

SUCCESS STORIES

Energy & Utilities



Identifying Condenser Tube Leaks with an SDT270 Ultrasound Detector

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Introduction

Heat exchangers come in many shapes, sizes, and configurations. Their purpose; to efficiently transfer heat energy from one medium to another while keeping those media separate.

Sometimes called “surface condensers”, these installations are used in a variety of industrial applications. We find them in refineries, water and wastewater treatment facilities, food processing, and power generation to name just a few.

Shell and tube heat exchangers consist of a bundle of steel tubes entombed in a shell. For the installation to perform effectively both bundle and shell must be leak free.

Two fluids of different temperature flow freely through and around the tubes. Separated by only the thinnest of steel, the transfer of heat energy is completed without the mingling of a single molecule.

Heat exchangers function under extreme high pressures and temperatures; conditions which, over time, contribute to failure modes that impact the installation’s integrity. A common cause of failure is corrosion. The corresponding effect is tube leaks.

In fact, the bundles consist of thousands of tubes, which provides excess capacity to accommodate leaks. Corroded and leaking tubes only need be plugged to effectively remove them from active duty. The exchanger can continue to function so long as a sufficient number of functional tubes remain. The leaking ones are by-passed.

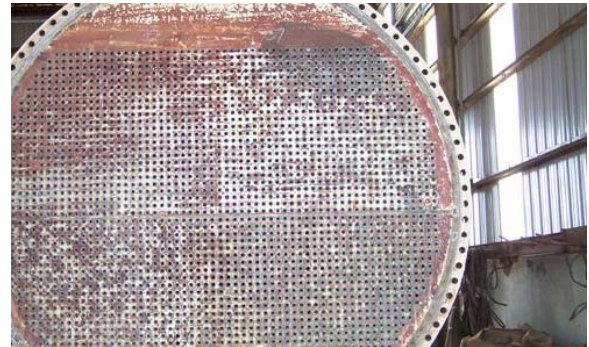


Figure 1 - Tube and Shell Condenser



Figure 2 - Scaling on turbine blades

There are systems in place to notify operators of the increasing presence of tube leaks. Tube corrosion can be attributed to increasing levels of contaminants like sulfates, organic acids, and chlorides.

One method used to identify contamination is to measure condensate samples for cation conductivity. Cation conductivity measures the electrolytic conductivity of a water sample and reports it in micro-Siemens per centimeter (uS/cm).

Silica and sodium levels are monitored constantly. When they exceed acceptable levels (measured in parts per billion = PPB) it’s time for action. If not, silica deposits on the tube walls and creates scaling.

Corroded leaking tubes allow the two separated media to merge. Contamination of highly pure steam and water transfers downstream to other system components.

Formations on turbine blades, pump vanes and valves diminish their efficiency, creates imbalance, and forces drive components to work harder just to maintain output (Figure 2).

Increased vibration levels accelerate component deterioration. Originally, tube leaks were caused by corrosion. Add in the juddering and jarring from vibration and new leaks appear in the form of cracked tubes.

Two Action Paths to Consider

Results engineers have two paths of action when silica and sodium level are high. With either choice, the station is forced to run at a lower output capacity for the duration of the maintenance.

Simple action is non-intrusive and fast. It involves valving off one side of the condenser and flushing the system. Acceptable sodium and silica levels are quickly restored, and the generator unit is back to full capacity fast.

In human terms, it's a detox. A detox is temporary. It treats the symptoms but doesn't address the problem. In the human example, bad diet and lifestyle is the culprit. In the condenser example its leaking tubes.



Figure 3 - Leaking tubes are identified and plugged

Flushing the tubes has environmental consequences to consider. Old water is disposed of, and new water brought in. The unit runs at reduced power, burning more coal, while producing less megawatts.

The leaks remain. Levels of sodium and silica will rise again. Another flush will be necessary soon.

The other action choice is to identify the leaking tubes and plug them; effectively removing the leakers from service. This is the better solution because it treats the cause. But it too carries downside.

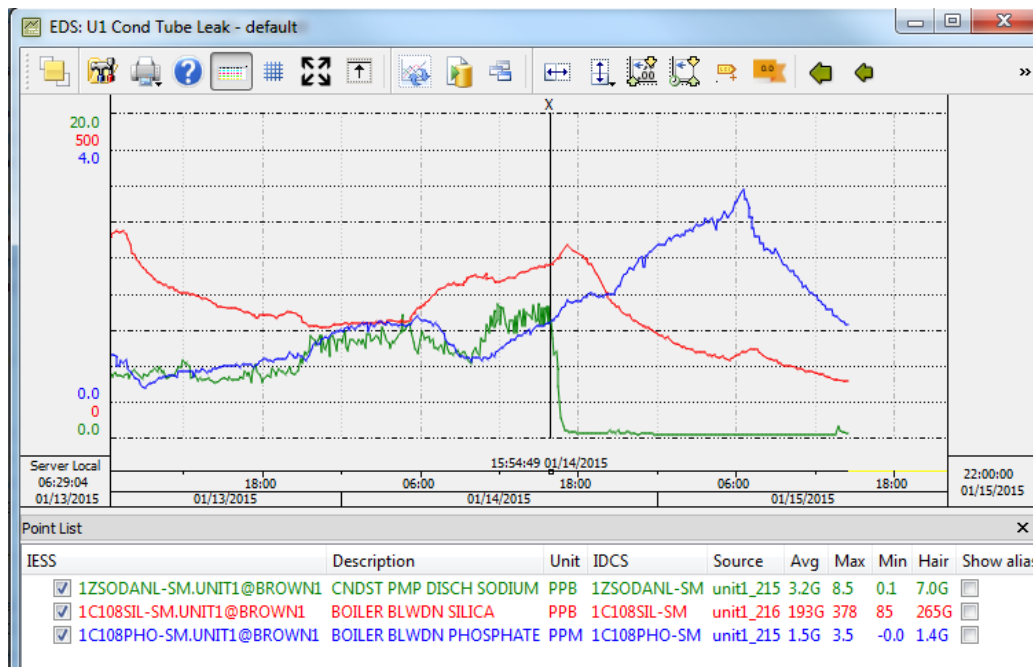
Looking for leaks can be unpredictably more time consuming than a system flush. Depending on the tools used for leak detection, you can be looking at a few hours, a day, or even longer. This needs to be communicated clearly so enough time is budgeted to do the job right.

Safety is an issue always. Inspectors are exposed to confined spaces and high levels of heat and humidity. The condenser is at or near operating temperature. They must work in teams; never alone. Personal hydration is paramount.

Bill Phipps is Production Manager at the AB Brown Power Plant in Mt. Vernon, Indiana. Located on the northern bank of the Ohio River, AB Brown is a four-unit, 700 MW power generating facility.

Two of the units are coal fired and the other two are gas. The coal units depend on leak-free condensers to operate efficiently. Water from the cooling tower passes through the inside of the tubes. Steam exhausted by the turbine passes over the tubes and is transformed back into condensate as ultrapure water. The water is returned to the boiler and converted back to steam.

The steam side of the tubes maintains 27 inHg (inches of mercury) vacuum. Any tube leak allows the water from the cooling tower to pass through and foul the ultrapure water with sodium and silica. Condenser tube leaks increase the silica and sodium counts in the boiler water and steam. Once the silica and sodium in the boiler water reach 750 PPB, they are forced to lower pressure on the Unit and lose Megawatt production.



January 2015 – Silica and Sodium is Rising

Figure 4 – Rising sodium and silica leaks in Unit 1 indicate small tube leaks. Condenser flushed on January 14, 2015, restored normal levels for now.

Figure 4 shows a typical graph trending higher silica and sodium levels in the cooling tower water on Unit 1. The presence of contaminants is below the 750 PPB threshold, but it puts Phipps' team on notice. On January 14, 2015, his team isolated and drained half of the condenser (Unit 1, 216) with the leak. The green line is the sodium and it immediately dropped; however, it takes a while for the silica levels to respond. The red line shows the gradual drop in silica. These levels will gradually rise again unless the tube leaks are found and isolated.

On January 10, 2015, sensors indicated high levels of sodium and silica in Unit 2. With valves they isolated and drained half of the condenser with the leak. See Figure 5.

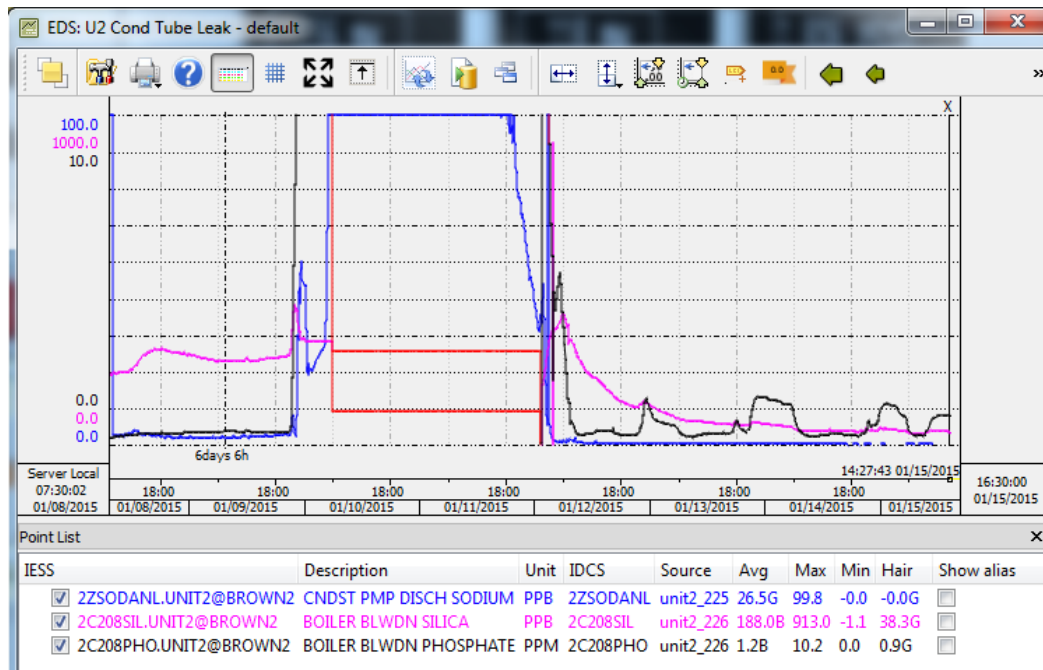


Figure 5 - Significant tube leak on Unit 2 caused reduction in output. Unit was shut down on January 10th and 11th for dye test. Leaks were found and isolated. Silica levels restored to normal by January 13th and 14th.

We knew we had a tube leak in Unit 2's condenser, in fact, during a planned outage they did a dye hydro on it to locate the tube leak. This graph of Unit 2 shows the difference in the silica and the sodium when we have a tube leak. Disregard the area between January 9 and 12 as this was the area that the Unit was offline, and the condenser tube side was filled with water and dye. Just look at the difference in the "pink" (Silica) amplitude before and after.

Phipps and his team are experienced at battling condenser tube leaks. "We usually helium leak test for Condenser Tube Leaks," says Phipps. The water side (inside) of the tubes are drained – the outside of the tubes (shell) is under vacuum. The helium detector inlet is inserted into the vacuum pump exhaust. Helium is sprayed around on the water side of the tubes. We have a box fabricated that allows us to narrow the area of a condenser tube leak down so that we shoot areas of the tube sheet instead of shooting each individual tube. Once the general area is located, then individual tubes have helium shot in them.

We had helium leak checked this half of the condenser 3 times but determined that the leak was so small we could not find it. This requires half of the condenser to be taken out of service to check for leaks. This has a negative effect on the heat rate, as well as during the summer months – Generator Output due to the backpressure created on the low-pressure turbine. We have the equipment and trained personnel to perform the Helium leak check. Since none of us had ever "heard" of a condenser tube leak using the Ultrasound equipment, and when the leak increased to a point that we thought we could locate it, the half of the condenser was again isolated.

A helium leak check was then performed, and the two leaking tubes were identified using Helium. Allan Rienstra had instructed the Results Engineer and Maintenance crew that if they could find the tube leak using helium, he then wanted them to use the SDT270 unit to "listen" to what a tube leak sounded like. When performing a Helium Leak Check the time involved is at least a day per condenser half. We hoped to reduce that time using ultrasound.

Once the two tubes were identified – the Results Engineer took the SDT270 Unit into the Condenser. He started in an area where the helium had not identified a leak. He did not use the precision tip but just "scanned" the area. He said he heard nothing in the areas where the helium had not detected a leak, however, when he waived the SDT270's airborne sensor in the area where the tube leaks were known to exist, he started hearing noise. As he continued scanning over the tubes that were leaking, he could hear a "psssst" then nothing as he moved away from the tube. He then put the precision tip

on and started checking each individual tube in about a 5 tube by 5 tube area. He said when he checked the leaking tubes – he actually had to turn the sensitivity down on the SDT Unit.

In all, he scanned approximately 18 000 tubes in 30 minutes with the SDT270 compared to a whole day with Helium Tracer Gas. The SDT270 Unit narrowed the leak(s) down to a small area.

It is his opinion that we should use the SDT Unit for finding Condenser Tube leaks in that:

1. He believes smaller leaks can be identified with the SDT270 Unit where they cannot be detected with helium.
2. He knows that he can find the leaks faster with the SDT270 Unit using the scanning method first.
3. It will be cheaper in that Helium Gas will not have to be purchased.
4. It will also return the Unit to full load capacity faster by significantly reducing the time that it takes to find leaks.

He may still use the helium to verify the leak, but the SDT Unit will be the first tool used. His confidence in the ultrasound has grown with each inspection. He states, “If you can’t find it with the SDT270 Unit, you will not find it with the helium.”

There was a time when Phipps used a contractor to helium leak check condensers. This came with an average cost of about \$10 000 per visit so they purchased the helium leak check equipment and trained their own operators.

The ultrasound equipment from SDT is more than justified in this cost savings alone. And since investing in ultrasound, they added additional attachments and purchased a software upgrade for the SDT270. “We will expand the program in hopes of identifying air leaks, valves leaking through, bearing lubrication and other issues that are in the capability of the SDT Unit,” states Phipps.

April 2015 – Furthering Their Confidence in SDT

In May, I revisited Bill Phipps to check on his progress. He was pleased to share his new success. On April 13, 2015, another leak was reported.

Silica levels spiked in the cooling tower blowdown water at 3:15 pm. Looking at the graphic below, the control room was alerted when blowdown silica spiked to 1 000 ppb (parts per billion).

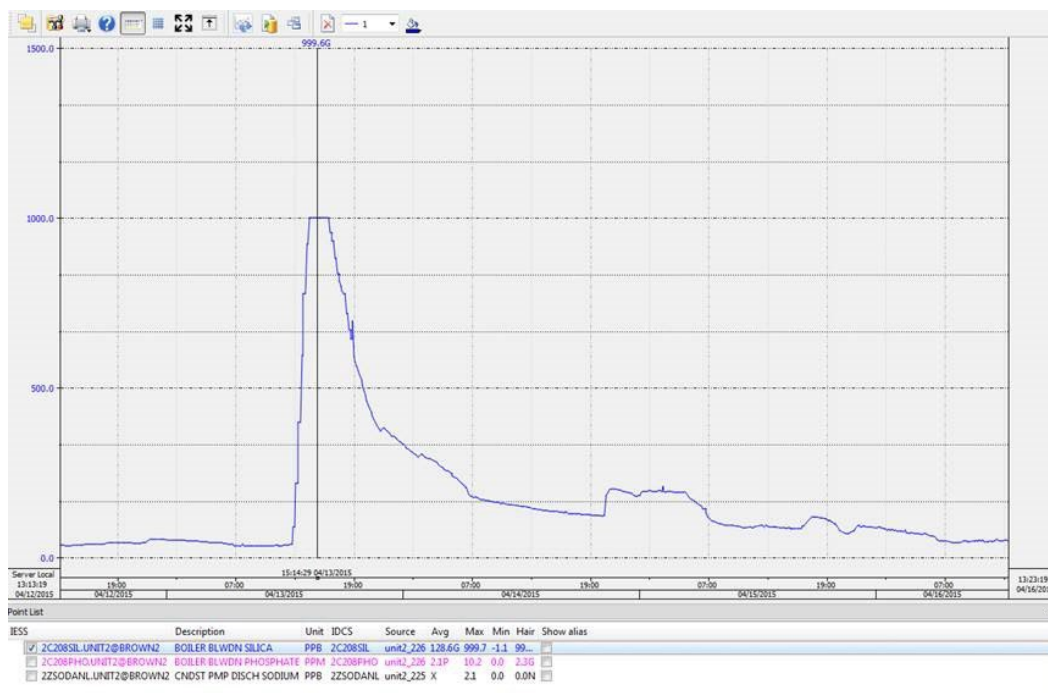


Figure 1 - Silica levels spiked on 04/15 indicating new and significant leaks on Unit 2 226.

This graphic conveniently points out the source of the spike too. Unit 2 226 tells them which side of the condenser to valve out. The turbine can keep running, albeit at reduced capacity, while the ultrasound team heads in to find the leak.

The SDT270 ultrasound equipment was used to rapidly identify the tubes and the area. The leak was massive and required plugging of 39 tubes. As a secondary check, and to follow procedure, the leaking tubes were then verified with Helium.

As Phipps' team continues to have this level of success with ultrasound, he expects they will fully eliminate the helium verification altogether.

Summary

Most reliability departments recognize the significant versatility of Ultrasound as an asset condition management technology. For those pursuing world-class reliability standards, implementing ultrasound testing for all its virtues is a necessity.

Compressed air leaks and screw pumps inspection in a Cameroonian power plant

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Dibamba Power Development Company is a heavy fuel oil power plant, the first independent power producer in Cameroon. Operating in the power generation sector in Cameroon and part of the Globeleq Group, the company's vision is to participate in Africa's growth through the development and operation of power plants.

The Yassa-Dibamba heavy fuel oil power plant requires compressed air at two pressure levels: 30 bar for the engine start-up air compressors and 7 bar for the auxiliary instrumentation. To produce the instrumentation air, the plant has 3 air compressors running more than 5 000 hours per year with very short stand-by times.

In order to optimize its costs and to guarantee the contractual availability of its machines, the company thought of applying proactive solutions to allow them to anticipate the different failures of their machines and better plan the necessary contingency actions.

Using their new SDT340 ultrasound detector and its flexible sensor, they began to search for air leaks to improve their efficiency, as one of the compressors is currently out of service.

This research led them to identify several air leakage sources, some of which could be directly corrected, while others required further action.

To date, the effects are convincing. In spite of the actions that are still in latency, maintenance technicians are already able to observe instantaneous effects, namely the reduction of the number of hours of operation of these remaining compressors up to 30%. This translates into a reduction of more than 4 hours per day, per compressor, over the last two weeks. And this despite the absence of one of the compressors. The impact will be quantifiable with the costs related to energy consumption and maintenance based on operating hours and therefore annual material consumption.

The compressed air leakage searches allowed them to reduce the stress on their start-up air compressors and therefore the costs related to their operation, to name but a few. The LEAKReporter application has been a plus in helping management understand the impact of these inspections from a financial point of view with very easy to visualize analyses.

Studies are underway to define the periodicity for regular inspection rounds to maintain or even improve these conditions.



The heavy fuel oil, to speak only of it, requires a rather complex treatment process that solicits several units, the majority of which have screw pumps that, before 2019, were the main sources of maintenance of the company, with an average of 200 million CFA (Central African franc) francs spent per year. This does not include downtime due to failures and even overtime generated during on-call maintenance teams.

The reliability of the installations depends on the state of the important number of auxiliary systems (pumps, centrifugal separators, compressors and others) contributing to the production of the 8 groups that the power station counts, each of which can produce 11MW (installed power).

In the case of these screw pumps, they have set up inspection routines which, coupled with the establishment of reference values, have enabled them to monitor failure states in order to recommend corrective/proactive actions in time. This has enabled them to considerably reduce their maintenance costs by up to 80% on screw pumps.

Maintenance of hydraulic equipment and components: ultrasound, the winning solution

Author: Patrice Dannepond

The challenges of maintaining hydraulic equipment and components

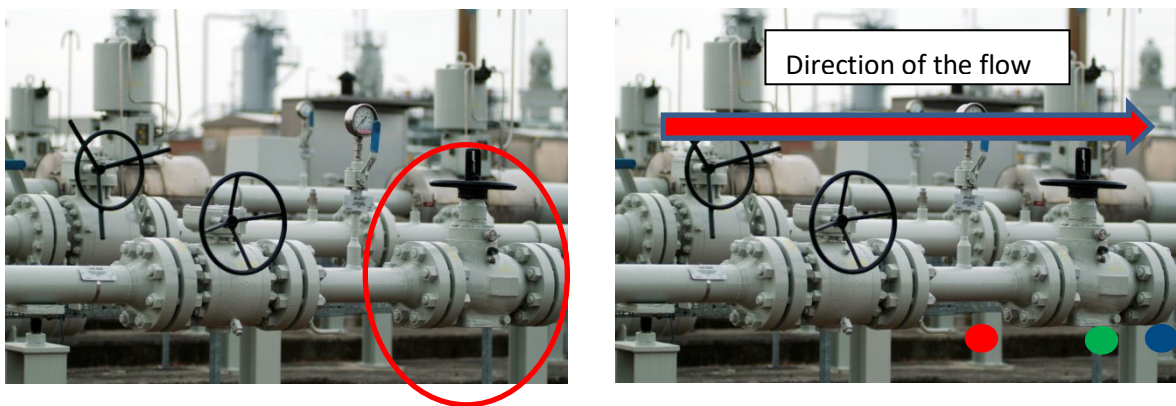
Of all the installations on a production site, hydraulic equipment and components certainly represent a major challenge in terms of availability.

It is also a safety issue, particularly for French nuclear power plants, which use SDT ultrasound detectors to monitor all their industrial valves, as well as safety valves in the oil and gas refining (TOTAL) and petrochemical (SANOFI, ARKEMA, BASF...) sectors.

In the organization of preventive maintenance on an industrial site involving hydraulic pumps, some companies would not be able to produce without a water supply. In France, the basic chemicals, yarn/synthetic fiber, paper and cardboard, metallurgy, parachemistry and pharmaceutical industries alone account for two-thirds of industrial water consumption. And the stakes are just as high in pumping stations for drinking water networks.

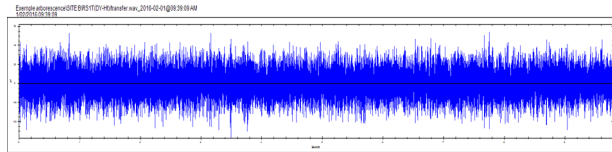
With an SDT detector, valve testing involves placing a contact sensor at three points: upstream, on the seat and downstream of the valve. Diagnosis is quick and immediate, based on a comparison of the 3 measurements. A rise in pressure on the valve seat indicates that the valve is leaking. This is confirmed by listening: the operator actually hears the leak.

Data management is simplified by storing measurements and processing them in the [Ultranalysis® Suite 3](#) software, with reports, alarms, missed measurement points and rounds. An ATEX version is available for hazardous environments.

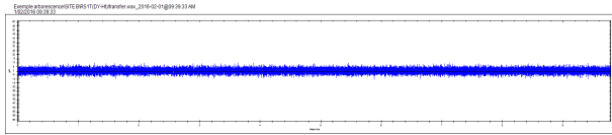


Inspection of a pressure reducer on a natural gas installation. measurement

● Upstream measurement ● Seat measurement ● Downstream



Upstream measurement: 21 dBμV

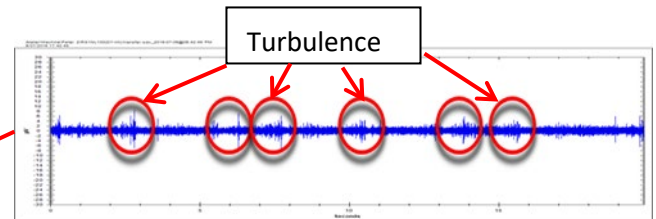
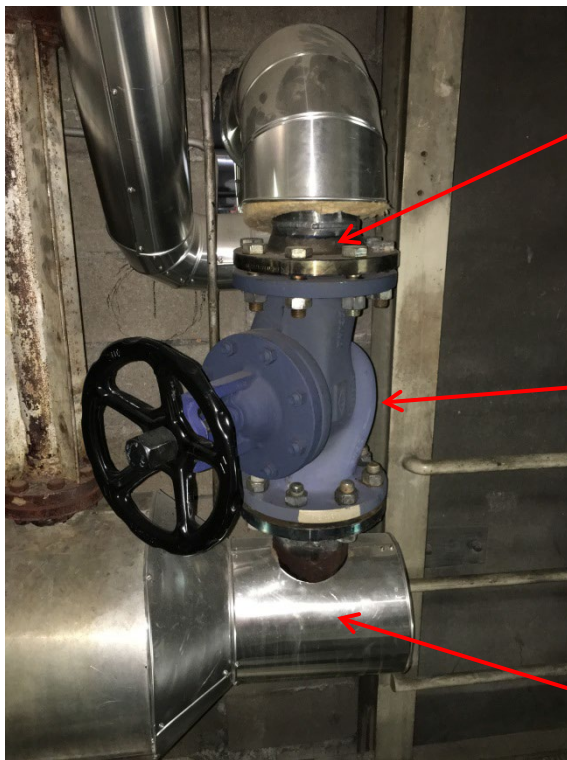


Seat measurement: 10dBμV, where turbulence and a slight whistling sound can be heard

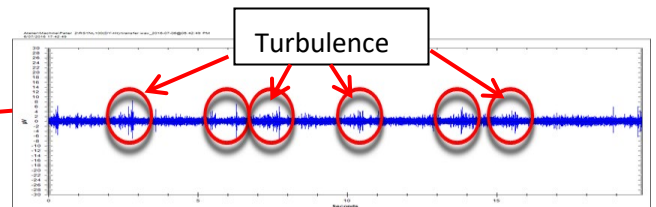
The customer's assessment after dismantling the regulator

In this example, the customer is a natural gas supplier and distributor. The company's maintenance department only visually inspected its valves and regulators. When they dismantled this equipment, they could never be sure that they were dismantling a component that could be considered a leak. This on-site demonstration highlighted the effectiveness of ultrasound measurement in finding a defective component quickly and efficiently.

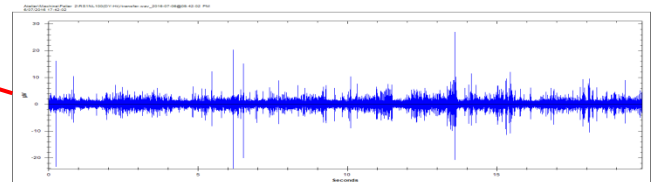
Below is a second example of a leak test on a steam valve in a boiler room at a cardboard plant.



Measurement downstream of steam valve



Measurement on steam valve seat



Measurement upstream of steam valve

Turbulence on the steam valve seat and downstream of the piping (highlighted on the spectra above), demonstrates that this component is leaking. This enabled the Maintenance Manager to confirm the failure of this component, which could cause a problem in the boiler room process.