SDT Ultrasound Solutions

Industry Listens To Us

Ultrasound Lube Technician Handbook

Contents

Introduction

Friction is all around us. Without it we would find it very difficult to run, walk, or even stand on our own two feet. We need friction to drive our cars and fly our airplanes; and we need friction for our motors to drive pumps. But when it comes to our plant machinery friction is both friend and foe. If part of your job is greasing plant machinery then you know well the battle against frictional forces that threaten the useful life of rolling element bearings.

Lubrication of rolling element bearings is one of the most misunderstood and abused tasks in industry. Can it be true that nearly all bearings never live to their engineered life cycle and bad lubrication practices are the leading cause of this infant mortality? Bearings depend on grease to reduce friction levels. When to grease, how much grease to apply, and how to control the process with ultrasound is the intended focus of this handbook.

Three Mistakes to Avoid When Lubricating a Bearing

Mistake #1 - Lubricating based on TIME instead of CONDITION

Lubricating a bearing once per week or once a month may seem like a sensible thing to do. After all, performing scheduled maintenance at regular periods is an age old concept ingrained early on. Even OEMs still advise best practices based on time intervals to ensure maximum asset lifespan. Are they right, or does their advice steering us in the wrong direction?

The problem with any blanket solution is that it attempts to cover the entire spectra of applications (thus the term "blanket solution"). However a one-size-fits-all solution ignores the variables introduced by environment and application. For example, two motors may have the same spec out of the box but end up being used for entirely different jobs. While one lands in a hot and humid climate, another could be installed in a cold and arid climate. One may be used in a high speed low load application while another at low speeds but with frequent starts and stops.

It is irrational to expect the lubrication needs of one to be the same for another when the conditions they operate in are so different.

Bearings need grease for one reason only; to reduce friction. As long as the lubricant is performing that service well, there should be no need to change it, or add more. Yet we frequently do, with catastrophic results.

Re-lubricating a bearing just because your calendar told you "time is up!" is the first mistake. Monitor, measure, and trend friction levels to know when it's the right time to grease.

Mistake #2 – Over and Under Lubrication

The second mistake we should avoid is adding too much, or not enough grease. Too much grease builds pressure, pushing the rolling elements through the fluid film and against the outer race. The motor now has to work much harder to push the rolling elements through a mud bog of grease. What takes more physical energy? Sprinting carefree through ankle deep water along the shoreline or slogging waste deep several meters offshore?

The increased friction and pressure from too much grease raises the temperature inside the bearing. Excess heat decreases the effectiveness of the lubricant causing the oil to separate from the thickener. Not adding enough grease has the same life-shortening effect.

How do we know when just the right amount of grease has been added? By monitoring the friction level with ultrasound as new grease is applied. Listen to the bearing and measure the drop in friction as the grease fills the bearing cavity. As the decibel level approaches normal baselines and stabilizes carefully slow the application of lubricant. Should the decibel level begin to increase slightly, stop! The job is done.

Mistake #3 – Using a "Listen-Only" Ultrasound Instrument

Like any job there is a right way and a wrong way to do things. Simply listening to a bearing with an ultrasound device that gives no quantitative feedback is a recipe for disaster. The audible feedback is too subjective to draw any comparative conclusions. No two people hear the same and there is no way to remember what the bearing sounded like a month ago.

The third mistake is depending solely on subjective ultrasound data when precise quantifiable data is available. Always use an ultrasound instrument with digital decibel metering. Better still, use a device that provides multiple condition indicators. Max and Peak RMS decibel measurements indicate alarm levels and greasing intervals while Ultrasonic Crest Factor provides insight about the bearing condition in relation to its lubricant. Crest factors help us differentiate between bearings that need grease and bearings that need to be replaced.

Ultrasound Helps

The insides of a bearing consist of four important components. The inner and outer raceways with their matching grooves form a path for the roller elements to glide on a thin film of lubricant. A metal cage separates the rolling elements, keeping them evenly spaced to distribute the load and stop them from crashing into one another. As these four components move in concert with each other frictional forces are present. Friction comes from rotational inertia, surface load, misalignment, imbalance, and defects. Zero friction is impossible, but optimal levels of friction can be achieved with correct installation techniques and the proper amounts of lubricant.

Determining optimal friction is best done with an ultrasound condition monitoring program. A bearing produces ultrasonic or acoustic energy from rolling friction and impulses. When lubricant levels are optimal the energy created is at its lowest. As frictional forces increase so too does the associated acoustic energy.

Use ultrasound to sort bearings with high friction from those with normal friction. Ultrasound measurements establish a baseline for bearing friction and trend over time. This is a proven method for determining conditional changes that require action such as changing or adding more lubricant. It is important to note that this action is driven by condition, not time. By using our tried and tested method you can easily distinguish between bearings that

- have too much grease
- have too little grease
- are in need of re-lubrication

Ultrasound ensures that the right amount of new grease enters the bearing while warning when grease levels become dangerously high.

Simple Tools Needed

The SDT200SD is an economical ultrasound solution designed for budget minded inspectors; However attention to detail, robustness, and quality have not been sacrificed at the expense of low price. Equipped with RS1 Needle and RS1 Threaded contact sensors, Acoustic Lube Adaptor, and Multi-Surface Magnet, the SDT200SD Lube Tech Kit answers the basic needs of lubricators. An optional Non-Contact Temperature Sensor can be activated for additional control of bearing condition prior to and after lubrication.

The SDT270SB is an entry level ultrasound solution built on the SDT270 Building Blocks Platform. Accurately measure ultrasound produced by friction and impulses to predict when new grease is needed. Monitor bearing condition before, during, and after re-lubrication to know just the right amount of grease to add. Equipped with RS1 Needle and RS1 Threaded contact sensors, Acoustic Lube Adaptor, and Multi-Surface Magnet, the SDT270SB Lube Tech Kit answers the basic needs of lubricators while offering an upgrade path to more advanced SDT270 platforms.

Advanced Tools Available

SDT270SU with Ultranalysis Suite software (UAS™) is and advanced ultrasound measurement and data collection solution. This solution combines the powerful features of the SDT270 with sophisticated database software. Manage all your greasable assets from one flexible tree structured database. Build custom task lists for routine condition assessment. Set alarms to trigger lubrication needs right in the field. Then trend bearing condition before and after greasing to create meaningful reports. Equipped with RS1 Needle and RS1 Threaded contact sensors, Acoustic Lube Adaptor, and Multi-Surface Magnet, the SDT270SU Lube Tech Kit answers the advanced needs of condition based monitoring to alert lube techs when action is needed.

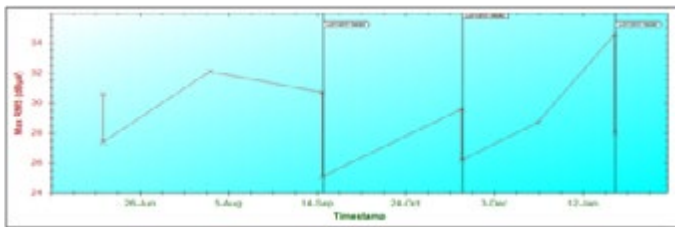

Figure 1 - Static trend captured by lube technicians at Cenovus Energy demonstrate before/after dBuV trend

SDT270DU with Ultranalysis Suite software (UAS™) is an expert ultrasound measurement and data collection solution. This solution combines dependable trending capabilities with advanced dynamic signal analysis. Dynamic ultrasound data displayed in the time domain provides powerful images of bearings properly and improperly lubricated. Equipped with RS1 Needle and RS1 Threaded contact sensors, Acoustic Lube Adaptor, and Multi-Surface Magnet, the SDT270DU Lube Tech Kit answers the expert needs of predictive technicians. The SDT270DU alerts lube techs when action is needed while providing graphical evidence of successful bearing re-lubrication.

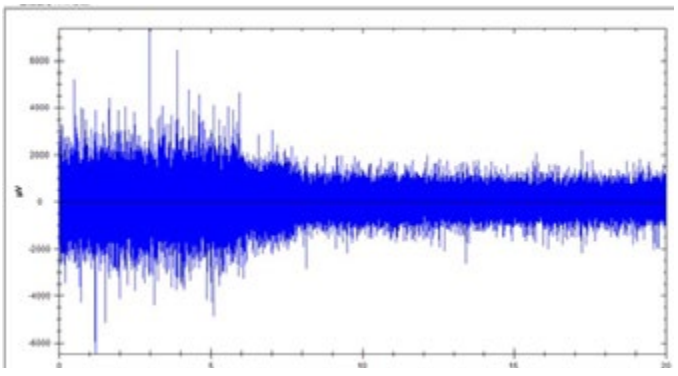

Figure 2 - Dynamic data collected from a bearing using an RS1T Threaded Sensor from SDT. This data sample is 20 seconds in length. Notable is the high overall amplitude of the signal and the random peaks caused by impulses. At 6 seconds the grease reached the roller elements. At 8 seconds the amplitude decreased to baseline and by 10 seconds the impulsive peaks all but disappeared. This is a typical result of a wav file captured on a bearing that was in need of grease, and received the correct amount.

How to Get Started

Success is dependent on organization and commitment. Without these two structural elements your ultrasound lubrication program will find difficulty getting traction. However with well-organized execution the program will be on a solid footing from the outset. Getting the commitment from all levels comes much easier when a program can demonstrate structure and cohesion. Results will prove the program faster which will trigger easier access to funding to grow and sustain the program.
There is only one clear way to create organization around a project and that is to define its goals. So start by asking "Why are we starting an ultrasound lubrication program and what rewards do we expect to reap?" There is no one easy answer to the question and probably several that make sense. Saving money is an obvious benefit that gets the attention of management but it is not specific enough. How will an ultrasound lubrication program save money?

- By reducing grease consumption
- By raising awareness of the right types of grease to use
- By making more effective use of lube tech's time
- By extending bearing life expectancy
- By decreasing energy consumption from over-greased motors
- By contributing to a mentality of best practices that positively infect other aspects of your business

Can you think of some others?

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A new beginning is the best opportunity to review what you have been doing previously. Identify what worked and improve or remove what did not. Since this handbook is designed to help create an effective and enduring ultrasound lubrication program, it is not our intention to go deeply into all aspects related to good lubrication practices. But there are some basic and relevant points that deserve to be noted.

Lubricant management program: Keeping you bearings healthy requires a lubricant with the right quality for the application. By quality we refer not only to the quality of the grease manufacturer, but quality in a broader sense which involves all the processes from manufacturing to application. Some general recommendations are:

- Contamination is one of the leading problems affecting the quality of lubricants and lubrica-

tion; keep high standards of housekeeping for storage, handling, and application.

- Keep a detailed list of products to use for each lubrication point. Selecting the right lubricant requires technical knowledge in several aspects. Using the wrong product will jeopardize the useful life of the component. Don't change lubricants without solid reasons. Consider contracting a lubrication consultant to direct advice on this.
- Provide training in every aspect relevant to lubrication practices and product knowledge to those responsible for lubrication.
- Set objectives to reach so you have a clear path to follow.

Application devices: Delivering the lubricant to the right point require some type of device. One of the most common is the grease gun. These come in different models but something common to all is the high pressure with which they deliver the grease; usually thousands of PSI; enough to overcome the backpressure in the zerk fitting. Dirty grease and even using the wrong grease kills bearings. Therefore it is necessary to extend the precautions for contamination and storage discussed above, to the application of lubricant through grease guns:

- Wherever possible insist on using a dedicated grease gun for each grease type to avoid the risk of applying the wrong product through cross contamination. Label the grease gun with the associated grease to be used.
- The same principle must be applied for your ultrasound device. When using SDT's acoustic grease gun adaptor to simultaneously apply grease and measure friction levels, assign a different lube adapter for each grease type used. Even a little left over grease in the adaptor can mix with new grease causing a chemical reaction and degrading the new grease.
- Always clean the zerk fitting and grease gun before and after every application.
- If the bearing has a drain plug remember to remove it during greasing to allow old grease to push out as new grease is applied. It is not enough to simply open the drain port. Often the hole will be clogged with wax and dried grease. Using a clean brush similar to a bottle washing brush, gentle free up the port to allow free flow.
- Apply grease always giving half strokes of the grease gun lever to avoid over greasing, and also to avoid damaging the bearing. Too much pressure on a full stroke can push the bearing cage into the roller elements.

Type of bearing inside: Lubrication technicians can make a mistake if they assume that a Zerk in the housing means a path to grease the bearing. Many times the motor or bearing manufacturer installs grease fittings on motors with sealed bearings. They do this in the event that the end user later decides to change from a sealed to an open bearing. You must identify every grease point that will be managed within the ultrasound program. Then, identify for each lubrication point the type of bearing inside, and the type of grease that will be used. Using acoustic lubrication here are some tips that can help you.

- Friction produces ultrasound. Friction inside the bearing comes from the contact between race, rolling elements and seals or shields.

- Less contacts means less friction so a ball bearing produces less friction than a same size roller bearing under the same lubrication conditions, speed and load.
- Sealed bearings produce more friction than open bearings. Consequently they will be louder ultrasonically. However sealed bearings should maintain a consistent baseline as long as the grease retains its functional characteristics.
- Open bearings present lower ultrasound levels initially. Over time they trend louder as the grease begins to deplete and lose functionality.
- Plain bearings produce the lowest friction levels. Their ultrasound baseline often trends in the single digits or low teens. Typically they remain consistent for their lifespan and only display sudden upward trend lines when the oil film becomes contaminated or the bearing is near failure.
  Download 'Plain Bearings' White Paper >>

Safety

Each company has its own set of safety regulations that must be followed. Safety is not a subject to be taken lightly or ignored. Everyone has the right to work in a safe environment and everyone's goal should be to return home to family and friends at the end of a working day. Be sure to complete any company sponsored safety orientation courses and stay current with requirements.

Have the correct PPE – especially the right gloves to protect your skin from dermatitis-related injuries. Wearing hearing protection around noisy motors and pumps just makes sense. The SDT270 and SDT200 come equipped with noise attenuating 130dB headphones. These headphones provide suitable hearing protection during data collection and monitoring.

Tie back hair and keep loose clothing in check to avoid coming in contact with rotating equipment. Similarly, be mindful that cabling from your ultrasound equipment could also come in contact with exposed rotating shafts, belts, and chain drives. Do not wear neck ties and chains or name badges with lanyards. Even pay attention to long shoe laces and keep them tucked safely inside your safety shoes.

Procedure for ultrasonic lubrication

Every plant is different but there are basic similarities that make a general procedure for ultrasonic lubrication relevant. This general procedure is meant as a guideline to be used to build out a more specific procedure for you. This may be an exercise best undertaken with the guidance of your ultrasound implementation consultant.

1. Determine the equipment to be used for ultrasound monitoring (SDT200SD/SDT270SB/SU/DU or other)
2. Determine which sensor to be used
   a. RS1T – Resonant Sensor Threaded w/ multi-surface magnet base or acoustic lube adaptor (Recommended)
   b. RS1N – Resonant Sensor Needle
3. Connect the RS1T contact sensor and correct cable to SDT200/270 ultrasound collector
4. Take initial dBµV reading using steps pre-

scribed by SDT ops manual or Level 1 training "Methods of Mechanical Inspections"

5. Determine, based on the dBµV reading, if the bearing is in need of grease. SDT uses the 8/16/24 dBµV recipe to determine failure stages.
   a. An increase of 8 dBµV over baseline is a call for grease.
   b. 16 dBµV over baseline is a serious warning the bearing has entered a failed state
   c. 24 dBµV over baseline is near catastrophic failure.
6. If the bearing is equipped with a drain plug it must be removed first so old grease can be pushed out and replaced with new. It is important to use a CLEAN brush or bottle cleaner to be sure the drain is free of debris and not clogged with old solidified grease.
7. With the RS1T on the zirk fitting or on the bearing itself, apply a half shot of grease
8. Wait for 30-60 seconds to allow uniform distribution of new grease throughout the bearing. The length of time is dependent on bearing size and rpm. After sufficient time take a static dBµV reading.
9. Repeat steps 7&8 for as long as the dBµV continues to decrease.
10. The target is to return the bearing back to its baseline dBµV value. An indication that over-greasing may have occurred is demonstrated by a return to dBµV baseline, stabilization of the static reading, followed by an increase in dBµV value with a further half shot of grease.

Frequency

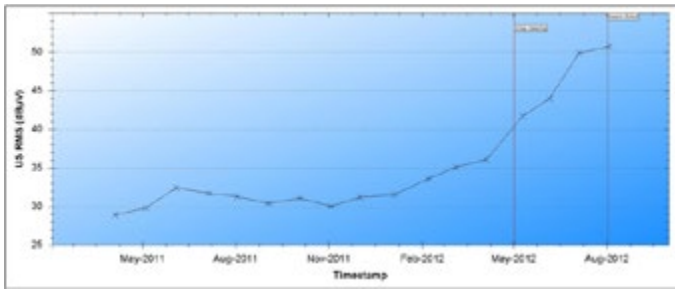
How often should machines be greased? There is no easy "one answer fits all" to this question. Presuming that full faith in ultrasound condition based re-lubrication is engaged then we can approach the answer with this simple logic:

Q: Why do bearings need grease?
A: To reduce the frictional forces between the surfaces of the bearing's rolling elements.

Q: Ok, so when does new grease need to be added to a bearing?
A: When the bearing's frictional forces increase beyond a set quantifiable level.

Q: What is a reliable and easy to use technology that determines changes in frictional forces?
A: Ultrasound

Back to the original question then, "how often should machines be greased?" The answer must be, when your ultrasound technology reports an increase in static baseline that is 8-10 dBµV louder than an established baseline. Knowing that 6 dBµV over baseline represents an two times increase in frictional levels. 8-10 dBµV is logarithmically and logically an intelligent point to create a re-lubrication interval alarm.

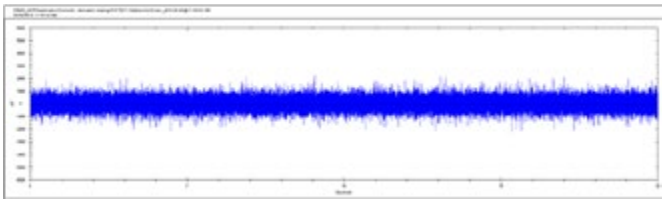


A simple trend graph like the sample demo data above shows a bearing's degradation over a 12+ month period. The baseline ranged between 29 dBµV and 32 dBµV for the better part of 10 months. Around May 2012 the bearing became noisy (ultrasonically) and breached the 40 dBµV mark for the first time. 40 dBµV represents 8-10 dBµV above baseline. This should have triggered an alarm for intervention. Lubrication of the bearing at this point to return it to baseline may have prevented the breach above 50 dBµV and resulting failure.

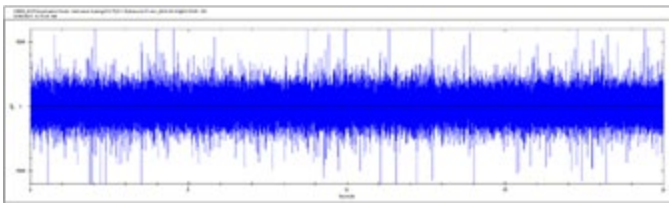
The SDT270DU and UAS can go much deeper than just this static dBµV trend. Using time wave analysis and Crest Factor in depth analysis reveals a lot about the state of your bearing. Time wave analysis allows us to capture a time block of data (20 seconds for example was chosen in the examples below) and view the ultrasound signals in real time. The Crest Factor is a linear ratio between the RMS µV level and the Peak µV value. The crest factor can reveal how "peaky" the bearing data is versus a bearing that has high levels of friction but no significant impulses (wear).

Look at the Dynamic data from three bearings below. The Y-Axis of these time signals has been scaled identically to make them comparable.

In Bearing 1we see a bearing in good condition with a modest level of overall noise and very short peaks. The RMS is 51.2 dBµV. The Peak is 67 dBµV and the Crest Factor is 6.17



In Bearing 2 we see a bearing in need of lubrication. The overall noise level is much higher in comparison to bearing and there are a lot of impulses related to surface to surface contact indicating the thin film of lubrication is not managing its task. The RMS is 57.8 dBµV (a factor of 2x higher than frictional forces in Bearing 1). The Peak is 79 dBµV and the Crest Factor is 11.48. The higher CF value on Bearing 2 indicates that not only high frictional forces exist, but also higher peaks caused by impulses in the bearing.

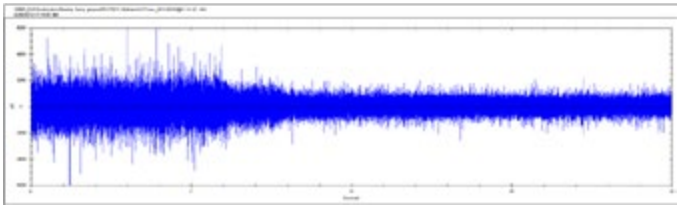


Summary Comparison Table for Bearing 1 & 2

	RMS (US) dBµV	Peak (US) dBµV	Crest Factor
Bearing 1	51.2	67	6.17
Bearing 2	57.8	79	11.48

Since Bearing 2 data suggests that it was in need of lubrication our Lube Tech did just that. The result is

visually obvious. The grease first reached the rolling elements at the 6-7 second mark. By the 10 second mark the bearing was noticeably quieter and the sharp peaks from bearing impulses are now considerably shorter.



Reporting

The objective of good reporting is to inform the people who need to be aware. They need to know what work they must do to bring an asset back to best condition. They need to know when that work should be done and the consequences of not acting on the work in a timely fashion. The job of the report generator can be compared to that of a translator. This job normally falls on the person responsible for collecting condition-monitoring data. CM data is the machine, the valve, the pump, the motor, the "whatever it may be" talking to you in an ultrasonic language. You are trained to understand that language. It is your job to translate what the asset is telling you into meaningful information that the planner, the repair crew, production and management can understand. That is what a good report should be; a product of considered engineering opinion based upon the facts you have gathered.

A report should NOT be data spewing. Time signals and spectra are merely hieroglyphics to most and while they may look pretty to techies, they will not impress upper management. Should they be included? Absolutely; But only include illustrations that support a clear explanation of the problem. Indeed using the graphics in the example above, including explanations and best recommendations form the essence of any good report.

What message should you be conveying then? Your report should start by stating the problem: "There is an issue with this machine, or this valve, or this bushing, or this transformer. Additional follow-up with vibration analysis and an oil lab report is recommended to confirm the problem." Identify the asset and identify the issue. Then clearly state what needs to be done to bring it back to best condition. A good report should also include a message about the consequence of doing nothing: "You can fix it now and the cost for the repair, including spares, labor and scheduled downtime, will be $500. Or, you can leave it alone, however, besides continuing to impact production and product quality, the cost to fix it on an emergency basis will be $50,000."

What is wrong with writing a strong messaged opinion such as this in your report? Is it politically incorrect to make that assertion and state the blindingly obvious? Or is there lingering fear of making a bad call. The latter is a confidence issue that relates either to distrust in the technology used for CM or the person charged with collecting the data. Both can be addressed through expert training.

Training

Many people ask, "Is ultrasound complicated" and without hesitation, the answer is "no". Yet the degree of sophistication can vary from one program to another. Should you embark on an ultrasound assisted lubrication program on your own? That is

probably not a good idea if fast results and longevity are adjectives that describe your goals.

Training is the foundation of an effective and enduring ultrasound program. Whether you choose a 1-day ultrasound lube-tech course or a full week implementation and certification, your program will survive and thrive through the experience of trainers who have helped create thousands of programs just like yours.

SDT Training Courses include:

- 1-day lube tech course
- 2 ½ day Level 1 certification (in accordance with ISO 183436-8 and ASNT Recommended Practice SNT-TC-1A)
- 2 ½ day Level 2 certification (in accordance with ISO 183436-8 and ASNT Recommended Practice SNT-TC-1A)
- On-site Implementation (1, 2, 3, 4, 5 day)
- Signal Analysis Training
- Custom courses to fit YOUR needs.

For more information visit:
www.sdthearmore.com/training

Benefits

Ultrasound assisted lubrication of plant assets offers significant benefits that calendar based lubrication cannot. Lubrication serves a primary purpose, which is to create a thin layer of lubricant between rolling and sliding elements that reduces friction. So it makes sense that the best way to determine the lubrication requirement of a machine is to monitor friction levels, not time in service.

Optimizing lubrication of plant machinery with ultrasound will result in a significant reduction in grease consumption. Having an ultrasound program in place will create a better culture leading to cleaner storage practices, sampling, and avoiding mixing greases.

Machines that are properly lubricated require less energy to run. Imagine that reducing the amount of money spent on grease will actually lead to lower energy bills. Machines that consume less electricity run cooler and machines that run cooler have longer life cycles.

Ok, the real reason to optimize bearing lubrication is to extend the life of bearings by making sure they have the right amount of grease, but not too much. When everything is running according to plan lube-techs will spend less time greasing bearings that do not need it. So when counting up the benefits of your ultrasound program do not forget to add “decreased labor” to the long list.

Finally, by monitoring the condition of your machinery’s lubrication, you are at the same time collecting valuable condition data about the machine itself. Dynamic and static ultrasound data coupled

with condition indicators such as Overall RMS, Max RMS, Peak RMS, and Crest Factor are all indicators of bearing health. Who knew so much good could come from such a simple shift from calendar to condition based maintenance? Now you know.

Contact SDT

In today's world of communications there are more options to reach out than ever before, and we really hope you will. Here are some popular ways to get in touch with an SDT Ultrasound Expert:

Telephone

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