Ultrasonic leak detector

Model 003

To detect leaks:

- In condensate purgers
- In valve seals
- Checking for wear on bearings
- Solving mechanical problems in general

Safety warning
Please read this before using your Detector

Misuse of the Ultrasonic leak detector could result in death or serious injury. Please follow all the safety instructions. Do not try to carry out repairs or adjustments while the equipment is in operation. Make sure that you turn off and block all the electrical and mechanical sources before doing any corrective or preventative maintenance work. Always check local guidelines on maintenance and prevention.

Safety instructions:

Although the Ultrasound leak detector is designed to be used when the equipment is in operation, the proximity of hot pipes, electrical equipment and rotating parts is potentially dangerous for the user. Take great care when using the Detector close to energized equipment. Avoid direct contact with hot parts or piping, any part in movement and electrical connections. Do not try to confirm the results by touching the inspected equipment with your hands or fingers. Make sure that you use the appropriate lockout procedures when carrying out repairs.

Take care with loose hanging parts, such as the wrist strap and the headphone cable, when carrying out inspections near moving mechanical devices, since these elements may become trapped. Do not touch moving parts with the ultrasonic probe. This will not only damage the part and the Detector, it could also cause personal injury.

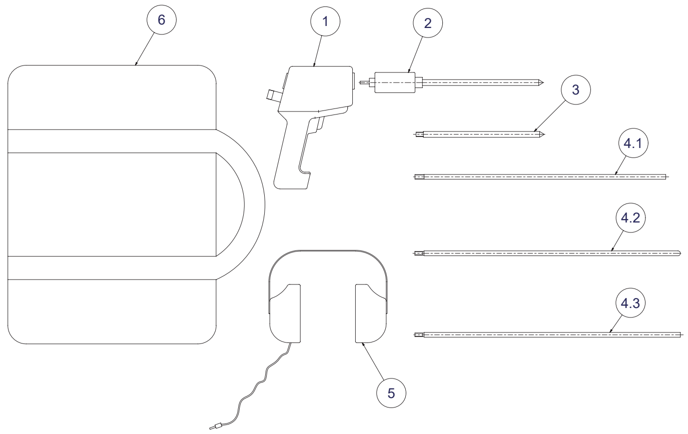
Wear the appropriate protective clothing. Do not get too close to the point of verification. Your Detector can locate problems from a distance. Take care when working around high temperature pipes. Wear protective clothing and do not try to touch any of the pipes or equipment while they are hot. Check with your safety officer before entering the work area and follow all the safety procedures.

Index

1. Ultrasonic leak detector.

It provides a simple way to detect leaks and carry out accurate mechanical inspections using advanced ultrasound technology.

Nº PIECE	PIECE	MATERIAL
1	Ultrasonic pistol	ABS plastic
2	Stethoscope module	Stainless steel
3	Stethoscope probe	Stainless steel
4	Stethoscope probe extension	Aluminium
5	Headphones	ABS plastic
6	Case	Cordura-type nylon
OPERATING CONDITIONS	OPERATING TEMPERATURE	0° C to 50° C (32° F to 120° F)
	STORAGE TEMPERATURE	-18° C to 54° C (0° F to 130° F)
	RELATIVE HUMIDITY	10-95% non-condensing up to 30°C (86° F)



Before you start taking measurements, we recommend that you first familiarize yourself with the components of your equipment.

2. Table of contents

Components

- Measuring gun

The main component of the Detector is the ultrasound gun. We will examine each part from back to front.

- Bar graph display

The screen contains a bar graph display with ten LED segments which indicate the intensity of the ultrasound signal. If only a few LEDs are lit up, this indicates a low level of ultrasound, while more intense ultrasound signals will lead to a large number of LEDs being lit up.

- Battery life display

This red light only comes on when the batteries need recharging.

NOTE: When the on/off switch is moved to the "on" position, the battery life light will flash before turning off again. This is normal and does not indicate the condition of the battery.

- Sensitivity selector

There are eight (8) levels of sensitivity that are read in decibels displayed from "0" to "70". As the dial is turned to the right, toward "0", the sensitivity of the instrument increases. As the selector is turned to the left, toward "70", the sensitivity will decrease. A low level ultrasound emission produces low amplitude. To detect low level ultrasounds, the instrument must be in a position of high sensitivity. 0 is the highest sensitivity setting. For higher amplitude signals, move the sensitivity to the left towards the "70". Combination of the bar graph display and sensitivity selector: Each bar lit up in the bar graph is equal to 3 dB.

Example A: Sensitivity selector set at 0 dB and the LED bar graph has 3 bars lit, so the total reading is 0 dB+9 dB=9 dB.
Example B: Sensitivity selector set at 40 dB and the bar graph has 4 bars lit, so the total reading is 40 dB+12 dB=52 dB.

- Connector for headphones

This is where the headphones are connected. Ensure they are connected firmly, until you hear a click. If you are going to use a recorder, please insert the connector cable here. (It uses a Miniphone connector).

- Switch

This is found at the bottom of the Detector. The Detector is always "switched off" until this switch is pressed. To operate it, simply press the switch, and release the switch to turn off the instrument.

- Stethoscope module

This is a module with a long metal probe. This probe is used as a "wave guide" and is sensitive to the ultrasounds generated internally, such as inside a pipe, the housing of a bearing, condensate purgers, valves, etc. Once stimulated by the ultrasound, it transfers the signal to a piezoelectric transducer placed directly in the casing of the module.

To use the stethoscope module:

1. Align the pin located in the rear of the module with the connector found in the tip of the gun and plug in firmly.

2. Touch the area to test or inspect.

3. Start with a maximum sensitivity in the sensitivity selector and reduce the sensitivity until you have a satisfactory sound and the level of the meter is reached.

- Headphones

They are highly resistant headphones designed to block out loud sounds in industrial environments. They allow the sounds received through the detector to be clearly distinguished.
Connect the headphone cable to the connection located in the measuring gun and place the headphones over your ears.

IMPORTANT: They are compatible with the security helmet.

3. Uses of the Ultrasonic leak detector.

3.1. Detection of leaks in condensate purgers

An ultrasonic test of the condensate purgers is a test that all users of purgers should frequently perform as a preventative measure. It is a problem of energy efficiency and environmental awareness, and of course also one of financial savings.

The user will become familiar with the different types of purgers and will know how to recognise them with great ease.

We should remember that there are three types of purgers:

· Thermodynamic
· Mechanical (closed buoy and inverted floater)
· Thermostatic (bimetallic and balanced element)

Before starting to detect a leak:

1. Determine what type of purger is in the line. Familiarise yourself with the way the purger works. It is intermittent or continuous drainage? We should easily recognise the operating sound of each type.

2. Try to check whether the purger is in operation. Place your hand close to it, but do not touch the purger, or even better, use a non-contact infra-red thermometer to check if it is hot or cold.

3. Use the stethoscope module.

4. Try to use the probe of the module to touch the discharge side of the purger. Press the switch and listen.

5. Listen to the intermittent or continuous flow operation of the trap.

Intermittent flow: Inverted floater, thermodynamic and thermostatic.
Continuous flow: Closed buoy with a thermostatic element.

While testing intermittent purgers, listen long enough to measure the true cycle. In some cases this can exceed 30 seconds. Bear in mind that the greater the load reaching the purger, the more time it will remain open.

When carrying out an ultrasonic test of a purger, a continuous running sound usually indicates the passing of steam. There are subtleties with each type of purger that should be taken into account.

Use the sensitivity levels of the Sensitivity Selector to help with your examination. If we are going to inspect a low pressure line, adjust it for greater sensitivity, toward the “0”. If it is a medium pressure system (over 6-8 bar), reduce the sensitivity level toward “80”.

Check upstream and reduce the sensitivity so that the indicator is at around 50% or less. Next, touch the body of the trap downstream and compare the readings. Only practice will help here, and we will need lots of it to reach an appropriate level of inspection.

- Confirmation of: Steam/Condensation/Flash Steam

In the cases where it is difficult to determine the sound of steam, flash steam or condensate:

1. Touch the immediate downstream side of the purger and reduce sensitivity to obtain a reading on the meter midline (approximately 50%).

2. Move between 15-30 cm (6-12 inches) downstream and listen. Flash steam will show a large drop in the intensity, while exiting steam will show a slight drop in intensity.

- Inverted floater purger

Operates with an inverted floater that moves as a result of the difference in density between the condensate and the steam. When there is condensate the floater lowers, it frees the seat valve and allows the condensate to exit. When steam enters, the floater rises and blocks the pathway, guaranteeing a line free of condensates. This action is repeated cyclically, automatically removing the accumulated air and condensates.

The inverted floater purger operates intermittently. If steam is leaking through the valve, we will detect the loss of this intermittent nature and the escape sound will be strong and continuous.

- Closed buoy purger with a thermostatic element

Operates with a float valve that opens up for the accumulation of condensates and transports it. It also incorporates a thermostatic element that allows for the automatic elimination of air

A closed buoy purger normally has a fault in the “closed” position. The valve is damaged or the thermostatic element leaks:

· If there is a leak through the valve, the sound will be constant and easy to hear.

· If there is no leak through the valve and we detect the passing of steam, the leak must come from the thermostatic element.

You are wasting energy.

- Thermodynamic purger

The operation of a thermodynamic purger is based on the “Bernoulli” principle: “In a fluid in movement, the sum of the static and dynamic pressures remains constant at all points. So if one increases, the other decreases and vice versa”.

The input pressure acts on the shut-off disc, which allows for the immediate discharge of condensate and air at the temperature of steam.

The steam then enters the purger. The high speed produced by the expansion of the steam creates a low pressure area at the rear of the shut-off disc. The flow is diverted to the back of the shut-off disc and creates a high pressure zone through recompression. The shut-off disc starts to lower.

When the high pressure is acting on the entire surface of the shut-off disc, it exercises a force greater than the input pressure. The purger closes. The subsequent presence of condensate in the entrance repeats the cycle.

A thermodynamic purger in good condition has a cycle (retention-discharge-retention) of 4-10 times a minute. In general, when there is a fault this is in the open position, allowing for a continuous stream of steam.

- Thermostatic purger

All thermostatic purgers work on the basis of the difference in temperature between the condensate and the steam.

- Bimetallic purger:

A bimetallic purger works on the basis of the principle of the combination in a column of metallic discs of two faces in a single bimetal, where each face has a different expansion coefficient. The bimetals are stacked in pairs, with the faces with the same coefficient (faces without notches) facing each other.

In the presence of cold water, the bimetals remain flat. On detecting a higher and higher temperatures, they become deformed in a convex shape, moving the seat against the valve. Maximum convexity, and with it, a totally watertight seal, is obtained just at the mid-point of moving from condensate to steam.

- Thermostatic purger with balanced element:

The thermostatic action of the balanced element allows the condensate and cold air to freely leave when starting up.
When the temperature of the condensate reaches that of saturation, the element closes and blocks the steam.
When the condensate cools, the elements opens and evacuates it. When steam is at the point of appearing, the cycle is repeated and the element closes, and so on.

If the purgers have a fault, you will hear a constant leak noise

3.2. Detection of leaks in valve seals

When a low pressure fluid escapes through a small space, it moves from a laminar flow to a turbulent flow. The turbulence generates a wide spectrum of sound known as “White Noise”.

As the ultrasound will be stronger at the location of the leak, the detection of the signal is relatively easy.

In the case of a valve where the valve is leaking, the fluid that escapes will move from an area of high pressure to one of low pressure, creating turbulence in the low pressure or “downstream” side. The ultrasonic component of this “White Noise” is much stronger than the audible component. If the valve has an internal leak, the ultrasonic emissions generated in the location of the orifice will be heard and registered by the meter.

The sounds of a valve with a leak can vary depending on the density of the fluid. In some cases, a subtle crackling sound will be heard, other times there will be a loud sound of leakage. Sound quality depends on the viscosity of the fluid and internal pressure differentials of the pipe.
As an example, water flowing at low or medium pressure can be easily recognised as water.

However, high pressure water running through a partially open valve may sound very much like steam. To discriminate between them: reduce the sensitivity, touch the line of steam and listen to the quality of the sound, then touch a line of water. Compare and once familiar with the sound differences, continue your inspection.

A correctly positioned valve will not generate any sound. In some high pressure situations, the ultrasound generated within the system will be so intense that the surface waves will move from other valves or parts of the system and make it difficult to diagnose the leaks in the valve. In this case we make a comparison of sonic differences by reducing the sensitivity and touching the upstream part of the valve, in the valve seat and just downstream of the valve.

- How to locate leaks

1. Use the stethoscope module and the headphones.

2. Start with the sensitivity selector at 0 (Maximum).

3. Start to scan, directing the module downstream of the valve and listen through the headphones.

4. If you detect a lot of ultrasound in the area, reduce the sensitivity adjustment and continue scanning.

5. Try to listen for an “escape” sound while watching the meter.

6. Follow the sound to the point where it is the strongest. The meter will show a higher reading the closer you are to the leak.

7. In order to focus on the leak, keep reducing the sensitivity and work on the suspect area until finally in a position to confirm whether one exists.

8. For comparative readings, generally in high pressure systems:

    1. Touch the upstream area and reduce the sensitivity to minimize any sound (in general, set the meter at the midline “50%” reading).

    2. Touch the valve seat area and/or the downstream side.

    3. Compare the sonic differences. If the valve has a leak, the sound level in the seat or downstream side will be equal to or greater to that of the upstream side.

- To confirm a leak

In high pressure systems, there can be parasite signals or false signals produced by nearby valve or pipes. In order to determine whether the signal analysed comes from a valve being inspected, proceed as follows:

1. Move closer to the suspect source.

2. Touch the upstream side of the suspect source.

3. Reduce the sensitivity until the meter shows a midline “50%” reading.

4. Touch it in short intervals, for example every 15-30 cm (6-12 inches) and watch for changes in the meter.

5. If the level of sound reduces as it is moved towards the valve to be tested, this indicates that the valve has no leaks.

6. If the level of sound increases as it is moved towards the valve to be tested, this indicates that the valve has a leak.

3.3. Checking foe wear on bearings

The ultrasound inspection and monitoring of the bearings is the most reliable method of detecting incipient faults in the bearings.
The ultrasonic warning appears in response to an increase in the temperature or the increase in low frequency vibration levels.
The ultrasound inspection of the bearings is extremely useful as a preventative measure:

- a. Start of a fault due to fatigue.

- b. Fault in the surface of the bearing - Brinelling.

- c. Lack of lubrication.

In ball bearings, when the metal in the track, the roller or the ball of the bearing starts to wear out, there is a slight deformation which will increase in line with its use. This deformation in the metal generates an increase in the emission of ultrasonic sound waves

The changes in the amplitude of 12 to 50 times compared to the reading for a new one is an indication of an incipient fault in the bearing. When a reading exceeds any previous reading by 12 dB, it can be assumed that the bearing has a fault.

This information was discovered through experiments carried out by NASA on ball bearings. In the tests carried out while monitoring the bearings in the frequencies from 24 to 50 kHz, they found that the changes in the amplitude indicate the start of a fault and that precedes other indicators, such as thermal indicators or changes in vibrations.

An ultrasonic system based on the detection and analysis of modulations of the resonance frequencies of the bearing can provide the capacity for fine detection while the conventional methods are incapable of detecting very minor faults. An example is when a ball passes over a pit or a fault in the surface of the bearing, producing an impact. A structural resonance of one of the components of the bearing vibrates or “rings” due to this repetitive impact. The sound produced is observed as an increase in the amplitude of the monitored ultrasonic frequencies of the bearing.

The “brinelling” of the surfaces of the bearing will produce a similar increase in amplitude due to the flattening process as the balls leave the guide. These flat spots also produce a repetitive ringing that is detected as an increase in the amplitude of the monitored frequencies.

Ultrasonic frequencies detected by the Detector are reproduced as audible sounds.

This “heterodyne” signal can assist a user in determining bearing problems. When listening, it is recommended that the user first become familiar with the sounds of a bearing in perfect condition. A new bearing is heard as a hissing or running noise.

Crackles or rough sounds indicate a problem. In certain cases, a damaged ball can be heard as a clicking sound, whereas at a high intensity, a rough uniform sound may indicate damage to the track or uniform damage in the ball.

Loud running sounds, like the running sound of a bearing in good condition, only a little rougher, may indicate a lack of lubrication.

Short-duration increases in the sound level with “rough” or “scratchy” components indicate a rolling element hitting a flat spot and sliding on the support surfaces, rather than rotating. If this condition is detected, we recommend carrying out much more frequent preventative inspections.

- Detecting bearing faults

Carry out comparative tests. The comparative method consists of inspecting two or more similar bearings and “comparing” the potential differences.

1. Use the stethoscope module.

2. Select a “testing point” on the housing of the bearing. Touch this point with the stethoscope module. Ensure that the module is in contact with the housing of the bearing. If this is difficult, touch the point where the grease is fed or touch the point closest to the bearing.

3. Approach the bearings at the same angle, touching the same area on the bearing housing.

4. Reduce the sensitivity.

5. Listen to the sound of the bearing through the headphones to hear the “quality” of the signal for the correct interpretation.

6. Select the same type of bearings under similar load conditions and the same speed of rotation.

7. Compare differences in meter readings and the sound quality.

It is important to consider two elements of potential failure. One is the lack of lubrication, while the other is over-lubrication.

Normal bearing loads cause an elastic deformation of the elements in the contact area giving a smooth distribution of the elliptical stress. However, the support surfaces are not perfectly smooth. Therefore, the distribution of the real stress in the contact area will be affected by random surface roughness. In the presence of a lubricant film on a support surface, there is a moderating effect on the stress distribution and the acoustic energy produced will be low. Lubrication can be reduced to a point where the stress distribution is no longer present, the normal rough spots will be in contact with the track surface and will increase the acoustic energy.

These microscopic uniformities begin to generate wear and it is possible that they will develop small cracks. Therefore, apart from normal wear, the useful or fatigue life of a bearing is strongly influenced by the relative thickness of the film provided by an appropriate lubricant.

- Low velocity bearings

Monitoring low speed bearings is easy with the Detector. The sensitivity range enables us to hear the acoustic quality of bearings. In extremely slow bearings (less than 25 RPM), it is often necessary to disregard the meter and listen to the sound of the bearing. In these extreme situations, the bearings are usually large (1 “-2” or larger) and greased with high viscosity lubricant.

Most often no sound is heard when the grease absorbs most of the acoustic energy.

If a sound (usually a crackling sound) is heard, this is some indication that deformation is occurring.

4. Solving general mechanical problems

When mechanical components are subject to wear, breakage, misalignment, etc., they are also producing changes in their usual ultrasound behaviour. This change can save us time and effort in diagnosing problems if properly monitored. Therefore, an ultrasonic history of key elements can avoid unscheduled downtime. And most importantly, if the equipment should begin to fail, the Detector can be extremely useful in preventing potential problems.

- Solving problems

1. Use the stethoscope module.

2. Touch the area to be inspected and listen through the headphones, observing the bar graph display.

3. Adjust the sensitivity until the mechanical operation of the equipment can be clearly heard.

4. Examine the equipment, touching the suspect areas.

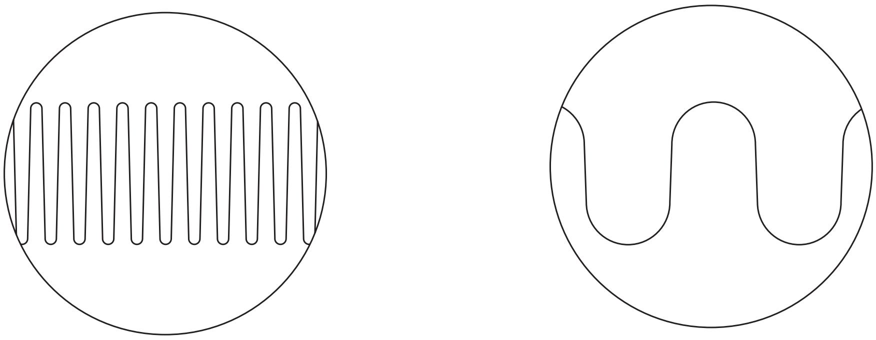
5. To focus on the sounds that are of interest for the diagnosis of problems, those to measure, gradually reduce the sensitivity to help to locate them.

6. Follow the sound to its strongest point and that is where the problem is.

5. Ultrasound technology

Ultrasound technology refers to sound waves above the range that can be heard by humans. The average threshold for being heard by humans is 16,500 hertz. However, some people are capable of hearing sounds up to 21,000 hertz, so ultrasound technology relates to frequencies of 20,000 hertz or more. The equivalent of 2,000 hertz is 20 kHz or kilohertz. One kilohertz is equal to 1000 hertz.

Figure A



Low frequency **High frequency**

As ultrasound is high frequency, it has a short wavelength. Its properties are different to low frequency or audible sounds. A low frequency sound requires less acoustic energy to travel the same distance as a high frequency sound. (Fig. A)

The ultrasound technology used by the Detector is what is generally referred to as air-coupled ultrasound. This type of ultrasound refers to the transmission and reception of ultrasound through the atmosphere without the need for a coupling agent (interface).

There are ultrasonic components in almost all forms of friction. For example, if you rub your thumb and forefinger together, a signal will be generated in the ultrasonic range. Although you may be able to very faintly hear audible noise of the friction, with the equipment the sound is very loud.

The reason for the loudness is that the Detector converts the ultrasonic signal into an audible range and then amplifies it. Due to the comparatively low-frequency nature of ultrasound, amplification is a very important feature. Although audible sounds are emitted by most equipment in operation, it is the ultrasonic elements of the acoustic emissions that are generally the most important.

For preventative maintenance, an individual will often listen to a bearing through a basic audio system to detect whether it has become worn. As this individual can only listen to the audio elements of the signal, the results of this type of diagnosis are general. The subtleties of the change within the ultrasonic range are not perceived and therefore omitted. When a bearing is clearly having problems in the audio range, this bearing need to be replaced immediately.

Ultrasound offers a capacity for preventive diagnosis. When changes start to be detected by ultrasound, there is still time to plan some proper maintenance.

In the area of leak detection, ultrasound offers a fast and accurate way to locate any type of leak.

www.vycindustrial.com
Avenc del Daví, 22 Pol. Ind. Can Petit 08227 TERRASSA (Barcelona) SPAIN
+34 93 735 76 90 119 info@vycindustrial.com