Ut
ultrasound testing

Part I of II:

# ULTRASOUND FOR SAFETY...

## IF NOT FOR ANYTHING ELSE!

Jim Hall

All through the late 1980s and 1990s, ultrasound was literally the all-purpose tool. Vibration and infrared (IR) were too expensive for most organizations to afford. Yet, you could purchase an infrared thermometer gun for $100 and an ultrasound instrument kit for between $750 and $7,000 and perform a multitude of applications on motor bearings, gear boxes, pumps for cavitation, leak detection (pressure/vacuum), steam traps and acoustic lubrication (introduced in early 1990s). You could hook up an ultrasound instrument to a vibration analyzer and utilize the contact or magnetic sensor on bearings to easily detect an outer race defect, sometimes missed by earlier vibration boxes unable to go above 20,000 Hz. Into the mid-1990s, ultrasound inspectors added electrical switchgear and substation inspection for arcing, tracking and corona discharge. A new era of ultrasound inspection had begun, dealing with SAFETY.

Figure 1: Air leak audit, chemical plant, Waco, TX


Figure 2: Electrical arcing heard within closed 480v panel at a power generation plant

Figure 3: Oil platform in Gulf of Mexico

"A new era of ultrasound inspection had begun, dealing with SAFETY."

## Ultrasound for Safely Finding Electrical Failures

This example demonstrates why using ultrasound for safety is so important. Many years ago at a Southern California military supplier of fins (i.e., wings) for heat seeking missiles, heat treat ovens were located in a room just a few feet from the 480v switchgear. The smell of minute gas leaks were present in the area. But then, intermittent arcing and a sizzling noise could be heard. Arcing from what appeared to be aluminum wiring was evident from a half open 480v electrical panel. (Creep-wire was another name for the soft aluminum wiring in those days. It was named so due to its tendency to creep out of its locked down position. Nowadays, it's all copper wiring.) Of course, loose wires can arc and heat up. Well, needless to say, everyone exited the premises immediately for safety's sake.

The facility did not have an ultrasound instrument. But, if ultrasound technology was available, the technician could have used it to first scan the switchgear panels before opening them. Then, once opened and reenergized, ultrasound could be used as a complementary tool to both infrared and corona camera inspection. Why? Infrared and corona cameras require line of sight, but ultrasound does not. So, learn to use them all in combination with each other. Become familiar with the sounds of electrical anomalies. Get some training. Do it in the name of SAFETY, if nothing else!

## Ultrasound for Safety in Remote Locations

Oil platforms in the middle of the ocean use compressed air and gases of different types. Some may even be vented overboard. On one particular oil platform, there was a lack of compressed air in a production area, most likely due to a leak in the system.

While scanning for possibilities with an ultrasound instrument, the technicians located a high amount of compressed air being vented from a drain that should not have been opened. This was only spotted while moving down an outboard stairway leading from one deck to the one below it. The technicians were scanning with the ultrasound and a long-range horn attachment. They located the leak 50 to 60 feet away.

The gas was not just manufactured compressor air; it was, in fact, nitrogen (N2) gas. Most of today's oil rigs use onboard nitrogen generators, but still, this is a costly gas to manufacture. Nitrogen has many uses on an oil rig, too many to list here. Although not volatile or caustic, too much nitrogen could cause nitrogen asphyxiation. An oxygen concentration that falls below 19.5 percent is considered unsafe for workers. When the oxygen content drops to about eight or 10 percent, you haven't much chance of survival. Nitrogen is a silent killer.

Ultrasound is sound above 20,000 Hz. It detects sounds above the human hearing range. It also detects friction, which can be a disturbance in the air. For instance, leaks of air or compressed gases, either a positive or negative pressure, produce friction in the air. Some instruments are capable of detecting a 5 psig leak of .005 inches at 50 feet. Having stated that, ultrasound cannot distinguish between a compressed air, nitrogen, or hydrogen gas leak. However, leaks to the atmosphere produce friction and since this friction is a disturbance of the atmosphere, it can be detected using ultrasound.

Ut
ultrasound testing

## Ultrasound for Safely Locating Gas Leaks

Within the military, safety is of the highest priorities. In the early 1970s, the U.S. Navy trained cryogenics technicians to produce liquid nitrogen and oxygen, as well as work-around and handle other gases that were primarily used for airfield facility maintenance, on aircrafts, or aboard aircraft carriers.

Figure 4: Leak on a liquid oxygen supply system

Liquid oxygen ***demands*** respect. As a cryogenic liquid, it is very volatile and highly explosive. Cryogenic liquids are liquefied gases that have a normal boiling point below –130° F (–90° C). Liquid oxygen has a boiling point of –297° F (–183° C) and has an expansion ratio, liquid to gas, BP to 68° F (20° C), 1 to 860. Oxygen has no warning properties!

To find leaks on storage units or supply lines, cryogenics technicians were taught how to use an ultrasound translator or receiver. The U.S. Navy supplied its cryogenics technicians with an ultrasonic translator unit that consisted of a wand with a piezoelectric sensor at the end and a microphone built into the box. Effective, but not so much in today's industrial market.

The ultrasonic translator receives the high frequency and heterodynes or demodulates the high frequency to a low frequency signal below 20,000 Hz. This is also known as Ultrasonic Down Conversion™ (UDC)[1]. UDC is what *all* ultrasonic translators perform.

Through UDC, the user of the instrument can discern a leak either afar or nearby, depending on the sensitivity of the translator being used and the application.

## Ultrasound for Safety in Industrial Plants

Besides the military, there is an *abundance* of opportunities to use an ultrasonic translator or instrument in most industrial plant environments for safety purposes. However, only a few of the ultrasonic instruments manufactured today are ***intrinsically safe*** or **IS** rated, meaning if the unit has the appropriate rating, the instrument may be used in an explosive environment.

Some ultrasound instruments manufactured today have an ATEX IS rating, while another popular ultrasound instrument manufacturer has an IS rated instrument with an ATEX EX and Mb Ex ib I for underground mining.

There's also the factory mutual (FM) IS rating, Class I, Groups A, B, C, and D. Here's an example of what these FM IS ratings means:

**Class I:** Locations are areas where flammable gases may be present in sufficient quantities to produce explosive or flammable mixtures.

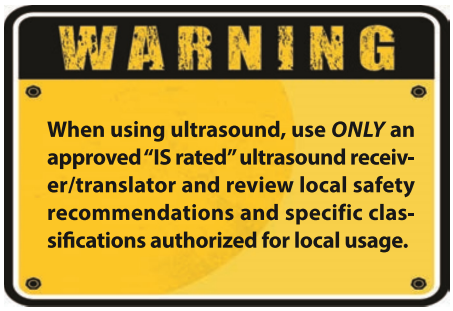
**Div I:** Area where explosive or flammable materials usually exist under normal conditions.

**Group A:** Atmospheres containing acetylene.

**Group B:** Atmospheres containing hydrogen, gases, or vapors of equivalent hazard, such as manufactured gas.

**Group C:** Atmospheres containing ethyl ether vapors, ethylene, or cyclopropane.

**Group D:** Atmospheres containing gasoline, hexane, naphtha, benzene, butane, propane, alcohol, acetone, benzyl, lacquer solvent vapors, or natural gas.




## Ultrasound Inspections for Safety

Ultrasound inspections may include:

- Hydrogen Leaks – Power generating plants use hydrogen to cool the generator;
- Electrical Transformer – Internal and external for arcing, tracking, corona and partial discharge;
- Boilers – Natural gas leaks around them and boiler leak of the horizontal flame box releasing toxic carbon monoxide;
- Electrical Inspection – Switchgear and substation for corona, tracking, or arcing and partial discharge;
- Underground Electrical Vaults – For corona, tracking, or arcing of transformers and electrical cables;
- Underground Utility Vaults and Tunnels – For various gas leaks (e.g., nitrogen, natural gas, etc.);
- Aviation Applications – For compressed gas or cryogenic gas leaks;
- Aviation Fuel Leaks – Using either positive or negative air on wings and fuel cells to locate leaks;
- Cockpit Pressurization – Ultrasound used on cabin doors, windows, fuselage and other areas that might create a loss of cabin pressurization;
- Marine Applications – Watertight hatches and manways for water or gas intrusion on a sealed door;
- Marine – To detect fugitive emissions at a manufacturing plant or aboard ship;
- Clean Rooms and Labs – Negative pressure leaks and cryogenic gas (inert and toxic) leaks within the false floor beneath the lab;
- Underground Utilities – Natural gas lines, electrical cables and transformers.

Of course, these are just some of the thousands of applications within the industrial manufacturing, transportation, military, power generation and other utilities where ultrasound can be used for safety purposes.

## What is your ultrasound SAFETY application?

Watch for Part II of Ultrasound for Safety….If Not for Anything Else! in an upcoming issue of *Uptime* Magazine.

### Reference

1. Ultrasonic Down Conversion™ is a registered Trademark, Reg. No. 4,377,926, Registered July 30, 2013.

***Jim Hall,*** *CRL, is the Executive Director of The Ultrasound Institute (TUI). Jim has been in the ultrasonic market for over 25 years and has trained many Fortune 500 companies in the use of airborne ultrasound, including the electrical power and generation, pulp and paper, automotive and aviation industries. Jim has been a contributing writer for Uptime® Magazine's (ultrasound segment) since the magazine's inception. www.theultrasoundinstitute.com*