 Kilohertz. Near either end of this range, hearing sensitivity has decreased significantly; sound has to be louder to be heard. Maximum human hearing sensitivity is in the 2,000 to 4,000 Hertz range, which includes most speech frequencies.

As children age toward adulthood, they gradually lose some hearing sensitivity. Deterioration generally affects the high frequency hearing ability most, and affects males sooner than females. The discrimination might relate to the size (and consistency) of the male eardrum as compared to the female. The older one gets the more high frequency hearing loss is present.

Even though we humans don't have much sensitivity to the higher (or to us, ultrasonic) frequencies, these sounds exist in nature. Bats use high frequency sonar to zero in on flying insects at and after dusk. Crickets rub their legs together and generate considerable high frequency noise as part of the chirp that we hear. (It is interesting to listen to crickets or bats with an EFI leak detector.) Some species of fish use very low frequencies for communication of a sort, and others use high frequencies. Rodents can communicate at frequencies far above our hearing range, up to 100,000 Hertz. Dogs and cats have high frequency hearing sensitivity above our limits. The so-called "silent dog whistles" generate high frequency sound that dogs can hear but humans cannot.

As the frequency (or pitch) of sound rises toward and beyond our upper hearing limit, its characteristics change considerably. If the source is "directional", such as inside a room with an opening, the low frequencies tend to spread out from the opening (source) of sound. High pitch sounds tend to form more of a beam, and the effect is more pronounced as the pitch rises. Higher frequencies are more directional. We know that if a sound source is distant, it does not sound as loud (the intensity is lower).

Sound is absorbed as it passes through air. High-pitched sound is absorbed more than low-pitched sound. Think about distant thunder. We hear a low pitch rumble. If lightning strikes nearby, we also hear a crackle with the rumble. The crackle is the high frequency portion of the noise. The higher frequencies are often absorbed before reaching us.

Relative humidity is a factor in sound absorption. Absorption is much greater in a relative humidity of ten to twenty percent. As relative humidity rises toward or beyond 40%-50%, the absorption for all frequencies is considerably less. The relative humidity factor is emphasized for higher frequencies. High frequency absorption in low humidity can be several times greater than for low frequencies. The bats at Carlsbad Caverns in New Mexico have to be closer to their flying prey to locate them, as compared to more humid locations.

Please remember that we are explicitly referring to sound in air.

A PRACTICAL USE FOR ULTRASOUND

There was little widespread commercial use of ultrasonic sound until the 1950's and 1960's when many televisions were equipped with ultrasonic receivers and external ultrasonic transmitters for remote control. Devices using infrared light later replaced this type of remote control. Research on devices using ultrasonic sound in air became relatively dormant after the loss of the only major product in that field. Only a few engineers who were especially interested in the field continued to work with high frequency airborne sound. Few other commercial applications have surfaced since the remote control era. Of course, if you see a bat flying toward you, you can frighten it away by giving it a blast of ultrasonic sound, but one does not see a bat flying toward one very often. Production of an ultrasonic Bat Chaser doesn't seem practical. A very loud source of high frequency sound energy can frighten mean dogs away. This is another practical application.

HOW AIRBORNE ULTRASOUND TOOL TECHNOLOGY WORKS

Ultrasounds, by definition, are beyond the limits of normal human hearing, so an inspector uses a sophisticated tool to translate ultrasonic signals to the range of human hearing.

The theory of ultrasonic detection is relatively simple. Frequency, the number of times a sound wave cycles from trough to crest, is expressed in cycles per second and measured in hertz. One kilohertz is 1000 cycles per second. The best human ears can generally hear noises in the range of 20 to about 20,000 Hz (20kHz). Ultrasonic detectors work at approximately 40 kHz, far above human hearing range. Thus, mechanics using the ultrasound tool can "hear" what is going on in operating machinery.

Fluid and gas systems and other working machinery have constant ultrasound patterns. When a leak occurs, the fluid passing through produces turbulence with strong ultrasonic components. Changes in the "sonic signatures" can be readily recognized as wear in components. An ultrasonic detector senses subtle shifts in the signature of a component and pinpoints potential source of failure before they cause costly damage.

The longer wavelengths of lower-pitched sounds travel easily and can be heard without special equipment. Higher-frequency sounds cannot penetrate solids; yet they slip through the tiniest of openings Ultrasound detectors are ideal for isolating such leaks.

These lightweight tools are battery powered, so operators can easily move from machine to machine. Their circuitry translates the high-pitched ultrasounds to those in the human hearing range, enabling users to hear a mirror image of the ultrasounds through headphones and gauge their intensity by the increase in sound in the headset and increasing reading on an analog meter.

Any ultrasonic tool should be checked for an intrinsically safe rating before it is used in hazardous areas.

ULTRASOUND AND LEAKS

EFI started production of its line of leak detector tools in the early 1960's. Then, as even now, the only generally practical alternative to these tools for locating leaks is the slow, inconvenient painting of suspected leak areas with soapy water, then watching for bubbles to appear. The EFI detectors are extremely sensitive to the ultrasonic noise generated by leaking pressurized air (or other gas, including steam), but they are as insensitive to ordinary noise as our ears are to ultrasonic noises. The detectors convert ultrasonic sound waves down to sounds that we can hear with our ears. This is similar to the way radios convert radio waves to audible sound.

We all know that a gas/air leak generates noise; sometimes we can hear it. Whether we can hear it or not depends on many factors. Some of those factors are the amount of other noise in the vicinity to mask it, the size of the leak, characteristics (especially the size and shape) of the hole that allows the leakage, the type of material, and the pressure that forces the gas out of the hole.

Leaks generate ultrasonic noise as well as noise that we can hear with our ears. The problem with listening for leaks is that our ears are not sensitive enough, especially for small leaks. They are not very directional due to their design and purpose. Another problem is that there is almost always some normal or machine noise in the vicinity, which would mask the leak source sound.

Using a leak detector to listen for the ultrasonic signature of a leak is far superior to using our ears to locate leaks.

Ultrasonic detectors can be made much more sensitive than the ear to detect leaks. Ultrasonic noise is also much more directional, making it easier to find the leak vicinity, move closer, and then pinpoint the source. In general, there is not much ultrasonic background noise to mask the leak noise. If there are other sources of ultrasonic noise, they are usually widely enough scattered to be unimportant, since ultrasonic noise is absorbed much more as it passes through a distance in air than is normal noise.

The detectors listen for noise in the 40-kilohertz region. This is a compromise. Lower frequencies are more susceptible to common low frequency noises. Higher frequencies are absorbed to a greater extent as they pass through the air.

To better visualize leaks, consider a hose attached to a bib or faucet. The water is turned on, and there is a shutoff nozzle on the end of the hose. You might find a damp spot somewhere along the hose where a leak will soon be apparent. There might be another spot with a very small hole that gradually forms a drip. Surface tension of water tends to hold it together until there is sufficient mass to pull it loose as a drop. There might also be a small hole in the hose that squirts a very fine stream of water. Finally, there might be a leak in the valve, with water coming out around the turn-off valve stem. If the water pressure were quite low, all of these problems would be less apparent. When the pressure is increased, each would be emphasized and become more prominent.

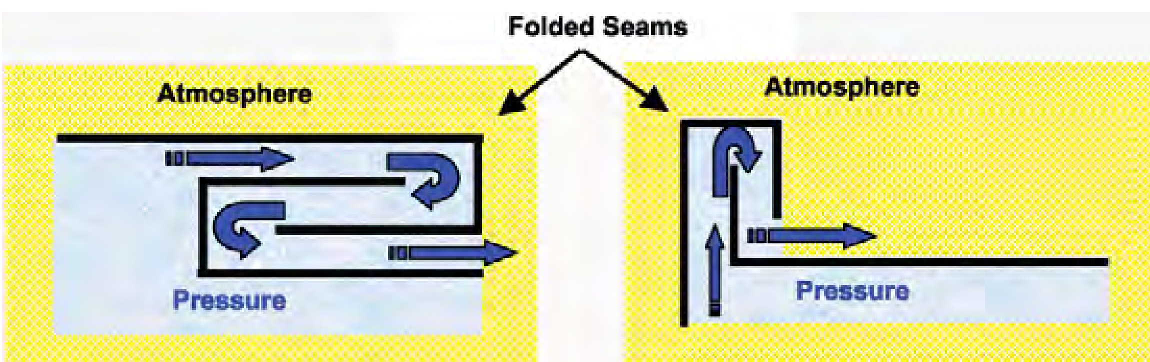
Suppose now that the same system is drained and dry, and is pressurized with air. The spot that was damp might or might not generate ultrasonic noise. Increasing pressure would increase the likelihood of detection. The source of the drip would probably be easy to detect. The air does not have surface tension, and there would be a small steady leak from the hole. As the air escapes from the holes, there would be turbulence and noise generated. As the pressure increases, noise increases. The hole that had a very fine stream of water should generate lots of noise and be detectable at a considerable distance.

Remember that this noise is generated at the point where gas is liberated from the higher-pressure area (inside the hose, through the hole) and out into the lower pressure area. As the higher pressure leakage passes into lower pressure outside, turbulence results, which creates the noise.

In the case of the faucet or any valve, and sometimes with threaded fittings, a different condition can exist. The high to low pressure transition can occur inside the structure, at the valve seat itself. This is the point of maximum energy and maximum sound generation. The sound then must travel through the air path following the threads or down the hose to the exit point, losing energy as it travels.

An example of this would be a welding tank where the valve has not closed completely. The leak is actually at the valve seat, this is the point of maximum energy. The sound now travels down the hose, losing energy as it travels, to the welding tip which is a much larger opening and also disburses the energy instead of concentrating it as a smaller hole would. The result is often less noise than would be expected, requiring the detector to be closer to the leak.

Folded or rolled metal seams/joints on containers or high quality ductwork can cause similar problems. A cross section of this type construction is diagrammed below.



A situation somewhat related to the faucet/threaded-fitting condition is found in searching for leaks in a vacuum system. More noise generating turbulence exists inside the chamber than out, because the high-pressure area is outside. The outside air is forcing its way through the hole into the lower pressure area inside. Detectors on the outside can still be very useful even in this adverse situation since turbulence will exist at the entrance point.

A quick example of the sensitivity of the leak detectors is to put on the headset and turn on the detector. Hold your free hand a few inches away from the front of the detector, and gently rub your thumb and forefinger tips together. The noise you hear is friction generated ultrasonic noise converted

down to the audible sound.

A similar example is to hold the detector opening a couple inches from one eye and then blink the eye rapidly. The friction of the eyelashes rubbing together generates the noise. Yet the detector does not react to ordinary sound in the vicinity. You do not hear people talking or machinery running.

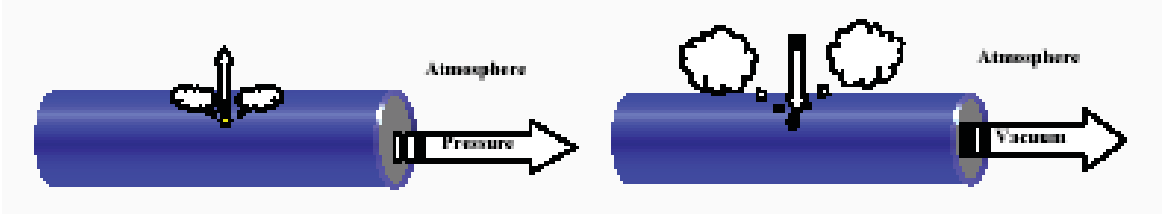
ULTRASONIC LEAK DETECTION

Pressure & Vacuum Leaks

Leaks generates noise. Sometimes we can hear it with our ears, sometimes not. Whether we can hear it or not depends on many factors such as:
1. The amount of other noise in the vicinity to mask it.
2. The size of the leak.
3. The characteristics (size and shape) of the hole that allows the leakage.
4. The type of material and its thickness.
5. The pressure or vacuum that forces the gas in or out of the hole.

Leaks generate turbulence, which generates ultrasonic noise as well as noise that we can hear with our ears. The problem with listening for leaks with our unaided ears is that our ears are not sensitive enough, nor directional enough, especially for small leaks. Another problem is that there is almost always some noise in the vicinity to mask the leak source sound.

Turbulence is produced as fluid or gas moves from high to low or low to high pressure. This turbulence contains strong ultrasonic energy that is detectable by the EFI detection units. This ultrasonic emission, once detected, is heterodyned (shifted in frequency) into the audible range where it can be heard by the human ear through earphones or viewed as an analog readout on a meter.



Sensing ultrasounds generated by a leak, the Microsonic unit can be used to locate leaks in pressurized systems regardless of the type of gas used. This is especially beneficial in areas where there is a saturation of gases or where a wide variety of gasses, pressurized vessels, and vacuum processes exist.

Time and convenience are also improved with ultrasonic detection since equipment may be tested and leaks located while on-line and all the machinery is still operating.

It can be generally noted that the larger the leak, the greater the ultrasound level.

GENERAL LEAK DETECTION METHOD

Ultrasound is a high frequency, short wave signal. The intensity of the ultrasound produced by a leak drops off rapidly as you move away from its source. For this reason, the leak sound will be loudest at the leak site. Ultrasound is fairly "directional" and therefore, pinpointing the source (i.e. the location) of the leak is quite simple.

Using the leak detector, with the sensitivity set at maximum, scan the general area of a suspected leak by waving the detector back and forth and listening for an increase in the hissing sound, (similar to the sound you hear when you fill a tire with air), in the headset and/or a peaking of the meter reading. Move in the direction of the loudest sound. If it is hard to determine the direction of the loudest sound, reduce the sensitivity until direction can be established. Follow the sound and continue to reduce the sensitivity to determine the direction of the leak. In order to confirm the leak site, move the detector back and forth over the suspect area. The sound level will increase as you pass over the exact leak point. In some loud factory environments shielding of the transducer may be required by using the rubber focusing extension or other shielding methods as explained below.

INTERFERENCE SOLUTIONS

If there is ultrasonic interference in the vicinity of leak you are searching for, reduce the sensitivity of the detector and work closer to the item being tested, or try one of the following:

- 1. Turn your back to the source of interference so that the detector is facing away from the trouble source. Ultrasound is extremely directional and your body acts as a sound block.
- 2. In extreme cases put an "ultrasound blocker", a "sound barrier", between the interference source and the area you are searching. An ordinary clipboard placed to reflect the sound back in the direction of the interference works well. A flexible curtain will absorb some of the sound, and reflect some back toward the source of the noise. Plastic sheeting is often used; the smooth surface is especially effective in reflecting the sound back toward the source. It is possible to make an

"ultrasonic soundproof" room or area in the midst of an otherwise noisy area this way.

- **3. The rubber focusing extension is also helpful in screening out ultrasonic noise interference. If there is too much ultrasound in the area, reduce the sensitivity setting and continue to scan. If it is difficult to isolate the leak due to competing ultrasound, place the rubber-focusing extension over the detector module and scan the test area. Listen for a rushing sound while observing the meter. Follow the sound to the loudest point. The meter will show a higher reading as the leak is approached. In order to focus in on the leak, keep reducing the sensitivity setting and move the tool closer to the suspected leak site until you are able to confirm the exact leak point.**

  To confirm a leak, position the rubber focusing extension (on the leak detector module) close to the suspected leak site and move it slightly back and forth in all directions. If the leak is at this location, the sound will increase and decrease in intensity as you sweep over it. In some instances, it is useful to position the rubber focusing probe directly over the suspect leak site and push down to seal it from surrounding sounds. If it is the leak, the rushing sound will continue. If it is not the leak site, the sound will drop off.

- **4. Wrapping a shop rag or towel around the detector and rubber focusing extension can also help block interfering ultrasonic noises.**

- **5. Another method is to put the shop rag over the suspected leak creating a void over the leak. Insert the end of the rubber focusing extension (on the leak detection module) into the area of the suspected leak. The area will be isolated from the surrounding ultrasound thus making pinpointing much easier. Sometimes a gloved hand can create the same effect.**

SAFETY FIRST, ALWAYS AVOID ANY PERSONAL CONTACT WITH MOVING, HOT/COLD, HIGH PRESSURE OR ELECTRICALLY CHARGED SURFACES

Common Sources of Interference

Expansion Valves in high pressure refrigerant lines: As the high-pressure liquefied refrigerant expands to gas, it can sound as if the entire surface of the expansion valve is leaking. To find leaks in these systems, it is generally better to shut the system down. While the high pressure is in the lines, make an immediate search for the leaks.

Glass bottles on conveyers: Bottles rattling against each other on a moving conveyer line can generate very high intensity ultrasonic noise. When searching for leaks in the vicinity of these lines, it is often better to wait until the line is stopped or to make a "sound proof" test area by enclosing the test area with visquine.

Pneumatic equipment and tools: Some air operated equipment regularly exhausts air, which amounts to a large leak. Try steps 1, 2, 3, above, if this does not help you may have to wait until the interfering equipment is not in use.

Grinders: Grinding machines and cutting wheels, especially when cutting metal, create large amounts of ultrasound.

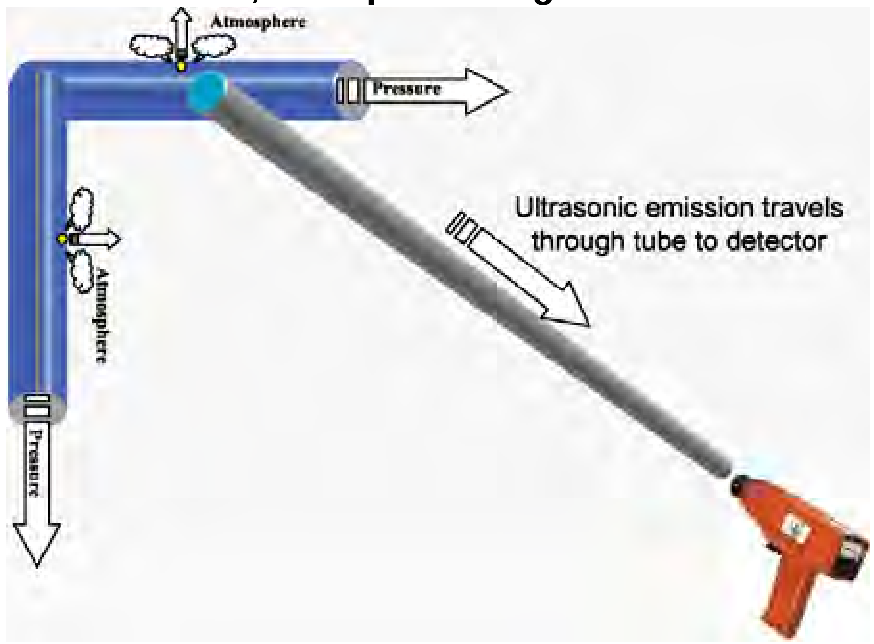
Computers: Computers are now found almost everywhere; they are often in maintenance offices, and sometimes on factory floors to control equipment or processes. Some computers and some computer displays (monitors) generate ultrasonic noise. Transformers in both sometimes operate at an electronic frequency comparable to that of the leak detectors. The transformer structures can vibrate at the operating frequency and generate ultrasonic noise. A noisy high voltage (flyback) transformer is an example. This noise when heard using a leak detector does not sound like a leak, it usually sounds more like a tone, buzz, or whistle. This is a good example of where the meter reading would only tell part of the story. The meter would read as if a leak were being detected but by listening you would be able to identify the type of sound and know it was not a leak.

Arcing: Electrical arcing creates turbulence in the air, which creates ultrasound. Again the signature is different from that of a leak. Low level arcing, called corona, would sound like a 60 cycle buzz. Arcing or sparking as around a defective spark plug wire would sound more like crinkling cellophane.

ADVANCED METHODS OF FINDING STUBBORN OR HARD TO GET AT LEAKS

WAVE GUIDES

When a suspected leak source has been identified by scanning an area that is not easily accessible for leak verification, a simple wave guide can be used to gain access to an ultrasonic emission. A simple wave guide can be made from ¾ inch PVC tubing cut to the desired length. One open end is extended to the suspected area and the leak detection unit (W7 or EI-500) is inserted in the other end. Ultrasonic emission if present will travel within the tube to the detector. A flexible wave guide can be made from 1.75 inch rubber hose or the rubber focusing extension can be used.



LIQUID LEAK AMPLIFICATION

Liquid leak amplification is the use of a LOW surface tension fluid that produces a thin film through which the escaping gas will pass. When it comes in contact with a low flow of gas, it quickly forms a large number of small bubbles that burst as soon as they form. This bursting effect produces an ultrasonic shock wave that is heard as a crackling sound in the headphones. In many instances the bubbles will not be seen, but they will be heard. This method is capable of obtaining successful leak checks in systems with leaks as low as 106 standard cc/sec.
If there are situations where a signal may be difficult to isolate, it may be helpful to reduce sensitivity. Point the system toward the test area and gradually reduce sensitivity until the weak signal becomes clearer and then follow basic detection methods.

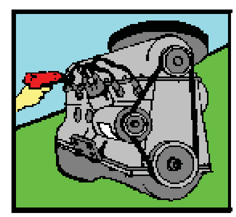
When testing for low volume pressure leaks, apply liquid at the test area and scan with the leak detector. For valve stems, seams, flexible materials and seals the contact probe can be used at the suspected leak point.

SECTION 4 - USES & APPLICATIONS
USES FOR THE TOOLS

Typical Applications:

- **Pinpoint pressure and vacuum leaks of any gas, air, steam or vapor.**
- **Find leaks around seals, seams, welds, hatches, fittings, and bulkheads, without pressure.**
- **Listen to internal, mechanical operations to predict failure or track wear**
- **Compressed air leaks.**
- **Steam systems (Traps - Valves - Gaskets - Boilers).**
- **Check bearings for wear and lack of lubrication.**
- **Motors, Pumps, Gear Boxes for internal wear.**
- **Electrical Systems for Arcing, Sparking and Corona.**
- **Hydraulic Systems (Valves, Seals, Controls).**
- **Drive Belts for cracks, wear and slippage.**
- **Enclosed Areas (Rooms, Containers, Roofs, Windows, etc.)**
- **Check Valves, Gaskets, Seals and Seam Leaks.**

Identify and locate engine, transmission, or rear end noises:

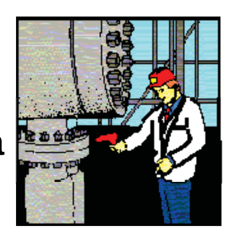


The Microsonic Stethoscope allows you to hear the noises from inside machinery without hearing all that is going on around you. By contacting the housing in the vicinity of the moving parts you will hear what is happening inside. Is it a smooth normal sound or a rough, intermittent or grinding sound? To listen to rear ends, differentials, rear axles with the vehicle on a lift you listen at various points while turning the wheels by hand to control the speed and better identify problems. Engines are analyzed by listening to the individual valves and pistons. Since ultrasound does not travel as normal sound does you can actually hear individual valves.

Bad spark plugs, leaking transmissions, radiator or block leaks are best found with the Microsonic Leak Detector.

Pinpoint Pressure or Vacuum Leaks:

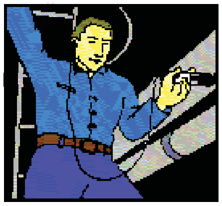
The Microsonic Leak Detector hears the high frequency energy created by any gas or vapor escaping in or out of an orifice. The Microsonic Detectors do not hear sounds the normal ear hears so it is easy to pinpoint leaks even in a very “noisy” shop.



By pointing the front of the detector at the leaking flange or joint you will hear the rushing or hissing sound that indicates a leak. Be sure to check the threaded fasteners that hold the

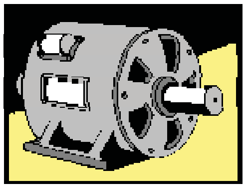
flange together, it may be one of these leaking, not the gasket.

In Manholes:



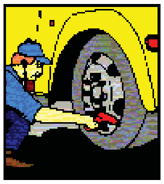
Steam pipes, compressed air, pressurized telephone cables are just a few of the many things that are run under the street that can develop leaks. Many of these leaks can be heard by placing the front end of the Microsonic Leak Detector at the "Pry hole" of the manhole before even opening the manhole. Once you hear the leak in the manhole then you can go into the manhole and pinpoint the tube, pipe or cable that is leaking and then make repairs.

Hear unusual noises motors:



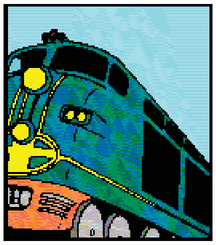
The Microsonic Stethoscope allows you to hear the noises from inside machinery without hearing all that is going on around you. By contact the housing in the vicinity of the moving parts you will hear what is happening inside. Is it a smooth normal sound or a rough, intermittent or grinding sound? Do you hear the brushes arcing? Can you hear the brush holders dragging? Is the shaft running true? Pinpoint these and other problems at an early stage so you can plan maintenance and have the necessary parts ready. Don't wait for an emergency breakdown and try and jury rig the repair because you do not have the right parts on hand.

Tires and Air Brakes:



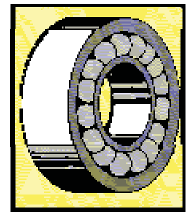
Hear the leaks from a distance. Simply scanning the vehicle will tell you if there is a leak in the air brake system or tires. Once you hear the leak then you move closer and closer until you pinpoint the exact source. When you do your walk around to check the lights you can detect tire or brake problems that would cause you trouble in today's run.

Railroads:



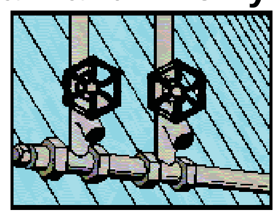
As the train rolls by you can hear the sounds of an airbrake leak but not the sounds of the train itself. With the Microsonic Detectors you can also hear a dragging brake as the train rolls by. Once the train has stopped you use the detector to pinpoint the exact leak spot. The Microsonic Detectors are good for finding leaks in the Diesel system, around injectors and gaskets. Using the stethoscope you can hear pistons moving, individual valves opening and closing and listen to the flow at the injectors to "hear" clogged injectors. Using the stethoscope to listen to the internal operation for correct sequencing facilitates trouble shooting pneumatic and hydraulic system problems.

Bearings:



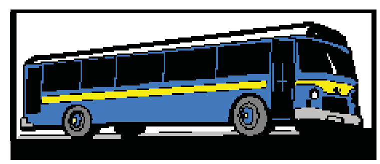
Over greasing a bearing is as bad as not greasing a bearing. Too much grease results in too tight packing, additional friction and pressure and heat build up. By listening to the bearing with the Microsonic Stethoscope while adding grease you can determine the optimum grease point. Use the stethoscope to listen at the bearing housing and begin pumping grease with your grease gun. As you add grease the sound diminishes, at the optimum point the bearing is quietest, as you add still more you will hear the sound begin to increase, stop, you have the optimum grease. For ease of use we offer a magnetically positioned transducer to leave both hands free while using your grease gun.

Leaking or Bypassing Valves:



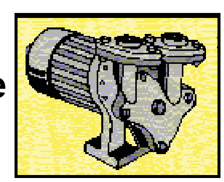
How often have you turned off a valve to work downstream and when you opened the system downstream you found the valve had not shut off fully? Use the Microsonic Stethoscope to listen at the valve as you shut it off. No noise, it is off. Still hear noise, it did not shut off fully and you are hearing flow, do not open the system downstream. Prevent chemical spills.

Busses:



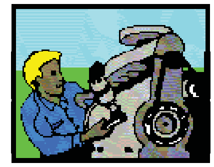
The Microsonic Detection Tools have many uses in Bus maintenance and repair. Air brake system leaks are readily detected and heard. Pneumatic system leaks or mal functions are easy to trouble shoot. Air conditioning problems and leaks are readily found. Tire and valve stem leaks are quickly located and pinpointed. Water leaks around the windows, door and baggage compartment seals are easily found and repaired and re-checked using the Tone Generator, a water test is never needed.

Pumps:



Are the valves opening and closing, as they should? Is there cavitation? Can you hear air in the chambers or lines? Is the pump running as smoothly as it should? Are the seals leaking? "Hear" the problem in its early stages so there is time to plan repairs, don't wait for disaster to strike.

<u>Diesel or Gas engines:</u>

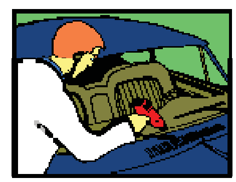


Listen to pistons, valves, vacuum systems, head gasket leaks. Find faulty injection systems, irregular firing as well as carburetor and intake leaks. All these problems and more are easy to find using the Microsonic Detectors because you do not hear the background noise or the other noises that your normal ear hears and that keep you from hearing and finding these problems with your unassisted ears

<u>Steam Traps:</u>

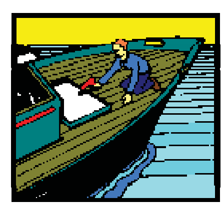
Is it stuck open, is it stuck closed? Does it cycle properly? Is my steam trap working as it should. Listen with the Microsonic Stethoscope and you will answer all these question with the greatest of ease. Even with the plant noises at their highest level you can hear the "operation" of your steam trap because the Microsonic detectors do not hear all that other plant noise.

<u>Wind Noise and Water Leaks in Vehicles:</u>



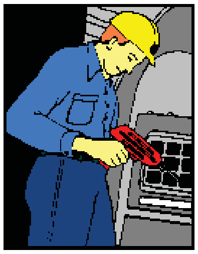
Put the Tone Generator inside the vehicle and turn it on. It fills the compartment with high intensity, high frequency sound energy. Sound will not pass through a solid but it will find any opening and work its way through. A leak is an opening from the outside to the inside. Anywhere there is an opening the high frequency energy will escape. Using the Microsonic Detector you will hear the escaping energy as a tone or whistle in the headset and there will be a rise in the meter reading. The closer you get the louder it will be until you reach the source, as you pass it the sound diminishes. You have now pinpointed the problem. Repair it and check it again, repair more if needed but you never need to wet the car. All searching and repairing is done while the vehicle is dry. No road testing for Wind Noise problems.

<u>Boats:</u>



Easily find where the water is entering around windows, portholes, and hatch covers. Hull leaks and seals are quickly checked using the Microsonic Detectors.

<u>Boilers and Heat Exchangers:</u>



Boiler tube leakage or blockages can be heard by listening on the outside of the shell in the vicinity of the tubes. Leaking or blocked tubes generate a different sound than normally operating tubes.

Heat exchangers of all kinds can be tested using the Tone Generator. The tone generator is set to impinge its energy on the outside of the tubes and the Microsonic Detector is used at the tube ends to listen for the "tone" that will be heard where there is a holed or leaking tube. If the leak is around the end roll then the tone will be heard around the periphery of the tube in question. Use of the Rubber Focusing Extension is recommended to make pinpointing easier. For very large heat exchangers the use of multiple tone generators to create a higher level of energy around the tubes is recommended.

<u>Compressors and Pneumatics:</u>

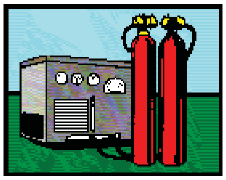
Pinpoint leaks in pneumatic systems that cause your compressor to run and run. Continuously running compressors means wasted electricity and wasted dollars. Continuously running compressors means replacing compressors before their time.

Continuously running compressors means you are not getting the air (or vacuum) to the tools that it is supposed to feed which means additional wear on these tools or machines and loss of production time.

Easily pinpoint these leaks as you walk through your plant. Take the Microsonic Detector with you and scan the plant as you walk. Make notes of the leaks and then when there is time available you know exactly where to send the repair person. Over a period of time you will clean up your plants leaks and save many dollars.

Leaks in Pneumatic Controls and their lines means your machinery or process is not working as it was designed. Pinpoint these leaks, Pressure or Vacuum and get the process working efficiently again.

<u>Any Gas or Vapor</u>:



The Microsonic Detectors "hear" the sound of a leak. It does not matter what is leaking, any gas of vapor. Compressed air, steam, oxygen, nitrogen, freon, any gas or vapor.

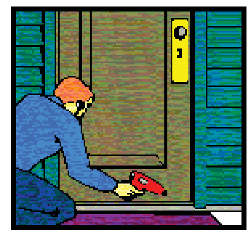
Aircraft:

Pressurization leaks, Pitot Static System leaks, Instrument air or suction leaks, leaks around the instrument faces, oxygen system leaks as well as water leaks into the cabin or the baggage compartment or the avionics area. Pinpoint and stop the water incursion before serious damage occurs. Find and fix those pesky wind noise whistles.

Using the stethoscope you can listen at the face of the gyro instruments to tell which one is starting to have trouble, don't wait until it fails in flight, predict failure and fix it before it becomes critical.

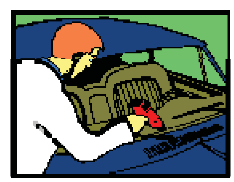
Seams and Seals:

Find leaks around doors, chambers, around windows, in roofs, refrigerators or compartments, virtually any enclosed area.



Find leaks in soundproof rooms. Find where you are losing air conditioning and heating. Seal your premise, why pay to heat or air condition the great outdoors?

Place the Tone Generator on one side of the surface to be tested (or inside the enclosure) and work the outside to listen for the Tone that indicates a leak. Repair it, seal it and then re check it to be sure it was done properly.

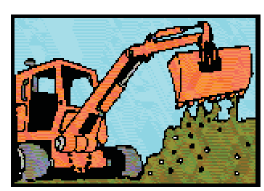


Delicate Machinery:

The extreme magnification of internal sound by the Microsonic Stethoscope allows you to hear the changes in even the most delicate bearings or machinery. If you know what you are listening to you can even hear the mechanism of a fine safe or lock. By listening over a period of time, you will develop a sound pattern that is normal for you machinery. When something starts to go bad you will know it and be able to effect repairs before the machine is damaged or the precision work it is supposed to do is compromised.

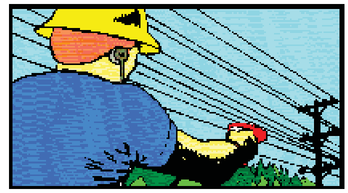
Hydraulics:

Using the Microsonic Stethoscope you will readily hear malfunctioning hydraulic systems. Bypassing cylinders, mal functioning valves and other system problems.



ELECTRICAL

Overhead Lines:



Hear the problem from the ground, no need to climb the pole or tower to tell where the leak is. Pressurization leaks in telephone overhead lines are readily heard from the ground. Just walk the line aiming the detector at the lines until the leak is heard.

Switch Gear – Pot Heads – Corona – Leak detection

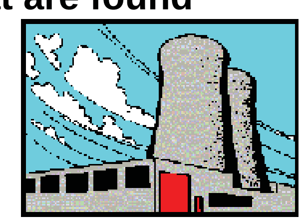
Ceramic Stress Tracking - Corona

Arcing – Sparking Tracking - Corona

Electrical Discharge:

Corona Arcing and Sparking in overhead power lines and transformers and other electrical equipment is readily detected.
Corona is heard as a 60 Hertz buzz, arcing and sparking sound like crinkling cellophane, sparking is intermittent, arcing is continuous when heard using the Microsonic Detectors.
Electrical problems in switch gear and substations are easily spotted. While you are checking the sub station don't forget to check air operated circuit breakers and for nitrogen leaks in the transformers.
Leaking insulators cause insulator deterioration and radio and TV interference. These corona or arcing problems can be detected from the ground. The higher the voltage the higher the line is above the ground but the higher the potential energy and thus the higher the ultrasonic energy that is created allowing you to detect the problem from the ground even for the high cross country lines.

Power Generation:



Power generating stations have most of the problems that are found elsewhere in this document. Pinpoint Vacuum leaks, pressure leaks, pneumatic controls, bearings, controls, hydraulics, compressors, switch gear malfunction, pumps, electrical corona arcing and sparking. All these problem areas and more are areas of use for the Microsonic Detectors.

SECTION 5 - MECHANICAL ULTRASONICS

Mechanical Ultrasonics

ROTATIONAL EQUIPMENT PRODUCES AN ULTRASONIC EMMISION RESULTING FROM FRICTION BETWEEN MOVING PARTS

How Mechanical Inspection Works

Mechanical movements produce a wide spectrum of sound. By focusing on a narrow band of high frequencies, the Ultrasonic unit detects subtle changes in amplitude and sound quality. It then heterodynes these normally undetectable sounds down into the audible range where they are observed on a meter (for trending and comparison purposes) and heard through headphones.

Based on research by NASA, it was established that ultrasonic monitoring provides early warning of bearing failure. Various stages of bearing failure have been established. An 8 dB gain over baseline indicates pre-failure or lack of lubrication. A 12 dB increase establishes the very beginning of the failure mode. A 16 dB gain indicates advanced failure condition while a 35-50 dB gain warns of catastrophic failure.

Mechanical Ultrasonic Detection

Mechanical inspection - Ultrasonic inspection and monitoring of bearings is a reliable method for detecting incipient bearing failure. The ultrasonic warning appears prior to a rise in temperature or an increase in driving torque. Ultrasonic inspection of bearings is useful in recognizing the beginning of fatigue failure, brinelling of bearing surfaces, flooding of or lack or lubricant.

In ball bearings; as the metal in the raceway, roller, or bearing balls begins to fatigue, a subtle deformation begins to occur. This deforming of the metal will produce an increase in the emission of ultrasonic sound waves. When testing, changes in amplitude of from 12 to 50 times the original reading is indication of incipient bearing failure. When a reading exceeds any previous reading by 12 dB, it can be assumed that the bearing has entered the beginning of the failure mode.

This information was originally discovered through experimentation performed by NASA on ball bearings. In tests performed while monitoring bearings at frequencies ranging from 24 through 50 kHz, the changes in amplitude indicated the onset of, or incipient, bearing failure before other indicators; including heat and vibration changes. (An ultrasonic system based on detection and analysis of modulations of bearing resonance frequencies can provide subtle detection

capability, whereas conventional methods have difficulty detecting very slight faults.) As a ball passes over a pit or fault in the race surface, it produces an impact. A structural resonance of one of the bearing components vibrates or rings by this repetitive impact. The sound produced is observed as an increase in amplitude in the monitored ultrasonic frequencies of the bearing.

Brinelling of bearing surfaces will produce a similar increase in amplitude due to the flattening process as the balls get out of round. These flat spots also produce a repetitive ringing that is detected as an increase in amplitude of monitored frequencies.

The ultrasonic frequencies detected by the system are reproduced as audible sounds. This signal can greatly assist a user in determining bearing problems. When listening, it is recommended that a user become familiar with the sounds of a good bearing; often heard as a rushing or hissing noise. Crackling or rough sounds indicate a bearing in the failure stage. In certain cases a damaged ball can be heard as a clicking sound, whereas a high intensity, uniform rough sound may indicate a damaged race or uniform ball damage. Loud rushing sounds similar to the rushing sound of a good bearing only slightly rougher can indicate lack or lubrication.

Pro-Active & Predictive Maintenance

Ultrasonic Technology 'Picks Up' what may be future failure.

Mechanical problems can be detected & avoided using ultrasound Preventative Maintenance

Ultrasonic scanning instruments are fast becoming standard tools for preventative maintenance programs in the food processing industry. The ability to use ultrasound tools to pinpoint and repair faulty steam traps, bearings, vacuum leaks and electrical problems before they cause serious disruptions is saving food companies thousands of dollars in unscheduled downtime.

Ultrasound detection tools provide information in two ways: They let the operator hear ultrasounds qualitatively through a noise-isolating headphone that blocks out plant noise and they display quantitative, incremental readings on a meter. The sensitivity of the tool can be adjusted to seek out particular sounds. The detector can even record the sound of an eye blinking.

Avoiding costly bearing failures

Inland Empire Foods in Riverside, CA, pre-cooks, dehydrates and packages a wide variety of beans for resale to other food processing companies. As part of Inland's preventative maintenance program, it uses a lightweight ultrasonic detection system to make monthly inspections of bearings throughout the plant.

Ultrasound testing allows operators to hear sounds the human ear cannot detect under normal conditions. All operating equipment and most leakage problems produce a broad range of sounds. The high-frequency, ultrasonic components of these sounds have extremely short wave lengths and tend to be directional. By pointing the ultrasonic tool in the direction of the object to be tested, the signal is isolated from background plant noises and its location easily detected. As subtle changes occur in mechanical equipment, the directional nature of ultrasound permits potential warning signals to be detected before actual equipment failure occurs.

According to plant manager Perry Sterner, "using ultrasound, we have the choice of testing for bearing wear either during actual production or when the plant is shut down. Wherever there is evidence of a problem," says Sterner, we use the ultrasonic detection tool to provide confirmation of our vibration readings and replace the faulty bearing.
"One of our biggest problems is dry bearings. Using the ultrasonic detector, we can hear if the bearing is running dry or if there is a small particle of dirt on the ball. If there is a flat spot on the ball hitting the raceway of the bearing, we'll hear it randomly as the ball rotates."

Sterner schedules periodic greasing of the bearings and can listen with the ultrasonic equipment as he pushes grease into the raceway. The meter readings are recorded monthly and are used to indicate when the bearings need to be replaced.

In addition to using the ultrasonic detector for predicting and preventing bearing failure, Inland Empire Foods periodically checks for leaks in steam traps, inspects motors for phasing problems, and checks starters for arcing with the sensitive listening equipment.

Recently, Sterner discovered another use for his ultrasonic detector. "Our QC department had placed a load of black-eyed peas *on hold* for possible infestation and disposal. I was curious to know if the ultrasonic device could detect the presence of insects in the tote bags. I put on the headphones and placed the ultrasonic detector near the sack. It was amazing. You could actually hear the insects crunching on the peas!“

Joe Coencas, Contributing Editor, Plant management

<u>Comparative & Historic Testing (Mechanical)</u>

There are two basic procedures of testing for bearing problems: *comparative and historical*. The *comparative* method involves testing two or more similar bearings and comparing potential differences. *Historical* testing requires monitoring a specific bearing over a period of time to establish its history. By analyzing bearing history, wear patterns at ultrasonic frequencies become obvious which allows for early detection and correction of bearing problems.

<u>Comparative Test</u> - Use the contact (stethoscope) module. Select a test spot on the bearing housing and mark it for future reference. Touch that spot with the contact probe. In ultrasonic sensing, the more mediums or materials ultrasound has to travel through, the less accurate the reading will be. Therefore, be sure the contact probe is actually touching the bearing housing. If this is difficult, touch a grease fitting or touch as close to the bearing as possible. For consistency, always approach the test spot at the same angle. Reduce sensitivity until the meter reads 20. Listen to the bearing sound through headphones to hear the quality of the signal for proper interpretation. Select same type bearings under similar load conditions and same rotational speed. Approach the bearings at the same angle, touching approximately the same area on the bearing housing. Compare differences of meter reading and sound quality.

<u>Historical Bearing Test</u> - Use the basic procedure as outlined above in the comparative test. Note meter reading, and sensitivity selection on your bearing history chart. Compare this reading with previous or future readings. On all future readings, adjust sensitivity level to the original level recorded in the bearing history chart. If the meter reading has moved form the original 20 mark up to or past 100, there has been a 12 db increase. (Increments of 20 on the meter in the linear mode is about 3 decibels; e.g., 20-40=3db, 40-60=3db, etc.) Note: Increase of 12 db or greater indicates the bearing has entered a failure mode. Lack of lubrication is usually indicated by an 8 db increase over baseline. It is usually heard as a loud rushing sound. If lack of lubrication is suspected, after lubricating, re-test. If readings do not go back to original levels and remain high, consider that the bearing is on the way to the failure mode and recheck frequently.

If a vibration program already exists for bearing analysis, an ultrasonic bearing monitoring program can be of assistance. Ultrasound detectors can be used to aid a diagnosis. The high frequency, short wave characteristic of ultrasound allows the signal to be isolated, so that a user can determine if a bearing has been correctly diagnosed as failing.

At times there can be false signals generated by equipment connected to a particular bearing. By adjusting the sensitivity and listening to the sound, it can be determined whether it is the bearing, a rotor or something else that is the root of the problem.

The ability to hear what is going on can prove very important. Ultrasound detectors work well on slow speed bearings. In some extreme cases, just being able to hear some movement of a bearing through a well greased casing could provide information about potential failure. The sound might not have enough energy to stimulate classic vibration accelerometers, but will be heard via ultrasonic detectors.

Sometimes there are so many bearings in a plant that not every piece of equipment can be checked routinely by a limited staff of trained technicians. Since ultrasound detectors require little training, a technician or the machine operator can determine potential bearing problems and notify the vibration technician for follow-up.

Gears, Pumps & Motors - Inspection

OPERATION AS A MICROSONIC STETHOSCOPE

Insert the Stethoscope Module (the one with the metal probe extending from the front) into the recessed front of the Pistol Detector body. Be sure that both connector pins line up with the receptacles and that the Module seats fully in the recess. Be sure the metal probe is screwed into the front of the module only “finger tight”. Over tightening could result in internal damage to the Stethoscope Module.

Sensitivity adjustments and calibration are essentially the same as described above for Leak Detector use with the following added stethoscope only adjustments.

If when using your stethoscope you find the unit is too sensitive, (the meter remains at full scale), when the volume sensitivity knob is all the way down, reduce the sensitivity of the Stethoscope Module itself by adjusting the potentiometer located in the module. Use the screwdriver supplied with your kit to turn down the control through the hole on the side of the module until the meter remains on scale.

The Microsonic Stethoscope will detect internal sounds in the ultrasonic range. It does not detect the sounds that the ear can hear, or other low frequency sounds, such as a heartbeat. The friction between moving parts of machinery generates ultrasonic sound. As a general rule, the ultrasonic sound is very similar to the low frequency sound heard by your ears, a mirror image but displaced in frequency. If you touch the probe to the case of a mechanical watch, for example, the ticking sound is similar to that heard with the unaided ear. The sound from the stethoscope, however, has much better “definition”. Minute sounds are present that was not noticed before.

The stethoscope is detecting sound generated by the friction of the parts rubbing together, and not just the clicking sounds of the escapement, or gear wheels meshing.

As wear begins in machinery, ultrasonic sound from increasing friction is building up long before the unaided ear can hear it. The Stethoscope is valuable because of this. It forewarns you. The repair or maintenance can be carried out at a more convenient time; rather than waiting for failure that always occurs at the most inopportune time. Furthermore, damage is often more severe during later stages of failure.

Since high frequency vibrations do not radiate as much as low frequency vibrations, use of the Microsonic Stethoscope allows you to more readily screen out some sounds and pay particular attention to others.

Internal flow can be heard with the Stethoscope to detect turbulence or blockage in lines or process flow. It is easy to tell if a valve has shut completely, is leaking, or bypassing. You can hear the action of the valve and the flow. As the valve closes completely, flow ceases. If the valve stops moving as if closed, and flow is still heard, the valve has not seated and sealed properly.

The Ultrasonic Stethoscope is the tool of choice for detecting bad or malfunctioning steam traps.

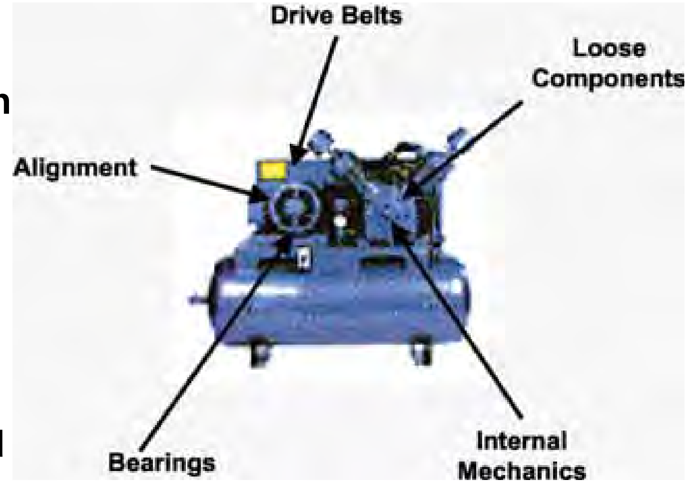
OVER GREASING DESTROYS BEARINGS

When using a grease gun to lubricate bearings, the stethoscope should be placed on the housing in the vicinity of the bearing as the grease is added. As you add grease the sound will continuously diminish until the optimum grease point is reached, adding more grease will cause the sound to increase and should be avoided as over greasing is as destructive as not greasing a bearing.

Air Compressor - Inspection

DESCRIPTION

Compressors are the heart of any compressed gas system. Routine inspection and maintenance can prevent unplanned downtime. Although any type of compressor can be inspected ultrasonically, the most common application centers on larger reciprocating types. Specifically, valve function in these compressors is critical. Minor valve leaks can rapidly lead to large leaks, which can effect production and impact on plant safety.



How Ultrasonic Compressor Inspection Works

As with any mechanical movement, there is a "normal" operation and a "deviation". In the case of valves, normal function is the typical open/close movement. Ultrasonically this will be observed as a rhythmic movement. When valve movement changes due to leakage or sticking, the sound pattern changes. Each condition has ultrasonic components that can be sensed and monitored by the ultrasonic detection unit. Due to the short wave, high frequency nature of ultrasound, the sounds produced by a compressor valve can be isolated, which provides a clear test result.

Detection Method

For the "contact' method touch the valve with the contact probe and reduce the sensitivity until it is possible to obtain a meter swing around mid-line and hear the valve open/close movement. When testing, be sure to compare similar valves to each other (i.e. intake to intake, exhaust to exhaust) and under the same conditions (i.e. idling vs. working). For additional localization, use the leak detection module with rubber focusing extension.

SECTION 6 - ELECTRICAL
Electrical inspection

- **OVERVIEW OF ELECTICAL EQUIPMENT AND ULTRASONICS**
- **OVERVIEW OF EQUIPMENT FOR HIGH VOLTAGE INSPECTION**
- **ELECTRICAL DETECTION METHODS**

Overview of Electrical - Inspection

Track Corona Discharges with Ultrasonic Detector
By Stan Bullock, Manager
Ultrasound detectors perfectly complement infrared instruments for the routine examination of electrical equipment. While infrared inspections allow operators to detect light that the eye cannot see, ultrasound allows them to detect sounds that the ear cannot hear. Corona, arcing, and tracking, which may not show up on infrared inspections, are revealed by ultrasound. Inspectors at Midwest Electrical Testing & Maintenance now pack an ultrasonic detector to scan primary power on all systems they inspect.

A person with no experience can learn to use the tool in about an hour. However, it takes more experience to be able to identify individual sounds. Usually the operator begins an inspection by fully opening the scale and broadly scanning the equipment. If a noise is detected, the operator uses the tuning and directional capabilities of the instrument to home in on the source.

Detect tracking on arresters
In surveys performed for one electric utility, potheads, bushings, and arresters in substations were scanned (Fig 1). This utility was experiencing arrester failures that caused troublesome power interruptions. The ultrasonic detector indicated tracking on several of the arresters.

Further investigation isolated ultrasound coming from an area of intense corona and arcing. On inspection, the connection was found to be pitted and corroded. Fortunately the 138-kV equipment was only operating at 12% load at the

time. Had it been operating at full load, the connections would probably have disintegrated, interrupting power to 80,000 to 100,000 customers.

Interlocked, metal-enclosed switchgear serving a large shopping mall was examined with an ultrasonic detector. Ultrasound was detected in a very localized area. Closer examination suggested arcing and tracing was occurring within the switch. Utility and mall maintenance personnel were called to deenergize the system and open the switch to perform a visual inspection. They found corona and tracking had destroyed 35% of the switchblade and that the contact surface was close to failure.

<u>Transformer voltage taps</u> that run hot cannot be detected with infrared equipment because the heat from the transformer barrel is greater than that from the loose connection. During inspection of a 1500-kVA dry transformer (Fig 3), serious tracking and arcing was heard in the secondary voltage tap. When the connections were dismantled, carbon buildup and arcing traces were found in the tap contacts.

In each of these cases, problems were detected that could not have been found without de-energizing the equipment. In some cases, even a visual inspection would not have found the defects.

Switch Gear – Pot Heads – Corona – Leak detection | Ceramic Stress Tracking - Corona | Arcing – Sparking Tracking - Corona

<u>**DESCRIPTION**</u>

When electrical apparatus such as switchgear, transformer, insulators or potheads and splices fail, the results can be catastrophic. This is just as true in industrial plants as it is in the power transmission and distribution side. Electrical discharges such as arcing, tracking or coronas are all potential for equipment failure. In addition, the problems of RFI and TVI impact on our valuable communication networks. All these conditions produce ultrasound and are detected with the Ultrasonic detection unit.

How Ultrasonic Electrical Detection Works

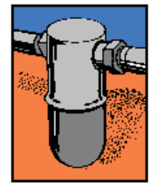
Arcing, tracking and corona all produce some form of ionization, which disturbs the air molecules around it. The Ultrasonic unit detects the high frequency noise produced by this effect and translates it, via heterodyning, down into the audible ranges. The specific sound quality of each type of emission is heard in headphones while the intensity of the signal is observed on a meter. Normally, electrical equipment should be silent; although some may produce a constant 60cycle hum or some steady mechanical noises. These should not be confused with the erratic, sizzling frying, uneven and popping sound of an electrical discharge.

Detection Method

Before beginning any inspection of mid or high voltage equipment, be sure to review your plant or company's safety procedures. Essentially, as in generic leak detection, the area of inspection is scanned using a high sensitivity setting. As the direction is determined and you approach the source, reduce the sensitivity until pinpointing is possible. If it is not possible to remove covers, or plates, scan around the seams and vent slots. Any potentially damaging discharges should be detected.

SECTION 7

STEAM TRAPS



- **Steam Traps and Valves explained.**
- **How to analyze them using the Ultrasonic tools.**
- **Determine good and bad traps and predict failure**

PREFACE

Any method used to check the operating performance of steam traps requires experience on the part of the individual conducting the test. The reason is that a great number of variables exist causing many different indicators being presented to our senses. Ultrasonic testing eliminates some of these variables allowing us to make a more accurate determination of the indications perceived.

This section describes the majority of indicators that exist under the most common or "normal" operation. Indications other than those covered in these instructions will require a more detailed investigation of the trap question, or disassembly.

The accuracy of results will improve in a direct relationship with the experience gained through continuing usage.

MAINTAINING STEAM TRAPS

Failed steam traps waste energy and adversely affect product quality. Therefore, a maintenance program for steam traps is a good investment.

Most plant and facilities professionals with steam systems in their care have asked questions like the following:

- **What are the signs of a malfunctioning steam trap?**
- **What inspection techniques are available?**
- **What testing instruments should we use?**
- **How do we start a steam trap maintenance management program?**
- **What kinds of training resources are required?**

Steam Trap Basics

Basically, all steam traps have the same function. They allow condensate and non-condensable gases to escape while holding steam in a device where a thermal or heat transfer process occurs. A regulator controls the input side of the process, and the steam, after releasing energy to the process, condenses and reverts back to its liquid state. The purpose of the steam trap is to retain steam in the heating element and to release the non-condensable gases and condensate. The principal design consideration is to balance the condensing rate and the import rate of the control device on the input side with the exiting condensate.

Stephen Banyacski, president of Nicholson Steam Traps (Walden, New York), emphasizes the need to choose the appropriate steam trap. "Properly sized traps relieve the condensate, react quickly to changes in load, and trap the steam while allowing air and other non-condensable gases to escape," he says.

Finding Malfunctioning Traps

As with any mechanical device, a steam trap can malfunction. "If the steam trap fails closed," says Banyacski, "the device that should be draining will flood, the heat transfer process will stop, and whatever product is being produced…will no longer be up to the required quality standards. If the trap fails open, there will be a waste of energy, steam will not be completely consumed or condensed in the exchanger, and steam will blow through." Banyacski notes that a plume of steam escaping from some part of the condensate-return system signals such a condition. Banyacski ads that it is

difficult to determine whether a steam trap has failed just partially open, indicating a slow leak and a developing failure. He continues, "Such a…failure could persist for quite some time without any outward sign. Therefore, a maintenance person should make periodic surveys of the installed steam traps." Banyacski emphasizes that steam blowing through a trap indicates that the trap needs to be repaired or replaced.

Trap Inspection Methods

Echoing Banyacski, Kevin Loken, manufacturers' representative and distributor with Kelly Equipment (Milwaukee, Wisconsin), says, "Oftentimes, a misapplied steam trap—too small, the wrong design—will malfunction." According to Loken, ultrasonic, infrared temperature measurements, and visual inspection have proven useful to maintenance personnel in checking for malfunctioning steam traps. Of the three, Loken says that ultrasound is the most reliable.

He points out that visual inspection requires an inspector to let a steam trap discharge into the atmosphere. However, doing that changes the parameters of the closed system and, therefore, can be unreliable.

Loken also says that there are enough variables in the system—backpressure, for example—so that temperature is not the most reliable indicator either. He recognizes, however, that portable infrared thermometers provide close estimations of pressures on valves, traps, and coil heaters. And he notes that these devices are also useful for spotting conditions such as heat loss, the need for insulation, overheating, overloads, and cooling failures. Thus, he recommends that an infrared thermometer be used along with ultrasound.

Agreeing with Banyacski, Loken says that traps that have failed completely open are easy to detect, but he points out that the object is to find failing traps before they fail completely. Ultrasonic testing can do that. "In essence, using an ultrasonic instrument is like putting the inspector inside the steam trap and piping system, allowing him to detect a leaking steam trap," Loken says. "Ultrasonic detectors translate ultrasonic emissions…into sounds the human ear can hear."

Loken claims that technicians who use ultrasonic detectors on a daily basis can achieve accuracy that exceeds 98%. And regarding frequency of inspections, he recommends that process components of equipment as well as drip, main steam traps should be checked twice a year. He suggests that heating steam traps (in facilities that use steam for space heating) should be tested annually. He also stresses the importance of instituting a reporting system to keep tabs on the location, type, size, capacity, and condition of all traps in a steam system.

Creating A Maintenance Program

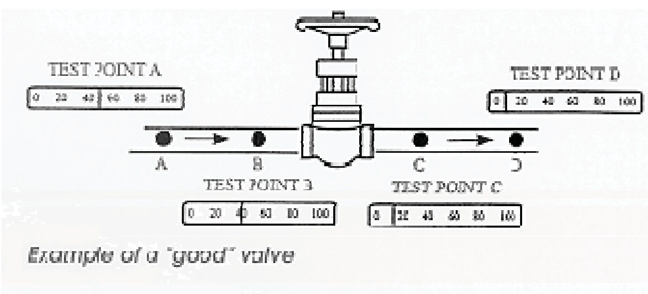
Why go through the hard work of setting up a maintenance program for steam traps?

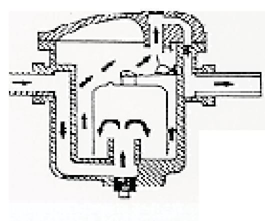
Loken supplies the answer: "A steam trap maintenance management program can pay for itself in less than a year. And the savings will multiply as the years pass."

When valves or steam traps leak or fail, it can be extremely costly in terms of product quality, safety and energy loss. Valve operation effects the way fluids will flow through a system. There are great differences in the way particular valves and steam traps work. Ultrasonic testing makes it easy to adjust for these differences and readily determine operating conditions while valves and traps are on-line.

How Ultrasonic Leak Detection works?

As fluid moves from the high-pressure side of a valve through the seat to the low-pressure side, it produces turbulence. This turbulence generates ultrasound, which is detected by the ultrasonic probe, and translated, via heterodyning, down into the audible range. The translated ultrasounds are heard through headphones and seen as intensity increments on a meter.





Leak Detection Method

Inspection methods vary depending on the type of valve or steam trap. Therefore the primary rule is to know the details of your system, for example the way a specific trap or valve may work under specific conditions. In order to determine leakage or blockage: touch upstream of the valve or trap and reduce the sensitivity of the tool until the meter reads about 50. It is desirable to hear the specific sound quality of the fluid, simply adjust the sensitivity until the sound you would expect to hear becomes clear. It's that simple. Next, touch downstream of the valve or trap and compare intensity levels. If the sound is louder down stream, the fluid is passing through. If the sound level is low, the valve or trap is closed. Ultrasonic valve and steam trap Inspection is considered a "positive" test in that an operator can instantly identify sound quality and intensity differentials and thereby determine operating condition accurately.

The Microsonic Stethoscope has proven to be an extremely effective tool for testing steam traps for proper operation. Thousands are now being used for this purpose, and our customers have realized substantial savings in both maintenance costs and steam generation costs by using this method. Energy costs will certainly continue to escalate, and an effective energy conservation program can make the difference between profit and loss.

The passage of steam through an aperture generates ultrasound, as does the friction between the operating components of a steam trap. With the EFI tool we can hear these sounds, and by interpreting what we hear we can determine if a steam trap is operating normally.

There are several types of steam traps on the market, but all have the same purpose, that is to remove condensed steam, air and gasses from the system and thereby improve efficiency and protect the system from damage. Steam pressure, temperature, and capacities determine what type of trap will be used in a particular application. A steam trap that fails in the open position will discharge live steam, thereby wasting energy and degrading system performance. A steam trap that fails in the closed position will not discharge condensate, and damage may result to system components.

There are two main types of steam traps, those that discharge condensate intermittently, and those that discharge continuously. In the first category are the inverted bucket design and the disk (thermodynamic) design. Float, thermostatic and float-thermostatic designs comprise the second category. Testing methods are essentially the same for both types, and we assume that the proper type trap has been selected for the particular application.

The first step in testing a steam trap is to determine if it is hot or cold. Place a hand near the trap. If the trap is cold the problem could be a plugged strainer upstream, or the trap outlet may be plugged with dirt. In an inverted bucket type the bucket may have come unhooked. In the float and the thermostatic type the thermostatic element may have failed shut or the float may be jammed or collapsed. The disc may be jammed in a disc trap. Under any of these conditions, no sound will be heard with the ultrasonic tool.

If the trap is hot, place the probe of the tool against the trap near the discharge side. A continuous rushing sound suggests that the trap has malfunctioned and is discharging live steam continuously. A properly operating inverted bucket should discharge intermittently, as should a properly operating disc trap, which will discharge 6 to 12 times per minute. The discharge of live steam in a float and thermostatic trap is evidenced by a higher than normal noise level and sound pitch.
These are but a few general guidelines for testing steam traps with the ultrasonic tools. As with any type of testing, the test instrument only

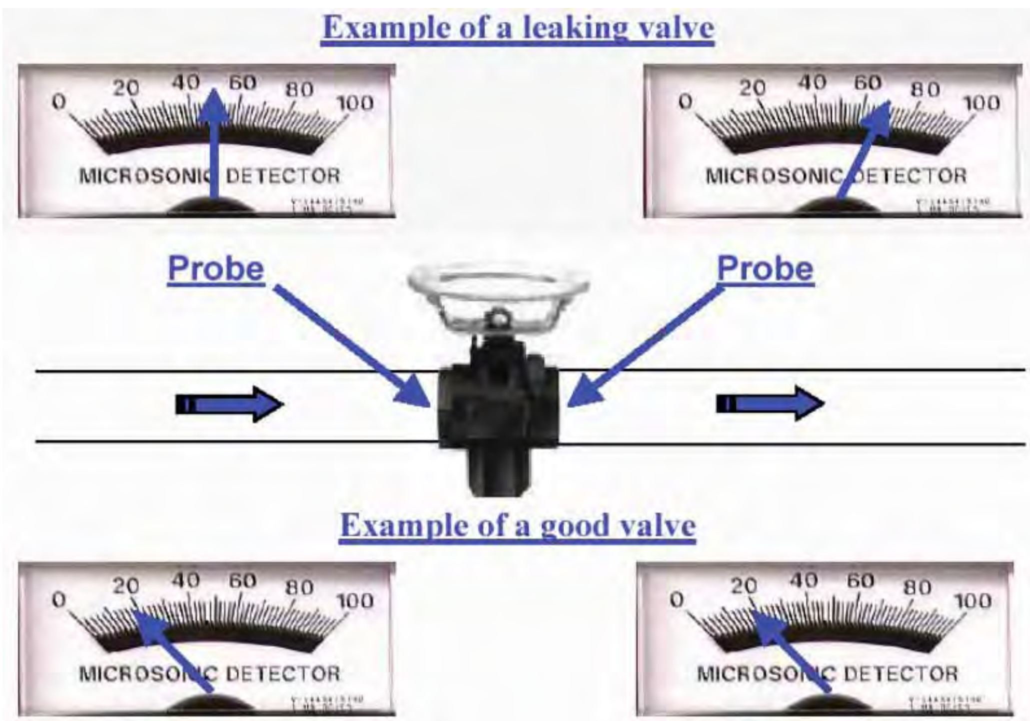
provides evidence, which must be evaluated by the user. As the users experience increases, so will the effectiveness of any testing program.

Valves

ULTRASONIC INSPECTION OF VALVES

Leak Detection Method

Inspection methods vary depending on the type of valve. Therefore the primary rule is to know the details of your system, for example the way a specific valve may work under specific conditions. In order to determine leakage or blockage: touch upstream of the valve and reduce the sensitivity of the instrument until the meter reads about 50. If it is desirable to hear the specific sound quality of the fluid, simply adjust sensitivity until the sound you would expect to hear becomes clear. It's that simple. Next, touch downstream of the valve trap and compare intensity levels. If the sound is louder down stream, the fluid is passing through. If the sound level is low, the valve is closed. Ultrasonic valve inspection is considered a "positive" test in that an operator can instantly identify sound quality and intensity differentials and thereby determine operating condition accurately.



SECTION 8

STEAM TRAP TESTING AND ANALYSIS

Steam Traps and Valves Explained.

How to analyze them using the Ultrasonic Tools.

Determine good and bad traps and predict failure.

This section prepared by:

Mr. Alex Allison

Of

Allison Mechanical, Inc.

Des Moines, Iowa.

Our thanks to Mr. Allison

And more thanks to:

Mr. Doug McMordie

Who created the trap diagrams:

“Steam Traps, Where are they”.

STEAM TRAPS

PREFACE

Any method used to check the operating performance of steam traps requires experience on the part of the individual conducting the test. The reason is that a great number of variables exist causing many different indicators being presented to our senses. Ultrasonic testing eliminates some of these variables allowing us to make a more accurate determination of the indications perceived.

This section describes the majority of indicators that exist under the most common or "normal" operation. Indications other than those covered in these instructions will require a more detailed investigation of the trap in question, or disassembly.

The accuracy of results will improve in a direct relationship with the experience gained through continuing usage.

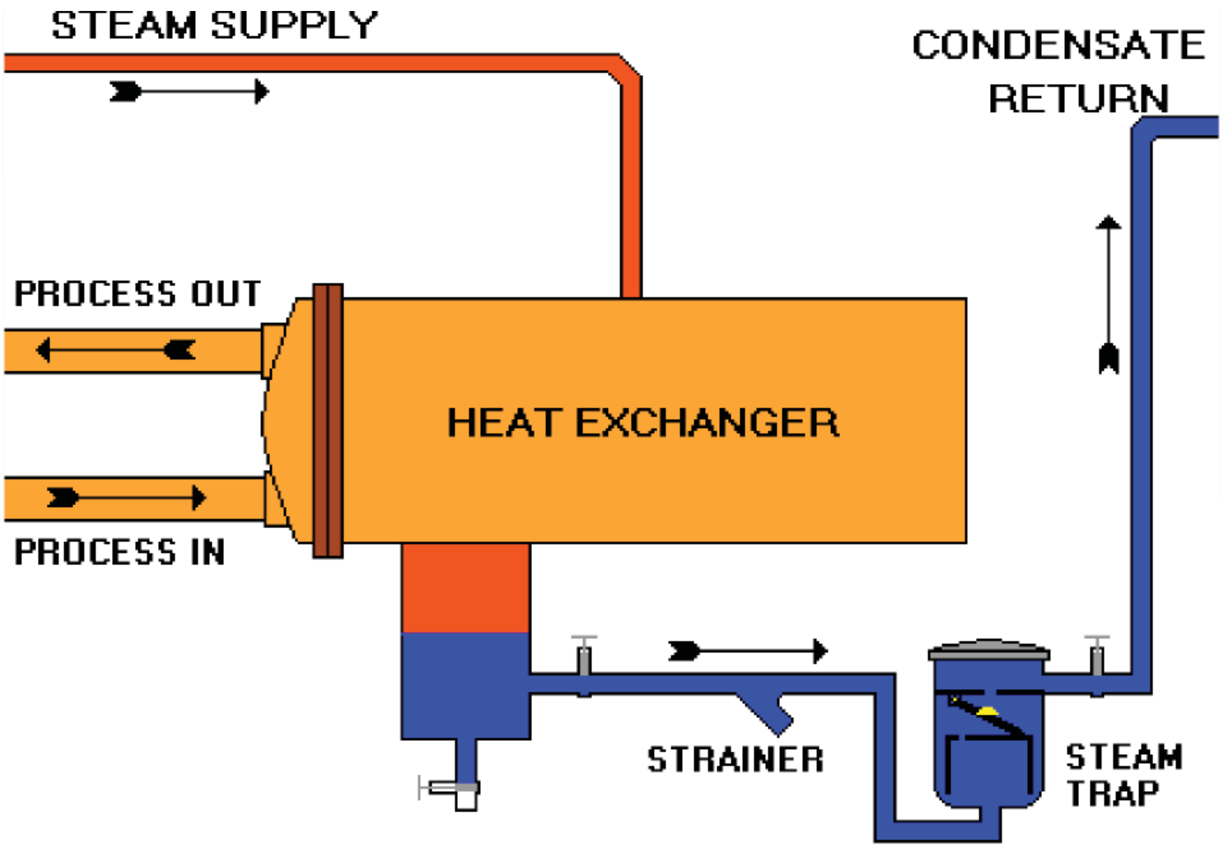
All traps appear to be discharging steam as they discharge condensate, but this is only flash steam!

STEAM TRAPS

Where Are They?

Process Traps

Typical Process Trap Application

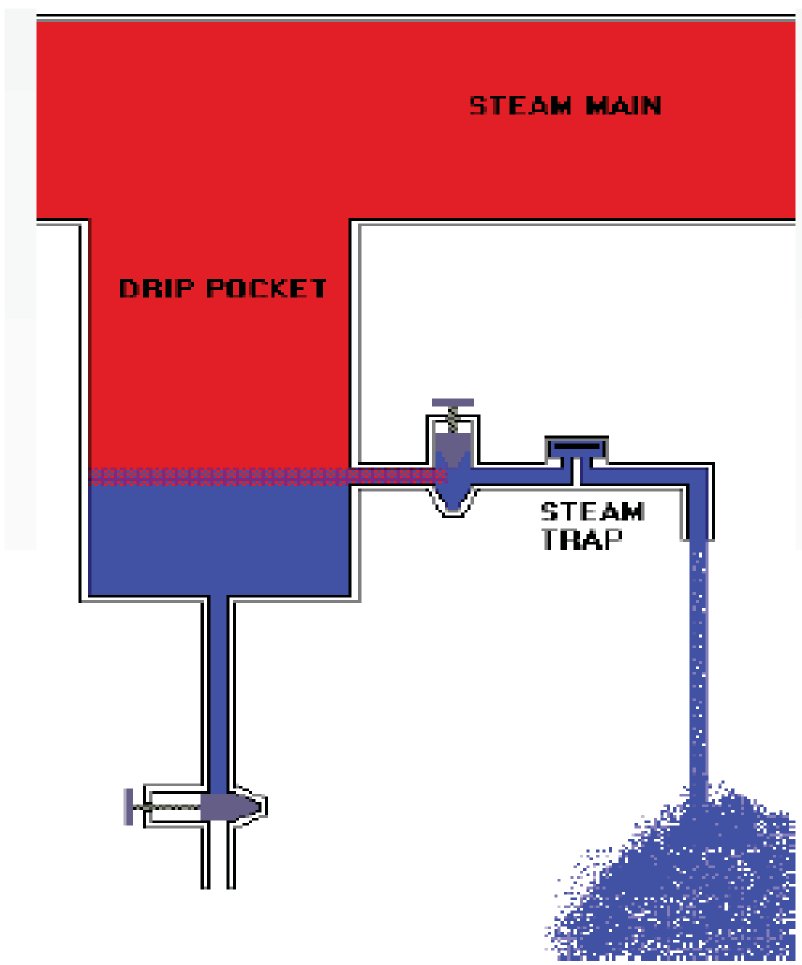


STEAM TRAPS

Where Are They?

Drip Trap

Typical Drip Trap Application

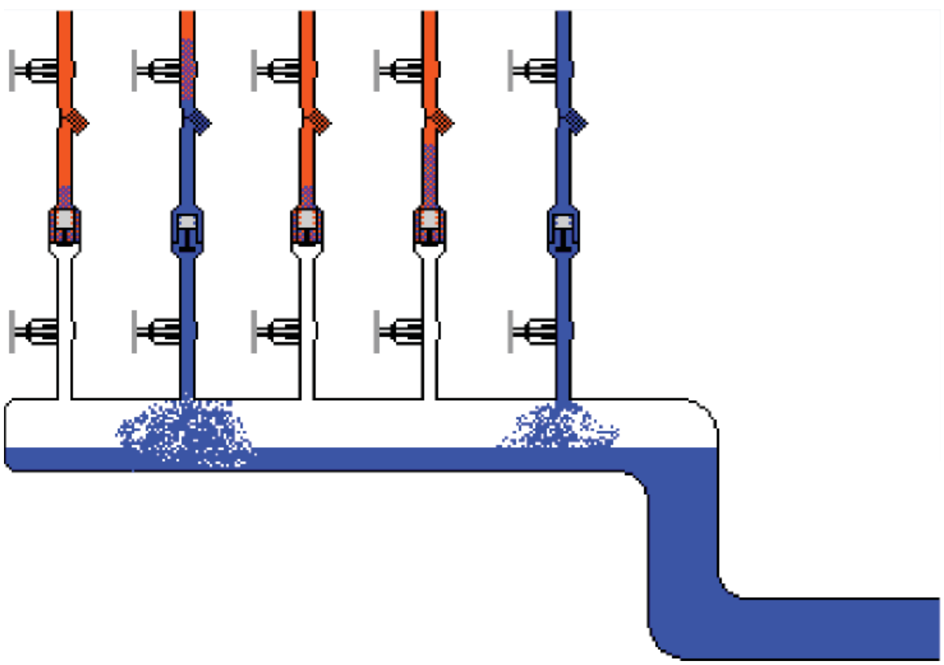


STEAM TRAPS

Where are they?

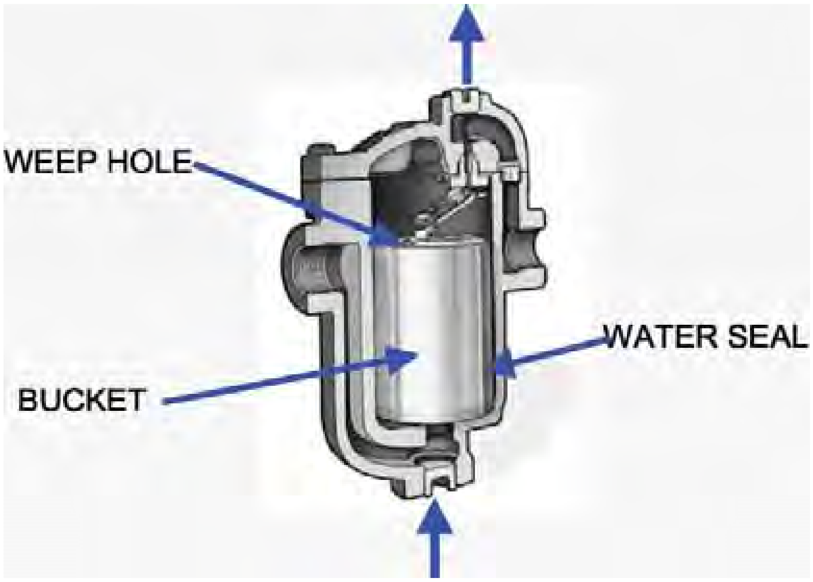
Trace Traps

Typical Trace Trap Application



STEAM TRAPS

INVERTED BUCKET TRAP (A)



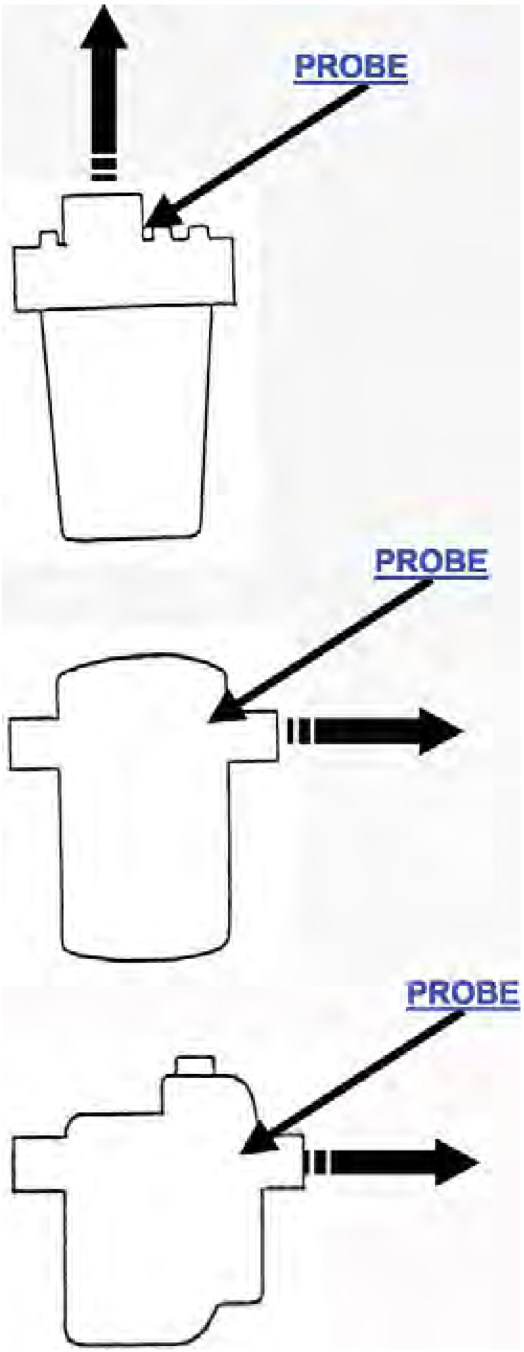
- **The maximum pressure rating on the bucket trap should be shown on the metal tag located on the trap.**

- **The pressure rating indicated on the "Tag" is the maximum steam pressure the trap will handle effectively. If there is more steam pressure at the trap than shown on the identifying tag you need to put in a different valve mechanism (A.K.A. "pressure change assembly") to allow the trap to operate.**

- **The size of the "hole" in the condensate discharge seat, along with the steam pressure, determines the trap's capacity to discharge condensate. Lower pressure steam traps have larger condensate discharge "holes" than higher pressure rated steam traps.**

STEAM TRAPS

INVERTED BUCKET TRAP (B)



INVERTED BUCKET TRAPS

Depend on a water seal and weep hole for operation.

Because they discharge condensate intermittently, they can be noisy.

PLACE PROBE ON TRAP AS SHOWN

STEAM TRAPS

INVERTED BUCKET TRAP (C)

DETAILED I.B. TRAP OPERATION

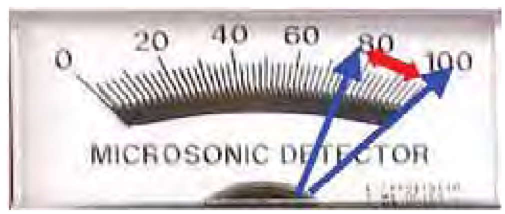
The operating characteristics of the I.B. trap vary according to the condensate load.

(1) LIGHT LOAD

The trap will "dribble" condensate without any distinct cycle. Indicator will show only a very slight back and forth movement at the extreme lower end of the scale.

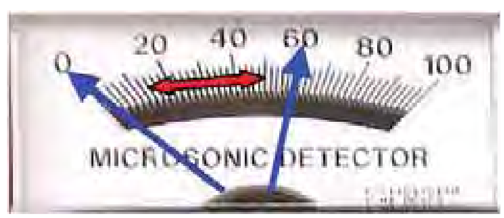
(2) MEDIUM LOAD

The trap will open and close intermittently with a distinct cycle.



(3) HEAVY LOAD

The trap will discharge condensate continuously. This is usually observed at start up of equipment. If trap does not catch up with the load and commence intermittent discharge this is an indication that the trap is undersized for the application. Continuously discharging under heavy load will register high on the scale with some back and forth movement of the indicator.

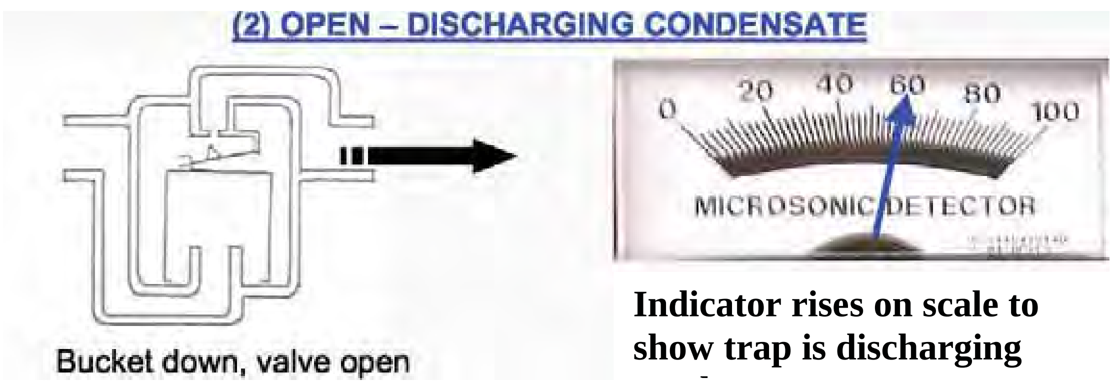


STEAM TRAPS
INVERTED BUCKET TRAP (D)

BASIC I.B. TRAP OPERATION - NORMAL LOAD

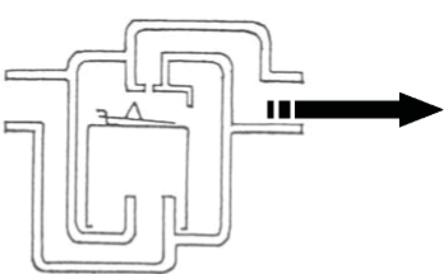
NOTE: Background noise level = "0"

Bucket up.
Valve is closed on seat.



Indicator rises on scale to show trap is discharging

(3) FAILED - OPEN BLOWING LIVE STEAM



Bucket linkage, damaged bucket, Badly worn valve & seat etc……

Indicator "Pegs" on scale along with high-pitched sound of steam passing through open valve seat.

STEAM TRAPS

INVERTED BUCKET TRAP (E)

NOTE: Background noise level = "0"

(4) LOSS OF PRIME

Badly worn linkage prevents valve from seating properly, or loss of prime as a result of "over-sizing" registers.

Erratic and rapid back & forth movement of indicator accompanied by an audible metallic ringing noise caused by the bucket dancing inside the trap body.

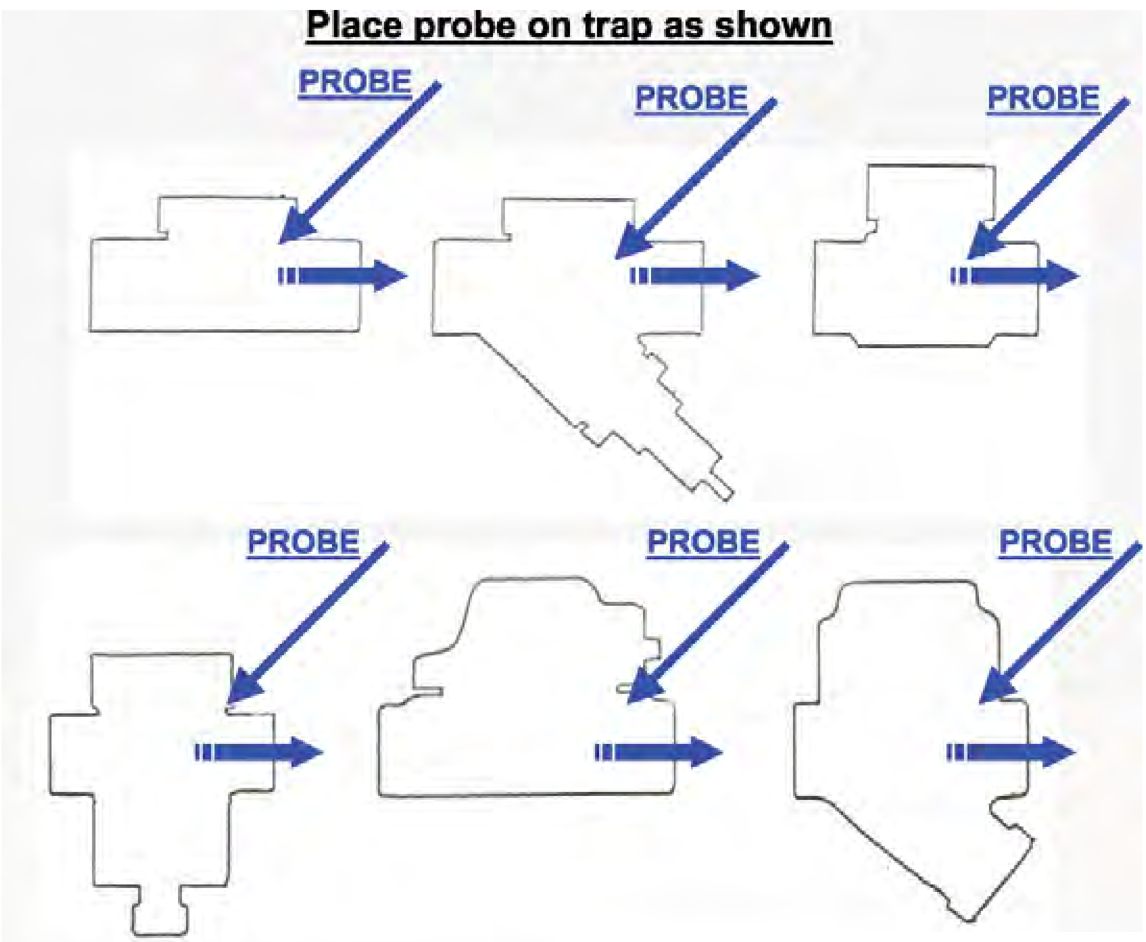
(5) LEAKING STEAM

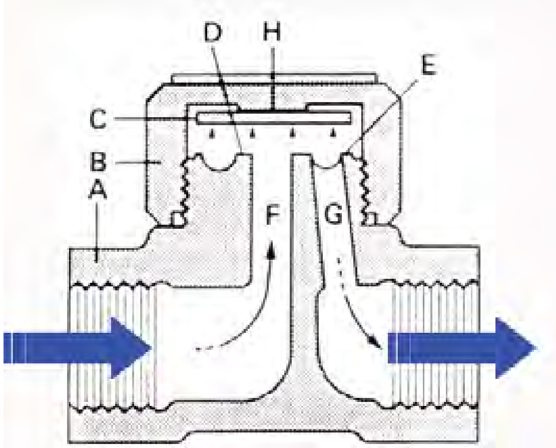
As a result of wear, the valve will not seal properly, allowing steam to leak through the seat.

Indicator needle does not return to "0" or level of ambient noise between cycles indicates leakage.

STEAM TRAPS

THERMODYNAMIC TRAP (A)





<u>Thermodynamic disk traps</u> can operate within their working range without any adjustment or change of valve size. Being frozen does not damage them.

On startup, air & cool condensate reach the trap, passing up the inlet orifice "F". The disc "C" is lifted until it is held against the boss "H" in the top cap. Air and condensate flow radially outwards from the center of the disc into the space between the seat rings "D" and "E" and are discharged through the outlet passage "G"

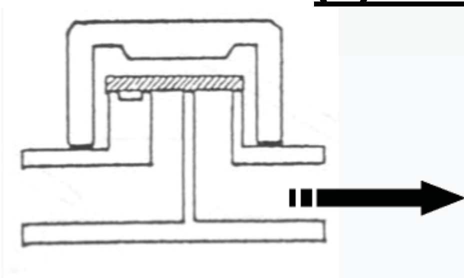
STEAM TRAPS

BASIC THERMODYNAMIC TRAP

OPERATION = NORMAL LOAD

NOTE: Background noise level = "0"

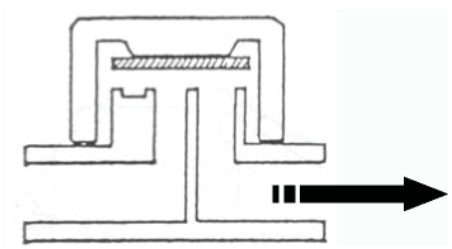
(1) CLOSED - NO DISCHARGE



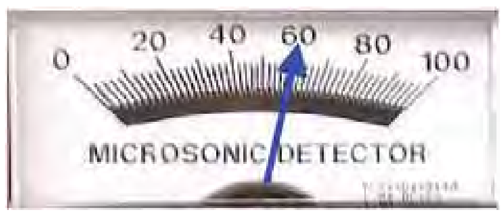
Disc valve closed on seat

Indicator at "0" on scale shows disc valve closed.

(2) OPEN - DISCHARGING CONDENSATE

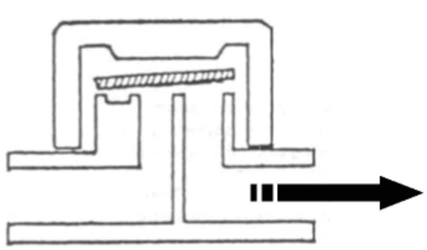


Disc up, valve open

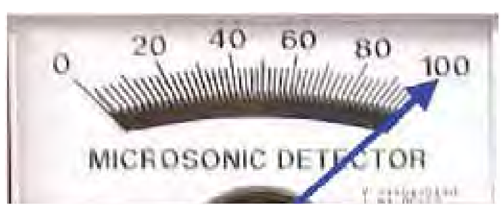


Indicator rises on scale to show trap discharging condensate.

(3) FAILED - OPEN BLOWING LIVE STEAM



Worn disc and seat.



Indicator "pegs" on scale along with high-pitched sound of steam passing through open valve seat.

STEAM TRAPS

THERMODYNAMIC TRAP ©

DETAILED THERMODYNAMIC TRAP OPERATION

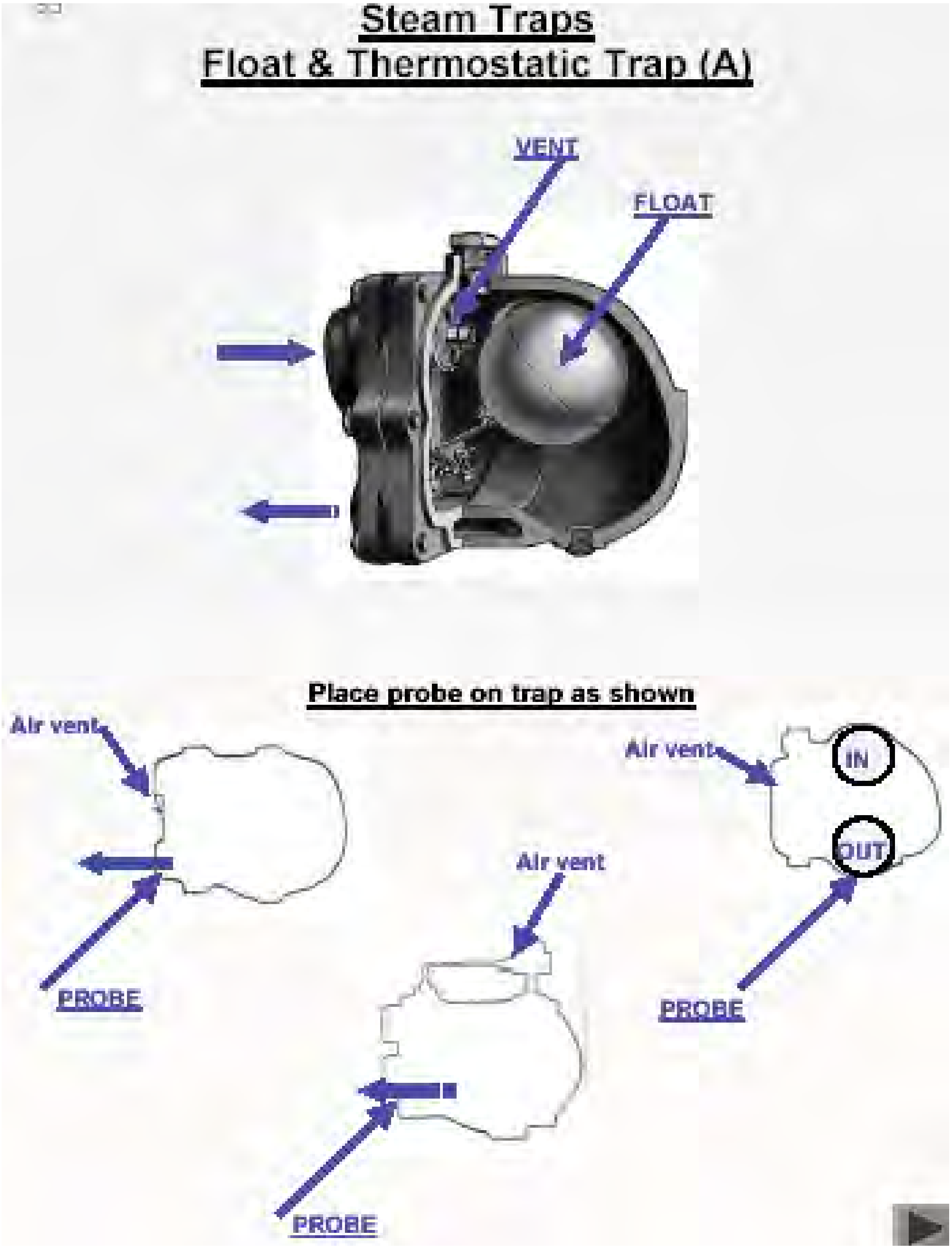
(1) LIGHT TO MEDIUM LOAD
Trap operates with intermittent cycle. Length of cycle will vary in accordance with the condensate load. A T.D. trap functioning properly will open and close with a distinct cycle

(2) HEAVY LOAD
Trap will discharge condensate continuously. This is usually observed at the startup of equipment. If the trap does not catch up with the load and commence intermittent discharge, this is usually an indication that the trap is undersize for the application. Undersize or continuously discharging under heavy load will register high on the scale but with some back and forth movement of the meter needle.

(3) CHATTERING OR RAPID CYCLE
Wear of the disc valve & seat will cause the trap to operate with a rapid cycle resulting in considerable steam loss. The trap should close between cycles for a period of at least 15 seconds. Any shorter period of closure indicates the need for replacement.

(4) LEAKING STEAM
As a result of wear, the disc valve will not seal properly allowing steam to leak through the seat. The indicator does not return to "0" or level of ambient noise between cycles indicates leakage.

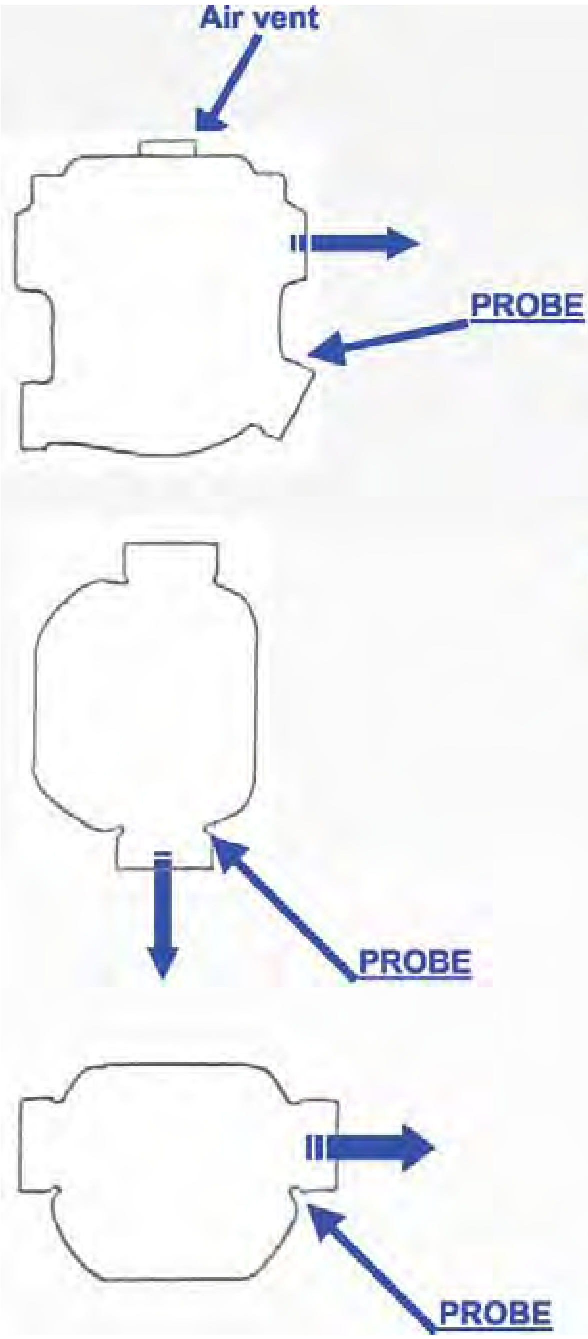
STEAM TRAPS

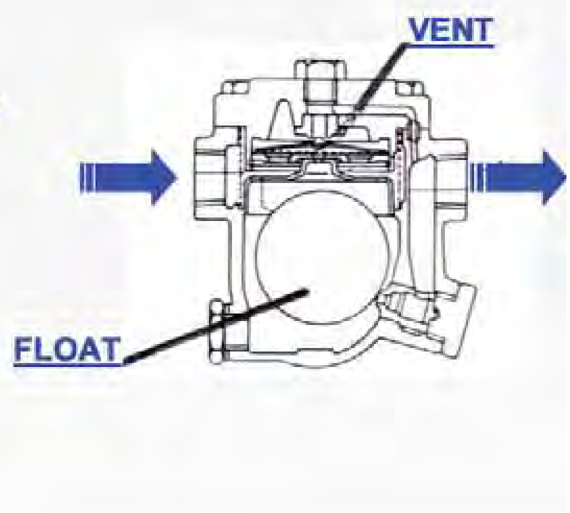

Steam Traps
Float & Thermostatic Trap (A)
VENT
FLOAT
Place probe on trap as shown
Air vent
PROBE
Air vent
PROBE
Air vent
IN
OUT
PROBE

STEAM TRAPS

FREE FLOAT TRAP (A)

Place probe on trap as shown





BALL FLOAT STEAM TRAPS are mechanical Traps and operate on the difference in density between steam and condensate.

Condensate entering the trap causes the float ball to rise and lifts the valve through leverage off the seat, thus discharging condensate continuously at steam temperature.

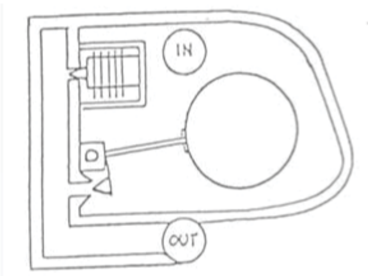
STEAM TRAPS

FLOAT & TRAP OPERATION (B)

BASIC F&T TRAP OPERATION - NORMAL LOAD

NOTE: Background Noise Level = "0"

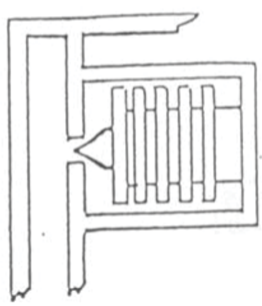
(A) - CONDENSATE VALVE:
Continuous modulating discharge, No on/off cycle.



Float moves up and down continuously.

Indicator moves back & forth smoothly indicating the modulating effect of the float & valve continuously discharging condensate

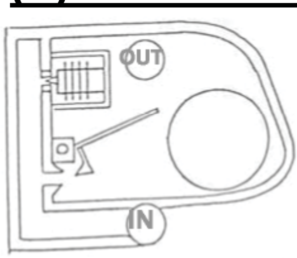
(B) - AIR VENT:



At pre-set temperature below 212 F thermostatic element closes air vent valve on seat.

1. **Note indicator reading.**
2. **Take reading on pipe upstream of trap or bypass air vent.**
3. **Normal, if reading 2 is greater than reading 1.**
4. **Air vent is leaking if reading 2 is less than reading 1.**

(C) - FAILED OPEN - BLOWING LIVE STEAM:



Worn valve & seat, broken linkage, damaged float, etc.

Indicator "pegs" on scale accompanied by high pitch sound of steam passing through open valve seat.

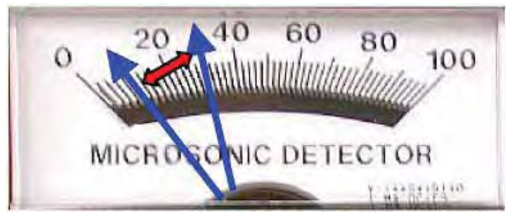
STEAM TRAPS

FLOAT & TRAP OPERATION (C)

DETAILED F & T TRAP OPERATION

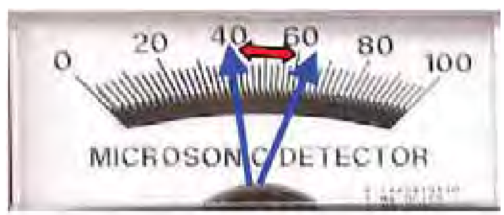
The Float & Trap discharges condensate continuously without any distinct on/off cycle.

(1) LIGHT LOAD
Continuous discharge of condensate under light load conditions will register a very slight modulating movement of the indicator at the bottom end of the scale.



Note!: Under extremely light load conditions, at times there may be no apparent movement of the pointer observed, which is normal.

(2) MEDIUM LOAD
Under medium load conditions the modulating pointer will register higher on the scale.

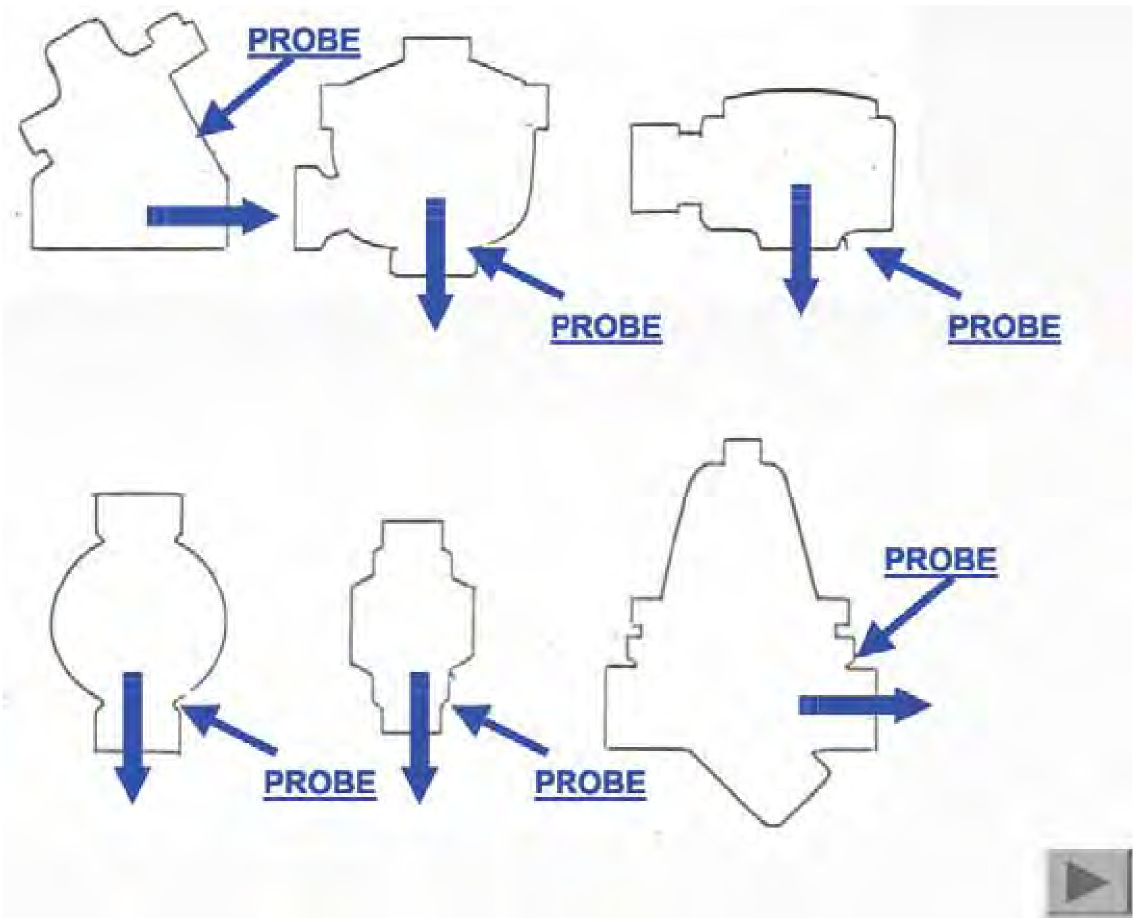


(3) HEAVY LOAD
Indicator will register heavy condensate load high on the scale indicating the trap is working at maximum capacity. This condition is usually observed at startup of equipment and the trap should catch up with the load and the modulating pointer will begin to move down the scale. If the pointer remains at the top of the scale, this would be an indication of under sizing.

STEAM TRAPS

THERMOSTTIC TRAP (A)

Place probe on trap as shown

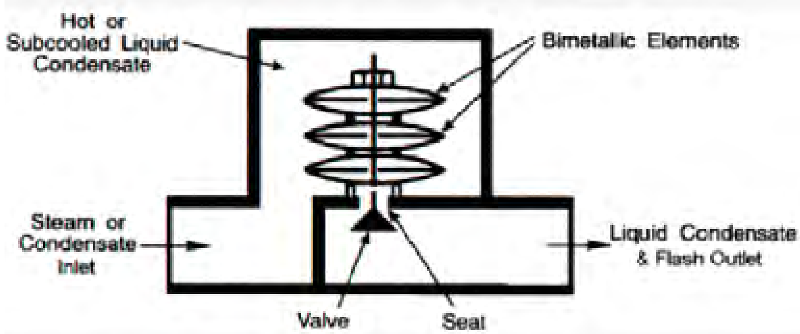


STEAM TRAPS

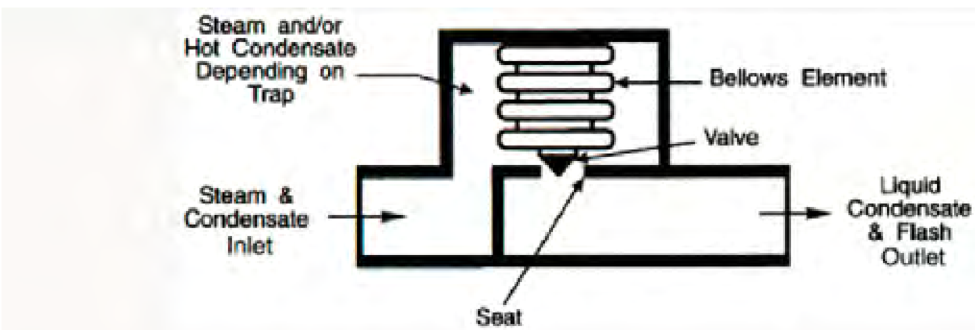
THERMOSTATIC TRAP (B)

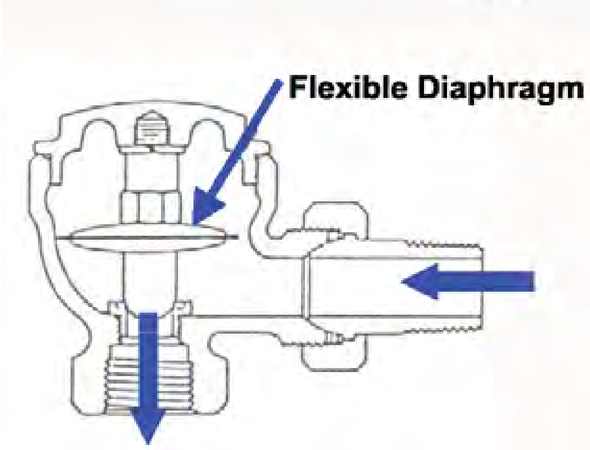
THERMOSTATIC TRAPS

BIMETALLIC THERMOSTATIC TRAP



BELLOWS STEAM TRAP





THERMOSTATIC TRAP: Cold condensate during startup drains through the trap. As temperatures reach 10 to 30 degrees Fahrenheit of saturation, the trap closes. During operation thermostatic traps find an equilibrium point to drain condensate which is approximately 10 to 30 degrees below saturation at a continuous flow.

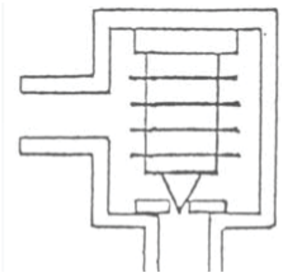
STEAM TRAPS

THERMOSTATIC TRAP OPERATION (C)

BASIC THERMOSTATIC TRAP OPERATION - NORMAL LOAD

NOTE: Background noise level = "0"

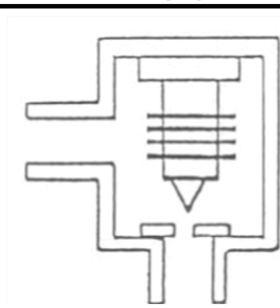
CLOSED - NO DISCHARGE



Bellows is expanded, valve is closed on seat.

Indicator at "0" on scale shows valve is closed. No steam leakage is indicated.

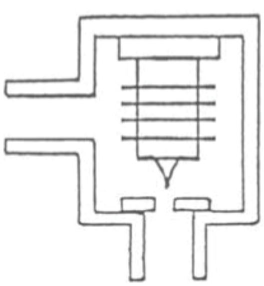
OPEN - DISCHARGING CONDENSATE



The bellow is contracted, the valve is open.

Indicator rises on the scale to show the trap is discharging condensate.

FAILED OPEN - BLOWING LIVE STEAM



Worn valve & seat, failed open bellows or bi-metal etc.

Indicator "pegs" on scale accompanied by the high pitch sound of steam passing through the open valve seat.

SECTION 9 - STEAM COST CHARTS

COST OF LOST STEAM

STEAM FLOW THROUGH STEAM TRAP ORIFICE TABLE

If you know the size of the discharge orifice in the steam trap you may use this table to estimate potential steam loss through a trap that has failed open. Take the lb./hr. figure X 24 hrs. X 30 dys X .25 X $6.00 to establish the approximate dollar loss.

Orifice Diameter	2 psi	5 psi	10 psi	15 psi	25 psi	50 psi	75 psi
1/32"	.31	.47	.58	.70	.94	1.53	2.12
1/16"	1.25	1.86	2.3	2.8	3.8	6.1	8.5
3/32"	2.81	4.20	5.3	6.3	8.45	13.8	19.1
1/8"	4.5	7.5	9.4	11.2	15.0	24.5	34.0
5/32"	7.8	11.7	14.6	17.6	23.5	38.3	53.1
3/1"	11.2	16.7	21.0	25.3	33.8	55.1	76.4
7/32"	15.3	22.9	28.7	34.4	46.0	75.0	104
1/4"	20.0	29.8	37.4	45.0	60.1	98.0	136
9/32"	25.2	37.8	47.4	56.9	76.1	124	172
5/16"	31.2	46.6	58.5	70.3	94.0	153	212
11/32"	37.7	56.4	70.7	85.1	114	185	257
3/8"	44.9	67.1	84.2	101	135	221	306
13/32"	52.7	78.8	98.8	119	159	259	359
7/16"	61.1	91.4	115	138	184	300	416
15/32"	70.2	105	131	158	211	344	478
1/2"	79.8	119	150	180	241	392	544

Orifice Diameter	100 psi	125 psi	150 psi	200 psi	250 psi	300 psi
1/32"	2.7	3.3	3.9	531	6.3	7.4
1/16"	10.8	13.2	15.6	20.3	25.1	29.8
3/32"	24.4	29.7	35.1	45.7	56.4	67.0
1/8"	43.4	52.9	62.4	81.3	100	119
5/32"	67.9	82.7	97.4	127	156	186
3/1"	97.7	119	140	183	226	268
7/32"	133	162	191	249	307	365
1/4"	173	212	250	325	401	477
9/32"	220	268	316	412	507	603
5/16"	272	331	390	508	327	745
11/32"	329	400	472	615	758	901
3/8"	391	476	561	732	902	1073
13/32"	459	559	659	859	1059	1259
7/16"	532	648	764	996	1228	1460
15/32"	611	744	877	1144	1410	1676
1/2"	695	847	998	1301	1604	1907

FAILED STEAM TRAP DOLLAR LOSS TABLE FOR RADIATOR TRAPS
Steam Cost @ $6.00/1000 lbs.

Pressure balanced thermostatic radiator traps are most commonly found on low pressure (25 psig and under) steam heating systems. Located on radiators, convectors and other radiant heat units, there may be literally hundreds of these scattered throughout larger facilities. The operating unit within the trap, a pressure-balanced disc or bellows, is filled with a distilled liquid to respond to the changes in temperature (i.e. pressure) within the trap. *The disc or bellows will generally "fail open"* after three to five years of hard work (after five years it has opened and closed hundreds of thousands of times). The orifice sizes (*) shown, for all the steam traps, are conservative estimates of the average size found in these traps. Actual dollar loss may be more or less than shown.

Pressure @ Trap	**2 psig**	**5 psig**	**10 psig**	**15 psig**	**25 psig**	**50 psig**	**75 psig**	**100 psig**	**125 psig**	**150 psig**
PIPE SIZE	*Assigned orifice size in the steam trap styles and sizes per differential operating pressures as shown.									
1/2"	*1/4"	*1/4"	*1/4"	*1/4"	*1/4"	*7/32"	*7/32"	*7/32"	*7/32"	*3/16"
Dollar Loss/Month	**$22**	**$32**	**$40**	**$48**	**$65**	**$81**	**$112**	**$143**	**$175**	**$151**
3/4"	*5/16"	*5/16"	*5/16"	*5/16"	*5/16"	*1/4"	*1/4"	*1/4"	*1/4"	*7/32"
Dollar Loss/Month	**$34**	**$50**	**$63**	**$76**	**$101**	**$106**	**$147**	**$187**	**$229**	**$206**
1"	*3/8"	*3/8"	*3/8"	*3/8"	*3/8"	*5/16"	*5/16"	*5/16"	*5/16"	*9/32"
Dollar Loss/Month	**$48**	**$72**	**$91**	**$109**	**$145**	**$165**	**$229**	**$294**	**$357**	**$341**

NOTE:
THE DOLLAR COST FIGURES SHOWN ON ALL THESE CHARTS REFLECTS THE COST OF STEAM IN THE 1980'S.

DOLLAR LOSS TABLE FOR FLOAT AND THERMOSTATIC TRAPS
Steam cost @ $6.00/1000 lbs.

Float & Thermostatic (F&T) traps are found where higher levels of condensate are produced (Unit heaters, end-of-mains, heat exchangers, etc.) The modulating control provided by the float allows for continuous discharge of condensate when necessary. The air vent in this trap will generally "fail open" after three to five years of hard work. The mechanism and float assembly, which allows the condensate to discharge, may operate efficiently for eight to ten years, and will normally "fail closed" after this time. However, sludge and debris accumulation may cause the assembly to fail open and waste "big bucks" as shown. Actual dollar loss may be more or less than shown.

Pressure @ Trap	**2 psig**	**5 psig**	**10 psig**	**15 psig**	**25 psig**	**50 psig**	**75 psig**	**100 psig**	**125 psig**	**150 psig**
LOSS FROM AIR VENT: The air vents in all the F&T traps generally utilize a 1/4" discharge orifice.										
Dollar Loss/Month	**$22**	**$32**	**$40**	**$48**	**$65**	**$105**	**$147**	**$187**	**$229**	**$270**
PIPE SIZE	*Assigned orifice size utilized by the mechanism assembly per sizes and differential pressures shown.									
3/4 & 1"	*1/4"	*1/4"	*1/4"	*1/4"	*3/16"	*1/8"	*1/8"	*3/32"	*3/32"	*3/32"
Dollar Loss/Month	**$22**	**$32**	**$40**	**$48**	**$37**	**$26**	**$37**	**$26**	**$32**	**$38**
1 1/4"	*5/16"	*5/16"	*5/16	*5/16"	*1/4"	*3/16"	*3/16"	*1/8"	*1/8"	*1/8"
Dollar Loss/Month	**$34**	**$50**	**$63**	**$76**	**$65**	**$60**	**$83**	**$47**	**$57**	**$67**
1 1/2"	*13/32"	*13/32"	*13/32"	*13/32"	*5/16"	*7/32"	*7/32"	*5/32"	*5/32"	*5/32"
Dollar Loss/Month	**$57**	**$85**	**$105**	**$129**	**$101**	**$81**	**$112**	**$73**	**$89**	**$105**
2"	*1/2"	*1/2"	*1/2"	*1/2"	*15/32"	*7/16"	*7/16"	*5/16"	*5/16"	*5/16"
Dollar Loss/Month	**$86**	**$129**	**$162**	**$194**	**$228**	**$324**	**$516**	**$294**	**$357**	**$421**

DOLLAR LOSS TABLE FOR INVERTED BUCKET TRAPS
Steam Cost @ $6/1000

Inverted bucket traps are generally found on higher-pressure steam systems. However, many like the long lasting characteristics of the trap and install them where one might normally find float and thermostatic traps. Due to the many different orifice sizes in the many different models of inverted bucket traps the guide below is a really "rough" estimate of the potential steam loss. For example: An Armstrong model 883, 3/4" bucket trap made for 15 psig steam will utilize a 1/2" orifice for high condensate capacity applications; whereas a model 881, 3/4" bucket trap for 15 psig steam will utilize a 1/4" orifice. The differences in potential steam loss between the two are significant. Therefore, we have tried to be very conservative when assigning the orifice size in the table below. The actual dollar loss may be significantly different depending upon the specific model of the trap.
The orifice sizes in the table below are referenced from the following Armstrong model numbers: 1/2" pipe size = Model 881; 3/4" pipe size = Model 882; 1" pipe size = Model 883. Order Armstrong Bulletin # 301-H which contains a complete guide to the orifice sizes in the different Armstrong bucket traps.

Pressure @ Trap	**2 psig**	**5 psig**	**10 psig**	**15 psig**	**25 psig**	**50 psig**
PIPE SIZE	* Assigned orifice sizes employed in the traps below when under the differential steam pressure shown.					
1/2"	*1/4"	*1/4"	*1/4"	*1/4"	*1/4"	*5/32"
Dollar Loss/Month	**$22**	**$32**	**$40**	**$48**	**$65**	**$41**
3/4"	*5/16"	*5/16"	*5/16"	*5/16"	*1/4"	*3/16"
Dollar Loss/Month	**$34**	**$50**	**$63**	**$76**	**$65**	**$60**
1"	*1/2"	*1/2"	*1/2"	*1/2"	*3/8"	*11/32"
Dollar Loss/Month	**$86**	**$129**	**$162**	**$194**	**$145**	**$199**

Pressure @ Trap	**75 psig**	**100 psig**	**125 psig**	**150 psig**	**200 psig**	**250 psig**
PIPE SIZE	* Assigned orifice sizes employed in the traps below when under the differential steam pressure shown.					
1/2"	*1/8"	*1/8"	*1/8"	*7/64"	*7/64"	*3/32"
Dollar Loss/Month	**$37**	**$47**	**$57**	**$53**	**$68**	**$72**
3/4"	*5/32"	*5/32"	*5/32"	*1/8"	*1/8"	*7/64"
Dollar Loss/Month	**$57**	**$73**	**$89**	**$67**	**$87**	**$84**
1"	*9/32"	*1/4"	*1/4"	*7/32"	*3/16"	*3/16"
Dollar Loss/Month	**$185**	**$187**	**$229**	**$206**	**$197**	**$244**

STEAM TRAP LOSS CALCULATIONS

Modified Napier Formula: ((PI_R2 X SP X 51.42 X %F/0 X8760)/1000) X cost of steam/1000 lbs

Dollars $$$ Lost Per Year Per Trap

% Trap Failed Open	COST PER THOUSAND POUNDS OF STEAM				
	$3.00	$4.00	$5.00	$6.00	$6.00
25%	$410.03	$546.70	$683.38	$820.05	$956.73
50%	$820.05	$1,093.40	$1,366.75	$1,640.10	$1,913.45
75%	$1,230.08	$1,640.10	$2,050.13	$2,460.15	$2,870.18
100%	$1,640.10	$2,186.80	$2,733.50	$3,280.20	$3,826.90

Prepared by Team, Inc.

Trap Population: 1000 **Dollars $$$ Lost Per Year**

FAILURE RATE:	% TRAPS FAILED OPENED			
	25%	50%	75%	100%
10%	$68,337.55	$136,675.10	$205,012.66	$273,350.21
15%	$102,506.33	$205,012.66	$307,518.98	$410,025.31
20%	$136,675.10	$273,350.21	$410,025.31	$546,700.41
25%	$170,843.88	$341,687.76	$512,531.64	$683,375.52
30%	$205,012.66	$410,025.31	$615,037.97	$820,050.62

Steam cost assumed at $5.00 per 1000 lbs

An example based on a 2,500 trap population If you have 2,500 traps, assume a trap failure rate of 15%. Since all traps do not fail at 100% open, assume failure rate at 75% open. Your estimated steam losses then would be: $ 307,518.98 X 2,5 (adjustment for trap population size), or $768,797.45 per year.

STEAM COST	RETURN ON YOUR INVESTMENT
$3.00	5.0 months
$4.00	4.0 months
$5.00	3.0 months
$6.00	2.5 months
$7.00	2.0 months

Assume 2,500 traps with a 20% failure rate
Assume 15% blow through or leaking
Assume 75% effective orifice average opening
Assume 375 traps need to be replaced
Assume all traps in tracer service
Assume $525 per trap repair cost

STEAM LEAK LOSS CALCULATIONS

Modified Napier Formula: ((PI_R2 X SP X 51.42 X 8760)/1000) X cost of steam/1000 lbs

Dollars $$$ Lost Per Year Per Leak

Cost Per Thousand Pounds Of Steam Using 150 lb. Steam					
ORIFICE	$3.00	$4.00	$5.00	$6.00	$7.00
1/64	$38.87	$51.82	$64.78	$77.73	$90.69
1/32	$155.47	$207.29	$259.11	$310.93	$362.76
3/64	$349.80	$466.40	$583.00	$699.60	$816.20
1/16	$621.87	$829.16	$1,036.45	$1,243.74	$1,451.03

Prepared by Team, Inc.

Leak Population vs. Orifice Size **Dollars $$$ Lost Per Year**

No. of Leaks	ORIFICE LEAK SIZE			
	1/64	1/32	3/64	1/16
10	$647.78	$2,591.12	$5,830.02	$10,364.48
15	$971.67	$3,886.68	$8,745.03	$15,546.71
20	$1,295.56	$5,182.24	$11,660.04	$20,728.95
25	$1,619.45	$6,477.80	$14,575.04	$25,911.19
30	$1,943.34	$7,773.36	$17,490.05	$31,093.43

Steam cost assumed at $ 5.00 per 1000 lbs

LEAK SIZE	RETURN ON YOUR INVESTMENT
1/64	18.0 months
1/32	4.7 months
3/64	2.0 months
1/16	1.0 months

Assume valve packing leaks
Assume 1/2" to 1" valves
Assume steam service @<150psi
Assume $100 per valve repair

BENEFITS OF THE TOOLS

THE HIGH COST OF PROCRASTINATION

Estimates of loss/year costs of air and Nitrogen have become staggering. The cost savings of the relatively simple project of repairing leaks are tremendous.

The estimated cost per year of on 1/8" air leak is $2,980.00. * If only one 1/8" air leak was assumed for each of the main plant areas, the total annual loss cost would be approximately $23,840.00. * Nitrogen leaks are even more expensive events. One Nitrogen leak of only 1/16" costs a whopping $10,700.00 (est.) per annum. If we use the air leak scenario for the 1/16" Nitrogen leak, the loss cost would be almost $75,000.00. A larger tank such as a broken 1/4" OD instrument line will cost a plant $270.00 per day. THAT'S OVER $90,000.00 per year in Nitrogen for ONE leak.**

Total savings of nearly $1,000,000.00 annually just for repairing fourteen or so small leaks . . . a fair return. There are likely more than that when one considers the total number of possible leak sources there are in some plants. The savings is more than sufficient to cover and definitely justifies the cost of the repair staff, the detection equipment, all the tools, a man lift and the materials needed to make the repairs.

Under these circumstances and with the costs involved in today's competitive market, a leak detection program must be an imperative. As the program progresses, routine leak monitoring could and should be undertaken to assure that a high level of line leakage does not again become a source of loss to the plant.

Information furnished by the Institute For Nondestructive Testing
***Air leak costs based on 100 psig, $0.22/Mcf, and 867 hrs/yr.**
****Nitrogen leak costs based on 150 psig, $0.214/Ccf, 8670 hrs/hr**
(industry standards for leakage and nominal area charges for Nitrogen. cost/Ccf often INCREASES with excessive consumption)

PAY BACK ANALYSIS

STEAM LEAKS

In a steam system with 150 lbs. of pressure and a production cost of $6 per thousand pounds, a leak 1/32" in diameter - no larger than the tip of a ball point pen - can cost $249 per year.

In a 50 p.s.i. System with a production cost of $8/1000 pounds, a number of small leaks totaling about 1/4" will cost $8,339.52 in one year. Double the number of leaks to total 1/2" and the cost will be $33,358.08.

At Sun Co.'s Toledo, Ohio refinery, the ultrasonic testing identified 188 malfunctioning steam traps. Savings from replacing these traps have been in the range of $56,000 per year based on reducing 450 p.s.i. steam consumption by about 1,000 lb./hr.

Chevron USA, Perth Amboy NJ has six to eight thousand steam traps throughout the plant. The plant generates close to 500,000 lb./hr. of steam. A steam trap audit revealed the trap failure rate was up to 28%. The refinery has increased its steam trap reliability by 15% within two years after ultrasonic testing was put into use. The reduction in steam losses is savings at least $50,000 a month.

Indiana University-Perdue University campus at Indianapolis has three to four thousand steam traps. Technicians using the ultrasonic testing to monitor steam traps and by-pass valves estimate they are saving $300,000 per year.

AIR LEAKS

In a 75 p.s.i. system with a production cost of $0.14/m cu. Ft., a number of leaks totaling 1/4" will cost $5,734.15 in a year. Double that to 1/2" and the cost of wasted air will be $22,940.25.

In a 100 p.s.i. system, based on nozzle coefficient of .65, and a production cost of $0.10 per thousand cubic feet, a number of leaks totaling 1/8" will result in the loss of 740,210 cubic feet of air per month, at a cost of $74.01 per month. Triple that to 3/8" and the waste will be 6,671,090 cu. Ft. per month and $667.19.

An electronics components company estimated ultrasonic testing would be instrumental in saving them $25 per day in the cost of operating two 250 cfm air compressors at 110 p.s.i. and eliminate the immediate need to purchase an additional compressor.

BEARINGS

N-Ren . . . A bearing on one of their two 500 H.P. motors froze up and did $2,500 damage. Using the stethoscope module, they picked up a bad bearing noise on the second motor . . . resulting in immediate repair and avoiding a complete shutdown in one area of the plant.

Anaconda Wire . . . On a Saturday, when the shop was shut down, maintenance personnel used a regular stethoscope and picked up a bearing noise with the machine running at low speed. The housing they listened to contained two bearings at a cost of $1,500 each. Their stethoscope could not determine which bearing was going bad. With the plant back in operation on Monday, and all other machinery running, ultrasonic testing was used to check the machine in question, while running at top speed. The ultrasonic test identified the front bearing as being the culprit while the back bearing was okay. They immediately replaced only the front bearing at a cost of $1,500, and were back into production much sooner than would have been the case had they replaced both bearings.

BENEFITS OF AN IN PLANT AIR LEAK SURVEY

BENEFITS AND METHODS OF AN IN-PLANT AIR-LEAK SURVEY
Contrary to conventional wisdom, air is not free. In fact, air costs more than water, electricity, or steam. Air leaks slow down a plant's operation, expending more power than necessary to supply compressed air, and can lead to shutdown. Uninformed maintenance practices are often the culprit.

For example, recently a small manufacturing company considering the purchase of a second, larger air compressor ordered an audit of its compressed air system. The findings showed that more than $75,000 of the $100,000 the company had been spending annually to run its primary air compressor was being wasted because of air leaks, uncontrolled demand, and poor applications. Installing a larger air compressor would only have compounded the problem while increasing energy consumption. What the company really needed was a program to educate its maintenance staff about testing procedures and technologies that would eliminate waste and allow the plant to run more efficiently.

Learning how to conduct an in plant air-leak survey is simple. A variety of tools using airborne ultrasound technology allow inspectors to detect deteriorating components and repair them before they fail. The results are startling, and the impact on the company's bottom line will impress top management.

What causes air leaks?

Audits generally turn up few leaks in the overhead distribution piping, although such leaks can easily be detected from the ground with the right equipment. Corrosion also is not a common cause of leaks. The real problems are usually at ground level in hoses, hose connections and fittings, quick couplers, filters, regulators, and lubricators.

Air cylinders often leak around the rod seals or piston packing. Piston-packing leaks are apparent at the cylinder control valve exhaust port. Pipefittings may be loose because equipment has been improperly installed or because sealant was improperly applied during installation.

Poor quality materials also can be a cause. In other instances, the location of the piping causes a leak. If a pipe connection is bumped occasionally by lift trucks, pallet jacks, or other material handling equipment, the fittings may become cracked.

Sometimes leaks are the result of human error. Workers may leave leaking tools on, often beyond the inlet air isolation valves, or neglect to close valves and halt the supply of air when there is no need for a particular application or when production is shut down.

The audit

Any manufacturing plant will benefit from a compressed air system audit. Typically, production demands account for only 50 percent of the total demand for compressed air the remainder is lost. An audit pinpoints all air leaks.

An audit at a small manufacturing plant revealed that the company was spending about $34,000/year to run two air compressors; if they had repaired the air leaks they could have run just as efficiently with one compressor. At a larger facility, an audit showed that repairing all air leaks would reduce the demand for air by approximately 900 scfm and save about $70,000/year.

It is also important to identify uncontrolled demand and improper pressure regulation, and to address poor applications for air, including conventional blow-off. Auditors evaluate the system's distribution and storage systems and review specific problem areas. They also evaluate the operation of all air compressors, determine the need for additional equipment or controls, measure energy demand, and judge energy use. The auditors thoroughly check all equipment, tagging leaks and noting their locations on a worksheet,

and provide a list of materials needed to fix the equipment.

The audit concludes with a report listing operating costs, the cost of improvements, projected savings, and a plan to achieve successful results.

Maintenance professionals who pay close attention to the air-leak audit quickly learn how to keep their plants operating efficiently. They assign maintenance crews to fix all leaks and go back through the facility to retest all the problem areas. An ultrasonic detector is the best tool for the job.

FINANCIAL RESULTS AND SAVINGS

In one plant repairing 324 air leaks lowered the demand for air an average of 750 cfm on the first shift, 475 cfm on the second shift, and 425 cfm on the third shift and Saturdays. The air leaks cost $52,304/year.

Eliminating uncontrolled demand through proper pressure regulation lowered the demand by an average of 570 dfm on the first shift, 330 cfm on the second shift, and 280 cfm on the third shift and Saturdays. Uncontrolled demand cost $37,008/year.

Installing high-efficiency, air-amplifying blow-off nozzles and eliminating or controlling questionable applications for blow-of lowered the demand an estimated 1035 cfm on the first shift, 570 cfm on the second shift, and 475 cfm on the third shift and Saturdays. Blow-off application improvements saved $64,933/year.

These three major areas of improvement accounted for $154,245 of the system's operating cost.

How to conduct an air-leak survey

All operating equipment should be checked every six months. The best plan is to inspect the entire plant department by department, always following the same pattern. However, if such a program seems too daunting, a plant might limit periodic inspections to one or two departments. As maintenance crews become more familiar with ultrasound and inspection techniques, the survey can be expanded to include the entire operation.

Air-leak inspections can be conducted with the equipment on or off. As a rule, technicians begin by determining at what kinds of loads the air compressors are operating. They use the ultrasonic tools to establish sound patterns of properly operating equipment. It is important to slowly scan the entire air line system.

The technician aims the ultrasonic detector directly at the part of the machine under inspection and makes small cross-pattern movements along all exposed sections. The more sensitivity levels the instrument has, the better it performs. If, for example, a one inch. pipe is suspected of leaking, the technician should wave the gun an inch or two in each direction, moving parallel to the pipe until finding the leak. Then the instrument's close focus adapter can be honed in on the exact location of the leak. The problem may actually be in the fitting.

When testing for leaks in air or blow-off applications near open air tubes, for example, the technicians must focus the tool away from interfering noise and isolate the ultrasonic sounds.

Every leak should be tagged with the location and an identification number. A note should also record a description of each leak, including the size. The make and serial number of equipment such as quick couplers, filters, regulators, and lubricators that may be causing a chronic leakage problem should be recorded so as to avoid purchasing the part again.

The technician should double-check each leak that is repaired before moving on to the next area. Often new leaks are inadvertently created during the repair stage and go unnoticed because the part is not retested. Using confirmation and shielding techniques, such as sealing, always pays off when the entire connection is checked one final time.

Confirmation techniques include moving the ultrasonic detector back and forth over the leak site to confirm the loudest point. The technician places the rubber-focusing extension over the suspect area to seal it from the environment. If this area is the sources of the leak, the sound will continue; if not it will diminish. For the shielding technique, the rubber-focusing extension is used alone, or the technician can cup a hand over the end of the probe to scan close to the surface of the test area.

After the equipment has been repaired, the tag is removed, but the recording sheet should be kept for reference. Finally, the technician should monitor the load of the air compressors are too large for its real air demands. Many compressors are designed to operate most efficiently at or near full load. If a

compressor is consuming 80 percent of the input power to deliver 50 percent of its capacity following repairs, the plant might be wise to consider smaller air compressors. The savings can be substantial.

After the number of air leaks has been determined and repairs have been made, it is important to document the program, including an estimate of projected cost savings. The costs of labor, materials, cooling water, and other related expenses must be factored in.

AIR LEAK COST CHARTS

(Information provided by The Institute For Nondestructive Testing, 1999)

Leak Diameter in inches	Air Loss Cfm	Air Loss cu ft/day	Loss $ per Day	Loss $ per Month	Loss $ per Year
1/64	0.5	576	$0.14	$4.20	$50.40
1/32	1.6	2,304	$0.58	$17.60	$211.00
3/64	3.7	5,270	$1.32	$40.10	$481.00
1/16	6.5	9,288	$2.32	$70.50	$846.00
3/32	14.5	20,880	$5.22	$158.70	$1,904.00
1/8	25.8	37,152	$9.29	$282.40	$3,389.00
3/16	58.3	83,952	$21.00	$638.40	$7,661.00
1/4	103.0	148,320	$37.08	$1,127.20	$13,526.00
5/16	162.0	233,280	$58.32	$1,772.90	$21,275.00
3/8	234.0	336,960	$84.24	$2,560.90	$30,731.00

Note: Based on 100 psig, $0.25/Mcf, 8760 hours/year)

DIAMETER OF LEAKS	Cu. ft/DAY AIR LOSS	DOLLARS LOSS/DAY	DOLLARS LOSS/MONTH	DOLLARS LOSS/YEAR
1/32 inch	**1,764**	**$.25**	**$7.50**	**$91.25**
1/6 inch	**7,100**	**$1.00**	**$30.00**	**$365.00**
1/8 inch	**27,486**	**$3.85**	**$115.44**	**$1,405.25**
1/4 inch	**112,233**	**$15.71**	**$471.38**	**$5,734.15**
3/8 inch	**251,950**	**$35.27**	**$1,058.10**	**$12,873.55**
1/2 inch	**448,933**	**$62.85**	**$1,885.52**	**$22,940.25**

Costs based on 75 psi Syst. at a production cost of $0.14/MCF, with a run time of 8,760 Hours/Year

These charts do not address the cost of premature compressor wear or replacement incurred from additional run time to accommodate air leakage.

AIR AND NITROGEN LOSS CALCULATIONS

$$\$\$\$ \text{ Loss Per Year} = [(20.57 * A * P)/ \{Dg * (T + 460)^{0.5}\}/1000] * 60 * 8760 * \text{cost}/1000 \text{ cu ft}$$

Dollars $$$ lost per year based on effective leak size and pressure

LEAK SIZE	AREA PI*R^2	SYSTEM PRESSURE (PSIG) 15	30	45	100	150
1/64	0.000192	$11.72	$23.43	$35.15	$78.11	$117.16
1/32	0.000767	$46.86	$93.73	$140.59	$312.42	$468.63
3/64	0.001726	$105.44	$210.88	$316.33	$702.95	$1,054.42
1/16	0.003068	$187.45	$374.91	$562.36	$1,249.69	$1,874.53
3/32	0.006903	$421.77	$843.54	$1,265.31	$2,811.80	$4,217.69

Density of Nitrogen: 0.0724
Density of Air: 0.07494
Temperature (T): 70° F
Density (Dg): 0.07494 (air)
Cost Per 1000 cu ft: $0.65

LEAK SIZE	RETURN ON YOUR INVESTMENT
1/64	2.8 years
1/32	8.5 months
3/64	3.8 months
1/16	2.1 months
3/32	1.0 month

ROI based on $0.65/1000 cu ft product
ROI based on 45 psi system pressure
Assume valve packing leaks
Assume 1/2" to 1" valves
Assume air service
Assume $100 per valve repair

Prepared by Team, Inc.

SPEECH GIVEN AT MEETING OF NON DESTRUCTIVE TESTING SOCIETY

THERMOGRAPHICS = LIGHT SIGNATURE YOU CANNOT SEE.

VIBRATION ANALYSYS = VIBRATION SIGNATURE YOU CAN NOT FEEL.

ULTRA SOUND = SOUND SIGNATURE YOU CAN NOT HEAR

As the name Ultrasonic implies, this term deals with that branch of acoustics whose frequency waves are above the highest frequency audible to the human ear. Ultrasonic vibrations (Sound Waves) are measured in terms of Hertz (Hz). One Hz is one wave cycle per second. The human ear is generally assumed to hear sounds with a frequency of 16 Hertz up to a limit of 20 Kilo-Hertz (20,000 cycles per second). However, most sounds, which we hear, are in a very limited range, considerably below this theoretical limit.

Today the most generally accepted definition of Ultrasonics refers to sound waves with a frequency greater than 16 Khz. The present upper limit of detectable ultrasonic frequencies is approximately 100 Mega-Hertz (100,000,000 cycles per second).

As the frequency of the sound wave changes, the way in which the sound wave propagates also changes. Low frequency sounds tend to propagate spherically with equal intensity in every direction. Higher frequency waves particularly those over 20 kilohertz tend to propagate more directionally like a beam. This makes the location easier to pinpoint. As the wave frequency increases it becomes more and more attenuated by distance, requiring the detector to be closer to the source or more sensitive to hear the vibration.

Leak Testing Objectives

Like other forms of nondestructive testing, leak testing has a great impact on the safety or performance of a product. Reliable leak testing saves costs by reducing the number of reworked products, warranty repairs and liability claims. The time and money invested in leak testing often produces immediate profit.

The three most common reasons for performing a leak test are:

1. MATERIAL LOSS

With the high cost of energy, material loss is increasingly important. By leak testing, energy is saved not only directly, through the conservation of fuels such as gasoline and LNG but also indirectly, through the saving of expensive chemicals and even compressed air.

2. CONTAMINATION

With stricter OSHA and environmental regulations, this reason for testing is growing rapidly. Leakage of dangerous gases or liquids pollutes and creates serious personnel hazards.

3. RELIABILITY

Component reliability has long been a major reason for leakage testing. Leak tests operate directly to assure serviceability of critical parts from pacemakers to refrigeration units.

MECHANISMS THAT PRODUCE ULTRASOUND

A number of different mechanisms produce translatable ultrasonic sound in the 40 kilohertz region. These mechanisms are:

1) **Turbulent fluid flow**
2) **Liquid movement**
3) **Mechanical movement**
4) **Sound generators**
5) **Electrical discharge**

Turbulent Flow:

Sometimes called sonic or choked flow, turbulent flow is the most widely recognized source of ultrasonic vibrations. Turbulent flow occurs with any fluid whether a liquid or a gas. This type of flow is one of the three basic flow modes. Laminar and molecular are the other two. Of the three, however, only the turbulent flow of a fluid across a pressure boundary creates acoustic waves. These waves can be transmitted through the medium of the fluid itself, through the containment structure, or through the air surrounding the containment structure. Thus, depending upon the situation, turbulent flow can be detected in a variety of ways. Turbulent flow often occurs through holes with a diameter of .015 inches to .0005 inches. It is generally assumed that the smallest detectable flow through leaks this size is 1×10^{-2} standard cc/sec. (a rate equivalent to a pound of Freon leaking out of a container every 3 months). Besides instrument sensitivity two other controllable factors, viscosity and velocity can improve test results. Lower viscosity fluids tend to create greater turbulent energy and as a result, pressurization with a gas like helium may allow the location of leaks, which could not be found with air. In

the same way, great velocity (or its complement, a greater pressure differential) causes increased turbulent energy. For practical purposes pressure differentials of 5 psi are at the lower limit of delectability but with small holes in rigid material leaks with a pressure as small as one-half pound pressure have been successfully detected. Higher pressures can cause the acoustic waves to have a higher and more constant amplitude, making leak testing easier and more reliable.

There has been considerable discussion as to which type of leak configuration is more likely to cause acoustic vibrations. Several authors have held that labyrinth type leaks such as threaded fittings or folded metal edges would diffuse the turbulent vibrations to such an extent that turbulent flow would be undetectable. Actual tests however have proven that even with pressure differentials as low as 10 psi labyrinth leaks can be detected.

Liquid Movement:

Besides turbulent flow, liquid movements such as cavitation, flashing of a liquid to a vapor, and bubble bursts can also produce high-energy ultrasonic noise. Cavitation can be especially useful for finding small vacuum leaks, which are usually considered difficult to find ultrasonically. By applying a high surface tension liquid, (such as alcohol) on the area to be tested, the ultrasonic energy produced as the film is broken by the vacuum, creates a signal which is detectable at a distance of several feet. In the same way, small bubbles from synthetic bubble fluids applied across a pressure boundary create strong ultrasonic signals as they burst and reform. Bubbles, which are often too small to be seen, can be heard easily ultrasonically. Soap and water will not work for this technique. Soap or detergent solutions form a great number of bubbles when applied. This makes it difficult to distinguish real from apparent leaks. In addition, soap solutions form large rather than small bubbles and as a result, they do not produce much ultrasonic energy nor do they burst very often. For these and a number of other reasons soap or detergent solutions have been banned by a number of regulatory agencies such as ASTM and ASME for any leak detection use.

Mechanical Movement:

Another widely used source of ultrasonic energy results from contact between metal parts and stress. Stressed material, which results in stretching, shearing, abrading or other types of deformation releases high levels of ultrasonic energy. Ultrasonic sound resulting from friction is often used to monitor machines to prevent shutdowns and predict maintenance needs. Examples of problems that are easy to detect are: Bearings with pits, cracked races, loose parts, lubrication failure, misalignment, malfunctioning valves or gears. By detecting defects such as insufficient oil film, worn

bearings, misalignment, or defective gears before significant increases in vibration or temperature incipient failures can be prevented.

Sound Generation:

A technique for testing unpressurized containers involves the use of an ultrasonic sound generator and a detector matched to the same frequency. When used in a closed container with walls, which reflect rather than dampen noise, the ultrasonic signals will pass through small leaks and can be detected. This technique has been used successfully on items such as: welded seams, airplane compartments, refrigerators, automobile windows, condenser tubes and large tanks.

Electrical Discharge:

The fourth type of ultrasonic noise that can be detected is generated by electrical discharges (corona), sparks, and flashovers. When an electrical spark jumps from one object to another, the heated air expands rapidly and produces an airborne shock wave. (This effect is similar to that of "thunder" which accompanies a lightning stroke). The strong agitation of the air produces ultrasonic noise. Therefore, the detection device can be used to locate electrical defects, i.e., high-voltage corona discharges, arcs in cables, on trolley arms, carbon brushes, transformers, motors, contactors, insulators, reactors, distribution systems and other electrical installations subject to electrical leakage or breakdown of insulation.

advance of a vibration or heat signature, making it very compatible Ultrasonic testing will often detect an ultrasound signature in when used to determine productive areas for the application of vibration analyses or thermographic imaging.

Ultrasonic test equipment is inexpensive, easy to use, and highly portable.

SECTION 11
FEATURES AND PRICE COMPARISON

OF COMPETITIVE EQUIPMENT

- **EFI- W-7 Microsonic Detection Kit**
- **UE Systems Ultraprobe 2000 Detection Kit**
- **SDT-USA 150 Detection Kit**

EFI- Electronics for Industry W-7 Industrial Detection Kit	**UE- Systems Ultraprobe 2000 Detection Kit**	**SDT USA SDT-150 Ultrasonic Detection Kit**
W7 Pistol style detector with analog & audio indication	2000 Pistol style detector with analog & audio indication	150-Detector with LED and audio indication
Ultrasonic Scanner Module	Ultrasonic Scanner Module	Ultrasonic Scanner Module
Ultrasonic Contact Module	Ultrasonic Contact Module	Ultrasonic Contact Module
Ultrasonic Tone Generator	Ultrasonic Tone Generator	Ultrasonic Tone Generator
Rubber Focusing Probe	Rubber Focusing Probe	Rubber Focusing Probe
Deluxe Headset	Deluxe Headset	Not Included
Inexpensive 9V batteries and AA batteries. (You can't use a charger in the field)	Rechargeable batteries & charger (ni-cads = memory degradation)	Rechargeable batteries & charger (ni-cads = memory degradation)
Instruction Manual & Adjusting Tool	Instruction Manual	Instruction Manual
Nylon With Foam Insert Carry Case	Haliburton Aluminum Carry Case	Sturdy Carry Case
Warranty (1) Year Parts/Labor	Warranty (1) Year Parts/Labor	Unknown
Manufactured – USA	Manufactured – USA	Manufactured - Europe
KIT PRICE $1,270.00 plus S/H	KIT PRICE $4,495.00 plus S/H	KIT PRICE $4,416.00 plus S/H

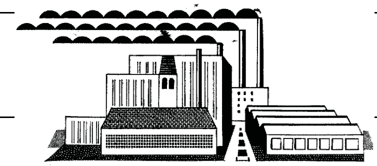
SECTION 12

SPECIFIC USES AND APPLICATIONS

This section contains separate, printable, pages for many of the more common problems that can be solved with the Electronics For Industry, Inc. tools.

You may wish to print these pages and use them as justification for buying and using Ultrasonic Tools in your plant, shop, hospital or other applications.

INDUSTRIAL & COMMERCIAL ULTRASONIC INSPECTION



DESCRIPTION

Inspection of mechanical equipment with EFI ultrasonic detection equipment has many advantages. Ultrasound inspection provides early warning of bearing failure, detects lack of lubrication, detects leaks in compressed-air and vacuum systems, prevents over lubrication and can be used on high as well as low speed bearings. In addition, since ultrasound is a high frequency, short wave signal, it is possible to filter out stray, confusing background noises and focuses on the specific item to be inspected. Basic inspection methods are extremely simple and require very little training. In addition, ultrasonic testing works extremely well with vibration technology. In fact the two technologies complement each other and enhance any PDM, (Predictive Maintenance) program.

Some common areas for ultrasonic inspection in the industrial & commercial environment:

- **COMPRESSED-AIR/GAS SYSTEMS FOR LEAKS**
- **VACUUM SYSTEMS FOR LEAKS**
- **BEARINGS FOR WEAR**
- **ELECTRIC MOTORS FOR BEARING WEAR AND ELECTRICAL SHORTING**
- **PUMPS FOR INTERNAL WEAR**
- **ELECTRIC PANELS FOR ARCING AND SHORTING**
- **HYDROLICS FOR INTERNAL LEAKAGE**
- **WIRE ROPE FOR EXTERNAL WEAR & FRAY**
- **DRIVE BELTS FOR CRACKS AND WEAR (with equipment in operation & belt guards in place)**
- **ENCLOSED AREAS (ROOMS, CONTAINERS, VAULTS, TANKS, ETC.)**
- **VALVES, GASKETS, SEALS**

How Ultrasonic Detection Works

Compressed gases, when leaking produce a turbulent flow with strong ultrasonic components. By scanning fittings, a leak will be heard as a distinct "hiss". Due to the high frequency, short wave nature of ultrasound, the sound will be loudest at its point of origin. The Microsonic unit translates the ultrasonic leak signals into recognizable audible signals where they are heard through headphones and seen as intensity increments on a meter. A unique test incorporates a patented ultrasonic transmitter called a Tone Generator. This device is placed in a cabin, tank or container where it floods the area with an intense ultrasonic signal. The generated ultrasound will deflect off solid seals but will flow through a leak path.

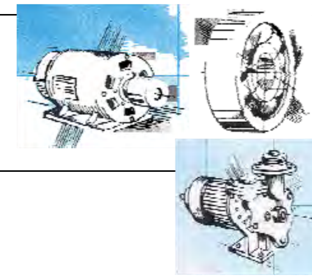
Detection Methods

Pressurized air & gas leaks produce turbulence with high frequency components. To locate compressed air and gas leaks, simply scan the test area with the hand held EFI Microsonic detector. If a leak is present, ultrasonic sound not audible to the human ear is produced. This high frequency sound will be "heard" by the EFI detector and converted into an audible "hissing" sound heard through the systems headphones. Simply follow it to the loudest point. If it is difficult to discriminate the leaks location, reduce the sensitivity and continue to follow to the loudest point.

REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!

BEARINGS, PUMPS & MOTORS

ULTRASONIC INSPECTION



DESCRIPTION

Inspection of mechanical equipment with ultrasonic instruments such as the Microsonic unit has many advantages. Ultrasound inspection provides:

- Early warning of Bearing failure
- Early warning of Poor of lubrication
- Prevent over lubrication during maintenance
- Effective on High & Low speed bearings
- Detect carbon brush “Hop” before damage to armature
- Monitor pump internal components

In addition, since ultrasound is a high frequency, short wave signal, it is possible to filter out stray, confusing background noises and focuses on the specific item to be inspected. Basic inspection methods are extremely simple and require very little training. In addition ultrasonic testing works extremely well with vibration technology. In fact the two technologies complement each other and enhance any PDM, (Predictive Maintenance) program.

How Ultrasound Bearing and Mechanical Inspection Works

Mechanical movements produce a wide spectrum of sound. By focusing on a narrow band of high frequencies, the Microsonic unit detects subtle changes in amplitude and sound quality. It then heterodynes these normally undetectable sounds down into the audible range where they are observed on a meter (for trending and comparison purposes) and heard through headphones.

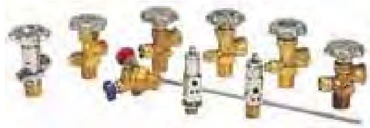
Based on research by NASA, it was established that ultrasonic monitoring provides early warning of bearing failure. Various stages of bearing failure have been established. An 8 dB gain over baseline indicates pre-failure or lack of lubrication. A 12 dB increase establishes the very beginning of the failure mode. A 16 dB gain indicates advanced failure condition while a 35-50 dB gain warns of catastrophic failure.

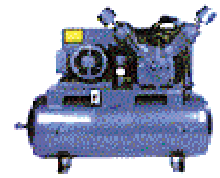
Ultrasonic Bearing Inspection Method

There are two basic methods for ultrasonic bearing monitoring: comparative and historical. In order to trouble shoot bearings or to establish a baseline, it is necessary to compare similar bearings for potential differences in amplitude and sound quality. To do this, make a reference point on a bearing housing or use the grease fitting, using the stethoscope module make contact with the machinery and reduce the sensitivity until the bearing reads 20 on the meter. Then compare this base reading to other similar bearings. A failing bearing will show an 8 dB gain. Once a series of bearings have been tested, and a base line set, data is recorded and then compared to future readings for historical trending and analysis.

<u>REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!</u>

COMPRESSORS, PRESSURE & VACUUM SYSTEM ULTRASONIC INSPECTION





DESCRIPTION

Compressors are the heart of any compressed gas system. Routine inspection and maintenance can prevent unplanned downtime. Although any type of compressor can be inspected ultrasonically, the most common application centers on larger reciprocating types. Specifically, valve function in these compressors is critical. Minor valve leaks can rapidly lead to large leaks, which can effect production and impact on plant safety.

How Ultrasonic Compressor Inspection Works

As with any mechanical movement, there is a "normal" operation and a "deviation". In the case of valves, normal function is the typical open/close movement. Ultrasonically this will be observed as a rhythmic movement. When valve movement changes due to leakage or sticking, the sound pattern changes. Each condition has ultrasonic components that can be sensed and monitored by the Microsonic detection unit. Due to the short wave, high frequency nature of ultrasound, the sounds produced by a compressor valve can be isolated, which provides a clear test result.

Detection Method

For the "contact' method touch the valve with the contact probe and reduce the sensitivity until it is possible to obtain a meter swing around mid-line and hear the valve open/close movement. When testing, be sure to compare similar valves to each other (i.e. intake to intake, exhaust to exhaust) and under the same conditions (i.e. idling vs. working). For additional localization, use the scanning module with rubber focusing extension.

Pressure & Vacuum Systems

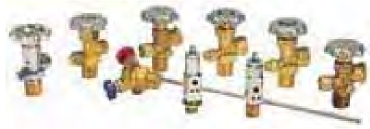
Compressed air and gas (Oxy, Nitrogen, LNG, CNG, etc) and vacuum systems are easily checked for leaks or system flow. Fittings, valves, couplings, regulators, hoses, piping, auto-bleeders, pneumatic actuators, gaskets & seals, etc are among the system components easily checked. Ultrasound is produced by the passage of air or gas though an orifice under pressure or vacuum. The ultrasonic signature is "heard" by our detectors and converted into a sound you can hear through headphones and seen as an indication on an analog meter.

Detection method

Simply scan detector along system components (pipe, valves, connectors, etc) until leak is found. Ordinary sounds such as background noise, talking or machinery (no matter how loud) are not detected. But leaks are easily pinpointed even in otherwise deafening background sound levels.

<u>REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!</u>

STEAM TRAP, VALVE & FITTINGS ULTRASONIC INSPECTION

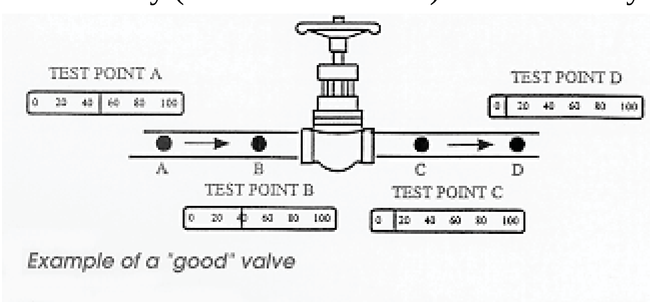


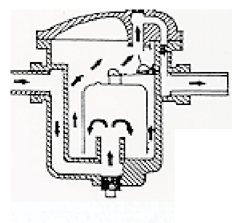
DESCRIPTION

When valves or steam traps leak or fail, it can be extremely costly in terms of product quality, safety and energy loss. Valve operation affects the way fluids will flow through a system. There are great differences in the way particular valves and steam traps work. Ultrasonic testing makes it easy to adjust for these differences and readily determine operating conditions while valves and traps are on-line.

How Ultrasonic Leak Detection works?

As fluid moves from the high-pressure side of a valve through the seat to the low-pressure side, it produces turbulence. This turbulence generates ultrasound, which is detected by the ultrasonic probe, and translated, via heterodyning, down into the audible range. The translated ultrasounds are heard through headphones and seen as intensity increments on a meter. High frequency tuning allows users to adjust for differences in fluid viscosity (i.e. water vs. steam) and reduce any interference from stray pipe noises.





Leak Detection Method

Inspection methods vary depending on the type of valve or steam trap. Therefore the primary rule is to know the details of your system, for example the way a specific trap or valve may work under specific conditions. In order to determine leakage or blockage: touch upstream of the valve or trap and reduce the sensitivity of the instrument until the meter reads about 50. If it is desirable to hear the specific sound quality of the fluid, simply tune the frequency until the sound you would expect to hear becomes clear. It's that simple. Next, touch downstream of the valve or trap and compare intensity levels. If the sound is louder down stream, the fluid is passing through. If the sound level is low, the valve or trap is closed. Ultrasonic valve and steam trap inspection is considered a "positive" test in that an operator can instantly identify sound quality and intensity differentials and thereby determine operating condition accurately.

<u>REMRMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!</u>

PIPE, JOINTS, VAULTS, VALVES, & TANKS ULTRASONIC INSPECTION

DESCRIPTION

Pipe is the heart of any gas or liquid distribution system. Inspection and maintenance can prevent unplanned leaks and downtime. Any type of pipe can be inspected ultrasonically.

- Concrete
- PVC, PE
- Steel
- Iron
- Aluminum
- Copper
- Fiberglass Filament Wound, Etc.

DON'T BURY A LEAK!!

Ultrasonic testing is done during assembly, ***WITHOUT WATER OR AIR PRESSURE, BEFORE BURYING PIPE!*** Find Rolled or Pinched Gaskets, Cracks or Pinholes. Frequently this equipment pays for itself with the first use! You may also use the EFI Microsonic tool to detect leaks underground after the project is buried.

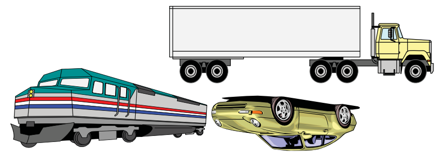
DETECTION METHODS

During assembly, a Microsonic tone generator is placed inside the pipe or other volume (Vault, Manhole, etc,) this will saturate the inside area with high intensity ultrasonic sound, not audible to the human ear. This high intensity ultrasonic sound will find and exit any hole in the pipe or joint. A hand held Microsonic Detector is then used to scan the area being tested for leaks (seals, gaskets, cracks or pinholes). When a leak is detected the operator will hear an audible indication in his headphones and will see an indication on the analog meter built into the detector. It's that simple, Ultrasonic testing is quick, accurate and cost effective.

Pressurized air & gas leaks produce turbulence with high frequency components. To locate compressed air and gas leaks, simply scan the test area with the hand held EFI Microsonic detector. If a leak is present, ultrasonic sound not audible to the human ear is produced. This high frequency sound will be "heard" by the EFI detector and converted into an audible "hissing" sound heard through the systems headphones. Simply follow it to the loudest point. If it is difficult to discriminate the leaks location, reduce the sensitivity and continue to follow to the loudest point.

REMEMBER, TO FIX IT………FIRST YOU HAVE TO FIND IT!

TRANSPORTATION & EQUIPMENT ULTRASONIC INSPECTION



DESCRIPTION

The most common areas for ultrasonic inspection in the transportation industry are: wind noise, water leaks, air brakes, and emission systems. Until the advent of ultrasound, water leak and wind noise detection involved many hours of trial and error with a water hose and flashlight. Often a few trips around the block, listening with a doctor's stethoscope for a wind noise captured two people for many hours. Air brake leaks and emission leaks can take hours to locate using conventional soap and water bubble testing. Not only can service shops benefit from Ultrasonic Inspection, so can Quality Assurance departments by providing accurate fast and simple testing.

How Ultrasonic Detection Works

Compressed gases, when leaking produce a turbulent flow with strong ultrasonic components. By scanning fittings, a leak will be heard as a distinct "hiss". Due to the high frequency, short wave nature of ultrasound, the sound will be loudest at its point of origin. The Microsonic unit translates the ultrasonic leak signals into recognizable audible signals where they are heard through headphones and seen as intensity increments on a meter. A unique test incorporates a patented ultrasonic transmitter called a Tone Generator. This device is placed in a cabin, tank or container where it floods the area with an intense ultrasonic signal. The generated ultrasound will deflect off solid seals but will flow through a leak path.

Some of the most common areas for ultrasonic inspection include:

- **COMPRESSED AIR & BRAKE SYSTEMS**
- **CNG & LNG GAS SYSTEMS**
- **VACUUM SYSTEMS**
- **ENGINE INTAKE SYSTEM LEAKS**
- **EXHAUST SYSTEM LEAKS**
- **ENGINE INTERNAL DIAGNOSTICS**
- **DRIVE LINE DIAGNOSTICS**
- **BEARINGS, PUMPS & ELECTRIC MOTORS**
- **FUEL TANKS**
- **WIND NOISE & WATER LEAKS & TRUNK COMPARTMENT LEAKS**
- **DOOR, WINDOW, FLOOR & ROOF SEALS**
- **HYDROLICS**
- **FUEL INJECTORS**
- **DRIVE BELTS**
-

Detection Methods

Pressurized air, gas & fluid leaks produce turbulence with high frequency components. To locate air, gas or fluid leaks under pressure, simply scan the test area with the hand held EFI Microsonic detector. If a leak is present, ultrasonic sound not audible to the human ear is produced. This high frequency sound will be "heard" by the EFI detector and converted into an audible "hissing" sound heard through the systems headphones. Simply follow it to the loudest point. If it is difficult to discriminate the leaks location, reduce the sensitivity and continue to follow to the loudest point.

REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!

MARINE
ULTRASONIC INSPECTION

DESCRIPTION

Ultrasonic inspection can be used in practically every phase of the maritime industry. There are application for marine vessels, dry docks, ship repair and shipbuilding. Some of the major areas of inspection cover water tightness integrity of bulkheads, leak detection of hatches and vapor recovery systems, condensers, steam systems, pressurized gas systems (including nitrogen blankets), valve leak detection/blockage and steam traps. Mechanical applications include early warning of bearing failure, inspection of motors, pumps, gears, gearboxes and compressors. Dry dock usage not only includes all of the above, but also extremely large energy savings through compressed air leak detection.

How Ultrasonic Detection Works

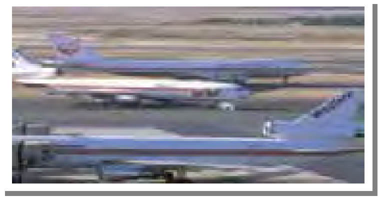
High frequency sounds are produced by operating equipment and fluid flows. The Microsonic unit detects subtle changes in mechanical equipment and turbulence produced by leakage to provide early warning. Ultrasounds are translated into the audible range where the sound quality is easily recognized through acoustically isolating headphones. The headphones are designed to be used in the extremely noisy environment of the engine room. Intensity levels are read on a meter for trending, diagnosis and trouble shooting purposes. A patented Tone Generator can be used to test for leaks in lieu of pressure by flooding an area with intense ultrasound. The sound will deflect off a solid surface and penetrate leak sites.

Detection Methods

To locate leaks around pressure or vacuum systems simply scan the area while listening for a "hissing" sound and follow it to the loudest point. Vapor recovery systems can be checked on-line in this manner. Hatches and bulkheads may be tested with the patented ultrasonic Tone Generator. Place the generator on one side (i.e. of the bulkhead) and scan the other side for sonic penetration, which will have a distinctive tone sound. Scan the area to the loudest point of emission, which will indicate the leak site. For valves, touch upstream and reduce the sensitivity to get a mid-line reading on the meter, then touch downstream and compare intensity levels. A more intense reading downstream indicates leakage. No sound indicates blockage. Set a baseline by selecting one test/reference point, touch that point with the contact probe, and reduce the sensitivity to obtain a mid meter reading. An increase of 8 dB indicates "pre-failure" or lack of lubrication, while an increase of 12-16 dB over baseline indicates the beginning of the failure mode. **It's that simple.**

REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!

AIRCRAFT
ULTRASONIC INSPECTIONS



DESCRIPTION

Aircraft have many systems that can be checked ultrasonically. Some of the more common applications include:

- **Locate leaks in oxygen systems**
- **Locate cabin pressure leaks**
- **Locate tire leaks**
- **Locate problems in hydraulic valves and actuators**
- **Locate leaks in cockpit windows & doors**
- **Locate problems with bearings, pumps, motors and gears**
- **Locate leaks in floatation devices**
- **Locate leaks in fuel cells**
- **Detect & locate corona affecting electronics**
- **Detect & locate arcing & sparking in electrical systems**
- **Locate vacuum and static system leaks**
- **Detect instrument face leakage**
- **Detect which gyroscopic instrument is starting to fail**

How Ultrasonic Detection Works

Operating systems such as compressed gas systems, valves, motors, pumps, etc., all produce ultrasound. Some high frequency sounds are generated from turbulence, others from friction. As components begin to wear, fail or leak, there is a change in the normal ultrasonic pattern. This can be detected as an increase in amplitude, a change in sound quality or a change in sound pattern. Since ultrasound is a high frequency, short wave signal, it will isolate the signal by localizing the problems and detect subtle changes for early warning detection.
The Microsonic test unit detects minute changes in ultrasound and converts these signals so that they may be heard through headphones, and observed as intensity increments on a meter. By using plug-in modules for either a scanning mode or a contact mode, equipment may be inspected for leakage or for mechanical problems. Due to its portability and its' rating of Intrinsically Safe, class 1, Division 1, Groups A, B, C, & D, the Microsonic unit may be used all around the aircraft.

Detection Methods

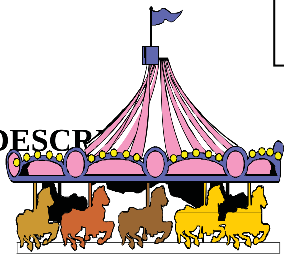
For general leak detection, in a scanning mode, move along the area to be tested with the sensitivity at high and, using a slight waving motion, listen for the loudest "hissing" sound and follow the sound to the loudest point. Use the patented Tone Generator to test for cabin pressure and cockpit window leaks in the same manner. The only difference will be the sound, which is heard as a distinctive tone, with graduating intensity. For valves and actuators, touch upstream and reduce the sensitivity to a mid-line reading. Compare with the downstream reading. Test bearings and mechanical equipment by reducing the sensitivity first and then tune the frequency until the desired mechanical sound is heard. Compare readings over time for trending. **It's that simple.**

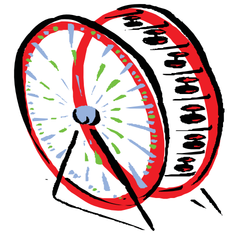
REMEMBER, TO HAVE TO FIND

AMUSEMENT RIDE INDUSTRY
ULTRASONIC INSPECTION

FIX IT…..FIRST YOU IT!

DESCR





Inspection of mechanical equipment with EFI ultrasonic detection equipment has many advantages. Ultrasound inspection provides early warning of bearing failure, detects lack of lubrication, detects leaks in compressed-air and vacuum systems, prevents over lubrication and can be used on high as well as low speed bearings. In addition, since ultrasound is a high frequency, short wave signal, it is possible to filter out stray, confusing background noises and focuses on the specific item to be inspected. Basic inspection methods are extremely simple and require very little training. In addition, ultrasonic testing works extremely well with vibration technology. In fact the two technologies complement each other and enhance any PDM, (Predictive Maintenance) program.

Some common areas for ultrasonic inspection in the amusement ride industry include:

- **COMPRESSED-AIR SYSTEMS FOR LEAKS**
- **AIR BRAKE SYSTEMS FOR LEAKS**
- **VACUUM SYSTEMS FOR LEAKS**
- **BEARINGS FOR EARLY WEAR**
- **ELECTRIC MOTORS FOR BEARING WEAR, BRUSH HOP, AND ELECTRICAL SHORTING**
- **ELECTRIC PANELS FOR ARCING AND SHORTING**
- **DRIVE BELTS FOR CRACKS AND WEAR (with equipment in operation & belt guards in place)**
- **PUMPS FOR INTERNAL WEAR & LEAKAGE**
- **HYDRAULIC SYSTEMS FOR INTERNAL LEAKAGE**
- **RAILS, TRACKS & SUPPORTS FOR LOOSE COMPONENTS & LEAKAGE**
- **FILTRATION SYSTEMS FOR FLOW**

How Ultrasonic Detection Works

Compressed gases, when leaking produce a turbulent flow with strong ultrasonic components. By scanning fittings, a leak will be heard as a distinct "hiss". Due to the high frequency, short wave nature of ultrasound, the sound will be loudest at its point of origin. The Microsonic unit translates the ultrasonic leak signals into recognizable audible signals where they are heard through headphones and seen as intensity increments on a meter. A unique test incorporates a patented ultrasonic transmitter called a Tone Generator. This device is placed in a cabin, tank or container where it floods the area with an intense ultrasonic signal. The generated ultrasound will deflect off solid seals but will flow through a leak path.

Detection Methods

Pressurized air & gas leaks produce turbulence with high frequency components. To locate compressed air and gas leaks, simply scan the test area with the hand held EFI Microsonic detector. If a leak is present, ultrasonic sound not audible to the human ear is produced. This high frequency sound will be "heard" by the EFI detector and converted into an audible "hissing" sound heard through the systems headphones. Simply follow it to the loudest point. If it is difficult to discriminate the leaks location, reduce the sensitivity and continue to follow to the loudest point.

REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!

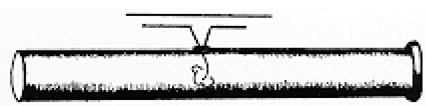
Heat Exchangers, Boilers, Condensers

DESCRIPTION

Leak Detection of heat exchangers, boilers and condensers most often involves inspection of three generic areas: tubes, tube sheets and housings. The Microsonic detection unit can be used to detect leaks three ways: pressure leaks, vacuum leaks or by utilizing a unique Tone transmission method.
While it may be necessary to take a unit off-line to inspect for leaks, with ultrasound, it is often possible to perform an inspection while on-line or at partial load.

How Ultrasonic Leak Detection Works

During a leak, the fluid will flow from high pressure to low pressure producing a turbulent flow at the leak site. This turbulence has strong ultrasonic components, which are sensed and translated (via heterodyning) into the audible range where they are heard in headphones and seen as intensity increments on a meter.



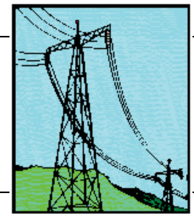
Turbulence produced in the tube as fluid moves from high to low pressure

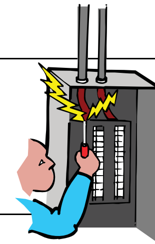
Leak Detection Method

Most often leak detection is concerned with tube leaks. In heat exchangers and condensers, there are situation where the end plates (headers) are removed or water boxes are isolated while the unit is still on-line or at partial load. The tube sheet is scanned while listening for a distinct "hissing" or "rushing" sound of a leak. By adjusting the sensitivity of the instrument to help discriminate direction, move in the direction of the tube with the loudest sound. Should the unit require off-line inspection, it is possible to use the Ultrasonic Tone transmission method. Using ultrasonic transmitters such as the patented Tone Generators, the heat exchanger is flooded with intense ultrasonic sound waves on the shell side and the tube sheet is scanned for a distinct tone sound coming from the leak. As above, adjust the sensitivity to discriminate direction and follow the sound to the loudest point, which will be the leaking tube. While under pressure or vacuum, fittings and casings may also be checked for leakage in a similar manner.

REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!

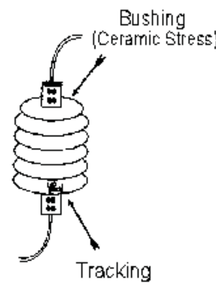
ELECTRICAL
ULTRASONIC INSPECTION





DESCRIPTION

When electrical apparatus such as switch gear, transformer, insulators or pot heads and splices fail, the results can be catastrophic. This is just as true in industrial plants as it is in the power transmission and distribution side. Electrical discharges such as arcing, tracking or coronas are all potential for equipment failure. In addition, the problems of RFI and TVI impact on our valuable communication networks. All these conditions produce ultrasound and are detected with the Microsonic detection unit.



How Ultrasonic Electrical Detection Works

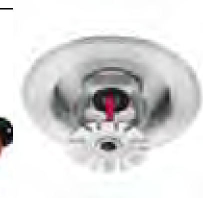
Arcing, tracking and corona all produce some form of ionization which disturbs the air molecules around it. The Microsonic unit detects the high frequency noise produced by this effect and translates it, via heterodyning, down into the audible ranges. The specific sound quality of each type of emission is heard in headphones while the intensity of the signal is observed on a meter. Normally, electrical equipment should be silent, although some may produce a constant 60-cycle hum or some steady mechanical noises. These should not be confused with the erratic, sizzling frying, uneven and popping sound of an electrical discharge.

Detection Method

Before beginning any inspection of mid or high voltage equipment, be sure to review your plant or company's safety procedures. Essentially, as in generic leak detection, the area of inspection is scanned using a high sensitivity level. As the discriminate direction, reduce the sensitivity until this is possible. If it is not possible to remove covers, or plates, scan around the seams and vent slots. Any potentially damaging discharges should be detected.

<u>REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!</u>

ULTRASONIC
DRY-PIPE FIRE SYSTEM SURVEY



Ultrasounds, by definition, are beyond the limits of normal human hearing. Using a sophisticated detector a technician is able translate ultrasonic signals to the range of human hearing.

The theory of ultrasonic detection is relatively simple. Frequency, the number of times a sound wave cycles from trough to crest, is expressed in cycles per second and measured in hertz. One kilohertz is 1000 cycles per second. Human ears can generally hear noises in the range of 20 to about 20,000 Hz (20kHz). EFI ultrasonic detectors start at approximately 20 kHz and can work upward to sound as high as 100kHz. Thus, Technicians using the ultrasound instrument can tune to and "hear" what is going on in operating machinery and pressurized systems. When a leak occurs, the fluid or gas passing through produces turbulence with strong ultrasonic components. Higher-frequency sounds cannot penetrate most solids; yet they slip through the tiniest of openings. Ultrasound detectors are ideal for isolating such leaks.

The pistol-shaped Microsonic detection unit is battery powered and lightweight. Operators can easily leak test large sections of piping quickly and effectively. Leaks in pressurized Dry-Pipe systems are found by simply sweeping the Microsonic detector over the area to be checked. Ultrasound generated at the leak source is made audible in the headphones and visible on the unit's analog meter. Testing using a soap solution and watching for bubbles is very time consuming and will frequently miss leaks altogether if the tested area is not visible

Conducting an ultrasonic leak survey

The best plan is to inspect the entire plant department by department, always following the same pattern. However, if such a program seems too daunting, a plant might limit periodic inspections to one or two departments. As maintenance crews become more familiar with ultrasound and inspection techniques, the survey can be expanded to include the entire operation.

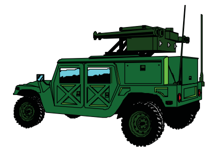
The technician aims the ultrasonic scanner directly at the part of the system under inspection and makes small cross-pattern movements along all exposed sections. The more sensitivity levels the instrument has, the better it performs. If, for example, a 1 in. pipe is suspected of leaking, the technician should wave the gun an inch or two in each direction, moving parallel to the pipe until finding the leak. Then the instrument's close focus adapter can be honed in on the exact location of the leak. The problem may actually be in the fitting.

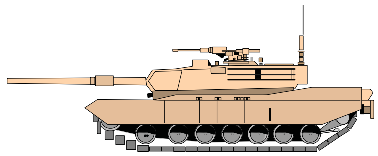
Every leak should be tagged with the location and an identification number. A note should also record a description of each leak, including the size.

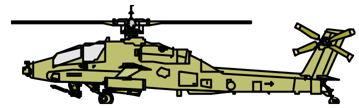
The technician should double-check each leak that is repaired before moving on to the next area. Often new leaks are inadvertently created during the repair stage and go unnoticed because the area is not retested. Using confirmation and shielding techniques, such as sealing, always pays off when the entire connection is checked one final time.

REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!

MILITARY VEHICLE GROUND SUPPORT ULTRASONIC INSPECTION







DESCRIPTION

The most common areas for ultrasonic inspection in ground and air transportation are: air/water/gas leaks into personnel & equipment compartments, pressurized systems leaks, air brakes, motors, pumps & bearings. Until the advent of ultrasound, liquid and gas intrusion detection involved many hours of trial and error with a water hose and flashlight. Often applying a liquid under pressure or listening with a conventional stethoscope for a pressure leak, required two people for many hours. Air brake leaks, exhaust and intake leaks can take hours to locate using conventional soap and water bubble testing. Not only can service facilities benefit from Ultrasonic Inspection, so can Quality Assurance departments by providing highly portable, fast, accurate, and simple testing.

How Ultrasonic Detection Works

Compressed gases, when leaking produce a turbulent flow with strong ultrasonic components. By scanning fittings, a leak will be heard as a distinct "hiss". Due to the high frequency, short wave nature of ultrasound, the sound will be loudest at its point of origin. The Microsonic unit translates the ultrasonic leak signals into recognizable audible signals where they are heard through headphones and seen as intensity increments on a meter. A unique test incorporates a patented ultrasonic transmitter called a Wave Form Generator. This device is placed in a cabin, tank, container or compartment where it floods the area with an intense ultrasonic signal. The generated ultrasound will deflect off solid seals but will flow through a leak path.

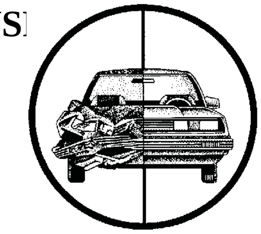
Some of the most common areas for ultrasonic inspection include:

- **COMPRESSED AIR SYSTEMS**
- **CNG & LNG GAS SYSTEMS**
- **VACUUM SYSTEMS**
- **INTAKE & EXHAUST SYSTEM LEAKS**
- **ENGINE INTERNAL DIAGNOSTICS**
- **DRIVE LINE DIAGNOSTICS**
- **BEARINGS, PUMPS, MOTORS, SERVOS**
- **AIR & VACUUM ACTUATORS**
- **COMPARTMENT SEALS & GASKETS**
- **HATCH, BULKHEAD, PORT, WINDOW, FLOOR & ROOF SEALS**
- **HYDRAULICS FUEL INJECTORS DRIVE BELTS**

Detection Methods

Pressurized air, gas & fluid leaks produce turbulence with high frequency components. To locate air, gas or fluid leaks under pressure, simply scan the test area with the hand held EFI Microsonic detector. If a leak is present, ultrasonic sound not audible to the human ear is produced. This high frequency sound will be "heard" by the EFI detector and converted into an audible "hissing" sound heard through the systems headphones. Simply follow it to the loudest point. If it is difficult to discriminate the leaks location, reduce the sensitivity and continue to follow to the loudest point.

REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!



COME-BACKS AND RE-DO'S = LOST PROFIT & LOST CUSTOMERS

A major repair has been completed and everything is just right, with form, fit and finish reflecting your shops reputation for quality work!

Your customer comes in to take delivery, inspects the repairs and expects all to be to pre-accident condition. All is well, the repairs are paid for, forms are signed, and off drives another satisfied customer!

Most of the time this is how it goes!

On occasion a vehicle comes back with a concerned or irate customer complaining about some aspect of the repair they feel was not done properly and frequently the complaint will involve:

- A WATER LEAK AT THE REPAIRED AREA (door, trunk, floor, window)
- AN AIR LEAK AT THE REPAIRED AREA
- A NOISE THAT "WASN'T THERE BEFORE"

Ultrasonic testing as a quality control procedure during repair and as quality assurance during a pre-delivery inspection can have a significant affect on customer satisfaction. Ultrasonic testing when shown to customers will also promote customer confidence and shop credibility.

ULTRASONIC TESTING CAN QUICKLY LOCATE AIR & WATER LEAKS AT:

DOORS, DECK LID, SUN-ROOF & T-TOP (seals, weather-strips, caulking, rust)
FLOOR PAN, ROCKERS, WHEEL-HOUSE, REAR BODY PANEL (caulking, welds, rust)
WINDSHIELD, BACK-GLASS & SIDE GLASS (seals & weather-strip, Rust)
WEATHER STRIPS, CAULKING & DRIP-CHECK

ULTRASONIC TESTING CAN SAVE TIME & MONEY BY QUICKLY LOCATING:

- SQUEAKS & RATTLES
- BEARING NOISES
- EXHAUST LEAKS
- DAMAGED BELTS
- VACUUM LEAKS
- INTERNAL ENGINE, TRANSMISSION & DIFFERENTIAL (WEAR or DAMAGE)

Until the advent of ultrasonic testing, leak detection could involve hours of trial and error with the use of water testing, bubble testing, tracing fluids or compressed air and powder, often requiring two technicians for hours. Frequently the results of these efforts were less than satisfactory!
Ultrasonic testing is fast, simple and accurate. Saving time, money and resources, while insuring customer satisfaction.

REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!

NEW CAR & TRUCK DEALERSHIP

- SERVICE DEPARTMENT
- BODY SHOP
- FACILITY MAINTENANCE

SERVICE DEPARTMENT

Ultrasonic testing as a quality control procedure during repair and as quality assurance during a pre-delivery inspection can have a significant affect on customer satisfaction. Ultrasonic testing when shown to customers will also promote customer confidence and shop credibility.

- **AIR AND WATER LEAKS INTO PASSENGER OR TRUNK AREAS**
- **DOOR, WINDOW, FLOOR & ROOF SEALS FOR WATER, AIR OR EXHAUST ENTRY POINTS**
- **EXHAUST SYSTEM FOR LEAKS**
- **SQUEAK AND RATTLE LOCATION**
- **NEW VEHICLE PRE-DILIVERY INSPECTION**
- **VACUUM SYSTEMS FOR LEAKS**
- **ENGINE INTERNAL DIAGNOSTICS**
- **DRIVE LINE DIAGNOSTICS**
- **BEARINGS FOR EXCESSIVE WEAR**
- **HYDROLIC SYSTEM DIAGNOSTICS OF VALVES, SEALS & PUMPS FOR INTERNAL LEAKAGE**
- **DRIVE BELTS FOR CUTS & CRACKS**
- **REDUCE DIAGNOSTIC TIMES SIGNIFICANTLY**

BODY SHOP

- **AIR & WATER LEAKS AT DOORS, DECK-LID, SUN-ROOF, REMOVABLE ROOF PANELS**
- **AIR & WATER LEAKS AT WINDSHIELD, BACK-GLASS, SIDE GLASS**
- **AIR & WATER LEAKS AT SEALS, CAULKING, WELDS, RUSTED PANELS**
- **LOCATE SQUEAKS & RATTLES**
- **LOCATE EXHAUST SYSTEM LEAKS AND RATTLES**
- **DETECT DAMAGED ENGINE BELTS**
- **DETECT DAMAGED BEARINGS**

FACILITY MAINTENANCE

- **LEAK TEST SHOP COMPRESSED AIR SYSTEM (MAJOR SAVINGS POTENTIAL)**
  - **SEE ATTACHED CHART INDICATING COSTS OF COMPRESSED AIR LEAKS**
- **LEAK TEST FACILITY DRY-PIPE FIRE SUPPRESANT SYSTEM**
- **LEAK TEST DOORS, WINDOWS, STORAGE AREAS**

Until the advent of ultrasonic testing, leak detection could involve hours of trial and error with the use of water testing, bubble testing, tracing fluids or compressed air and powder, often requiring two technicians for hours. Frequently the results of these efforts were less than satisfactory!

Ultrasonic testing is fast, simple and accurate. Saving time, money and resources, while insuring customer satisfaction.

REMEMBER, TO FIX IT…..FIRST YOU HAVE TO FIND IT!

SECTION 13

WHERE TO GET MORE INFORMATION
Resources with Web Links

http://compressorwise.com
CompressorWise.com is an independent research and publishing company established to help compressor operators save money and get the most from their compressed air systems. We use the internet to deliver information about the best people and companies in the compressor business.

http://www.oit.doe.gov/bestpractices/steam
Government steam systems resource site (VERY GOOD)

http://www.oit.doe.gov/bestpractices/compressed_air/ Government
compressed air resource site (VERY GOOD)

http://enerchecksystems.com/index.html
Complete ultrasonic Dist./Mfg. (good how to site)

http://www.amgas.com/ldpage.htm
American gas & chemical Co. Ltd. Leak detection technology

http://leakzone.com
Large leak detection resource site

http://steamlink.com/1wdm.html
Steam trap resource site

http://uesystems.com/
Competing ultrasonic equipment Mfg. (good resource for applications, how to information.)

http://www.maintenanceresources.com/referenceLibrary/ezine/ultrasonic.htm
Ultrasonic testing procedures for steam traps

http://knowpressure.org/
The Compressed Air Challenge is a voluntary collaboration of industrial users; manufacturers, distributors, and their associations; consultants; state research and development agencies; energy efficiency organizations and utilities.

http://www.e4i.com
Web site for Electronics For Industry, Inc.

SECTION 14

ADDENDUM – LAST MINUTE CHANGES AND ADDITIONS.

The End

Please visit our Web Site:

www.e4i.com

Thank You