



*Did  
you  
know?*

# GEAR BOX

# 101

*THE ULTIMATE*

# *Cooling Tower Handbook*

*for research, performance, and maintenance*

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**GEAR BOX**

101

# WHAT ARE WE GOING TO COVER?



Single Speed Vs. Two Speed Vs. VFD Motor Operations



Gearbox Best Practices



Checking & Analyzing Your Gearbox Oil



Vibration Monitoring

# WHY YOU SHOULD CARE...

Your gearbox operations can make or break your cooling tower performance. Working in the field, you may encounter many types of gearbox failures; but do you know why your gearbox failed or how to prevent failures from happening?

Today, you will hear from the industries best; providing tips and advice to help you understand why your gearbox fails, how to prevent failure from happening and exactly how this affects your cooling tower performance.

# Chapter 1

## CHOOSING YOUR GEARBOX OPERATION



# How to operate under a single speed motor

When it comes to the single speed motor operation of your gearbox, one of the main things to concern yourself with is damage to the gear teeth. The main cause of this damage is because of large torque spikes. This means, as energy is transferred from the motor through the driveshaft to the gearbox, the torque is displaced and absorbed by the gearbox internals.

To prevent large torque spikes remember the following: Always use a **NEMA Design B motor** to limit starting torque. **Never use a “Y Delta” starter**, as these can produce large torque spikes. Additionally, make sure that the fan is not “wind milling” in reverse direction prior to motor start up.

## EXTRA TIP:

If icing is not an issue in your area you may want to consider a non-reverse option to be added to your gearbox. This option will take the wind-mill worry out of the equation for a small cost.

Single  
Speed

# How to operate under a two speed motor

Two speed motor operation can also present gear teeth damage issues. Remember to make sure that the gearbox has an adequate torque rating at both motor speeds. Also, use a time delay when changing from the low speed to the high speed.

## Two Speed

### *Our Advice:*

You will still be dealing with the same pesky “reverse wind milling” effect as the single speed motor operation. We bet that you have more important items to worry about than your fan “wind milling”, thus again, we highly recommend getting the non-reverse adder.

# How to operate under a Variable Frequency Drive (VFD)

Variable Frequency Drives (VFD) need to be looked at a little more closely. Yes they can save money in power consumption over time and yes, they can prolong the life of the gearbox by reducing some of the harsh wear and tear of single or two speed motors. However, VFD's need to be set up correctly or they will cost you money and shorten the life of your gearbox. To operate your VFD correctly, remember these two simple tips:

**1) You must remember to lockout speeds that excite the systems natural frequencies (+or - 5 Hz).**

**2) Both critical speed and blade pass frequencies should be taken into account.**

If you don't know what these speeds are for your tower call us or your vendor to help determine your speeds. Keep in mind that the deceleration rate of the gearbox should be greater than the natural coast-down time. Additionally, make sure that you are not operating your gearbox above the nameplate speed.

Lastly, do not operate below the minimum speed allowed by the gear manufacturer. For example, Amarillo Gear Company's minimum speed is 450 RPM. If you are using a single reduction gearbox, you may want to consider the low speed option. This ensures that the vertical upper bearing is properly lubricated at all times reducing the need for mechanical or electrical oil pumps.

The logo for Variable Frequency Drive (VFD) is displayed in a large, bold, yellow font. Above the text is a stylized graphic consisting of two white chevrons pointing downwards, set against a dark blue background with white geometric lines.

Variable Frequency Drive



# Ask the Expert:

## gearbox best practices

*By Amarillo Gear Company Staff:*



**Q1: The biggest gearbox failure that we tend to see from our customers is non proper lubrication of a gearbox. This leads to major maintenance issues and repairs. What recommendations does Amarillo Gear have towards gearbox best practices?**

*One of the contributing factors to shortened gear box life is lack of maintenance of the gear box in accordance with the manufacturer's requirements. For Amarillo Gear, our gears are designed and rated to AGMA standards so we also adopt their recommendations for proper maintenance of the gear box and this includes periodic inspections for oil leaks and oil changes. Some customers opt to use our GSU, which is our gear box service unit to periodically filter the oil. Use of this filter along with periodic sample testing can extend the time between oil changes and help the gear box achieve maximum design life.*

**Q2: As Amarillo Gearbox specialists, why do you think gearbox lubrication, or lack there of, is such a common issue?**

*We realize maintenance budgets are sometimes cut and some owners choose the "pay later" option by not spending a little to maintain the gear box now. The minimal cost to maintain the gear box now will reap bigger rewards by extending the gear box life significantly.*

**Q3: Amarillo Gear Company has many years of experience dealing with gearboxes. Drawing from this experience, why is gearbox maintenance so important?**

*In the scope of the tower cost, the gear box cost is minimal. However, lost production because a cooling tower is down due to a gear box that was not properly maintained can cost the owner many times what a properly maintained gear box costs.*

**Q4: What suggestions would Amarillo Gear have for implementing a successful gearbox maintenance strategy?**

*Follow the recommendations in the manufacturers published Operations and Maintenance manual for optimum gear box life and reliability.*

**Q5: What other top gearbox issues do you see and what advice would you give?**

*None really come to mind. The Amarillo Gear fan drive is one of the most reliable gear boxes designed and built today. Sometimes other gear manufacturers design and rate to lesser standards than AGMA. According to CTI STD 111, the gear box should be properly sized to an AGMA Service Factor of 2.0 on the motor power. Gears not designed or rated to the AGMA standards for fan drives or sized to fan absorbed power generally have a significantly shorter service life, no matter the maintenance program.*

**Q6: What is the best general piece of advice that you would give to Amarillo Gear customers?**

*Buy only gear boxes properly designed for the application with a long track record of reliability. This will insure that the manufacturer has done their part and then properly maintain the gear box for optimum reliability.*

**Q7: Tell us one fact that most people don't know about either Amarillo Gear Company or their Amarillo Gearboxes.**

*Some do not know that we still actually design and manufacture the gears that go inside the gear box. Since it is the most critical component, it is paramount that we control its quality and design. This is unusual in that some manufacturers have turned to outsourcing this component or even the entire gear box to cut costs. We are experts at gear design and it shows in the quality and reliability we provide.*

# Chapter 2

## HOW TO CHECK & ANALYZE YOUR GEAR OIL



# Checking your gearbox oil

Gearbox lubrication is commonly the largest issue related to gearbox failures. Be sure to check your oil. There are three reasons to check your oil. First is to check the oil level and make sure that it is not low. Second, debris can mix with the oil causing failure. Third, humidity can increase the water content in your oil, thinning it out and also causing failure. It is recommended by Amarillo Gear Company to change your oil every six months or at 2,500 hours.

Additionally, we suggest maintaining your gear oil by draining the water off of the bottom of the oil sump or filter the oil through an oil filter.

## *EXTRA TIP:*

Just as you maintain your car at a certain number of miles, your gearbox oil **NEEDS** to be changed every 2,500 hours or every six months.



## Checking Your Oil

# Analyzing your gearbox oil

## How do you select and read your oil sample?

Well, selecting and reading your oil sample analysis can be an art in itself, so be sure to request the **Karl Fisher analysis**. The Karl Fisher analysis will provide accurate water content. This will help to paint the picture you're looking for. Water content should be below .01%. Every analysis should include viscosity and a total acid number (TAN). An increase in both the viscosity and TAN indicates oxidation and your oil should be changed immediately. If you see a high particulate count, this means that damage may have already occurred to your gearbox. If this happens, your gearbox will likely need to be repaired.

When it comes to **selecting the right oil for your gearbox** make sure that it follows these manufacturer recommended guidelines:

Extreme Pressure or "EP" additives do not come recommended. They have been proven to cause damage to the internal lining of the gear case over time. Additionally, EP additives will significantly reduce the bearing life at high operating temperatures. Instead use a 220 viscosity oil (either mineral or synthetic). If you are using a mineral oil please note that the minimum operating temperature is 20°F and the maximum operating temperature is 180°F. For synthetic oils the minimum operating temperature is also at 20°F and the maximum should be at 220°F.

Synthetic oils generally last longer and handle higher temperatures better. For a little more in oil cost you can help extend the overall life of your drive. Next time you order a new gearbox ship it with synthetic oil! If you are in a colder climate and oil temperatures fall below 20°F, consider adding an oil heater.



Analyzing  
Your Oil

# Ask the Expert:

## Avoiding gearbox failures

By: Mandy Parks,  
Component Sales Manager  
Cooling Tower Depot, Inc



**Q1: From a customer support and sales perspective, how does gearbox failure affect cooling tower cost and performance?**

*I have been supporting customers with cooling tower parts for 11 years. In my experience, the biggest cost pertaining to gearbox failure will be unscheduled downtime. Additionally, likely damage to surrounding mechanical equipment can be quite costly. I further recommend having a spare gearbox to shorten downtime, and to avoid pricey expedited shipping expenses.*

**Q2: Proper lubrication is the key to gearbox performance and lifespan. What additional suggestions would you have to help easily maintain lubrication and prevent failure?**

*There are many additional items to help keep a gearbox from failing. The most important option that*

*I recommend everyone having is an oil level switch to monitor oil levels. This will alert the maintenance team when oil levels fall too low. The second most common item I recommend is an oil sight glass so that the maintenance team can easily check oil levels. There are many other important options to discuss, such as oil pumps, heater and thermostat monitors, non-reverse adders, vibration switches etc. Each of these significantly help reduce the likelihood for gearbox failure. However, in my opinion, oil level switches and the oil sight glass are definite must haves!*

**Q3: By not checking or changing your oil, how quickly can gearbox failure happen?**

*If you are not taking the necessary precautions to check or change your oil, gearbox failure is indefinite. It will likely take around 2 years for your gearbox to fail. If you maintain your gearbox properly a gearbox can last 10 -15 years.*

# Chapter 3

KEEP YOUR GEARBOX  
RUNNING



# Checking the seals

Now that you have selected the right motor operation and the right oil, how can you keep your gearbox operating the way you want it to?

One way is to check the seals. The standard Nitrile Rubber seals on the input shaft of your gearbox will generally last 3-5 years (under continuous operation). They can easily be changed in the field, and will help ensure proper oil levels at all times.

## *Our Advice:*

**You can upgrade your seals to Viton. Doing this will allow you to get the most life out of your seals!**

Check  
Your  
Seals



# Monitor your vibration

Another way to ensure a long lasting gearbox is to monitor vibration. Vibration switches work well in preventing a catastrophic failure. We recommend a vibration switch that is mounted outside the fan stack to avoid corrosion of the internal mechanism. The plenum area is a harsh and corrosive environment, and locating switches outside the stack make it much easier to access for resetting and maintenance...you won't have to get a confined space permit! Consider using a vibration transducer to help you with diagnostics.

## *EXTRA TIP:*

**For the best in vibration monitoring consider using a vibration transducer. The transducer gives a much more accurate reading and can help with diagnostics and the prevention of a catastrophic failure.**

Vibration

# OVERVIEW

## Preventative maintenance & gearbox failure



Large torque spikes cause gear teeth damage. Use a NEMA Design B motor to limit starting torque.



Look into a non reverse adder to counteract your fan from the reverse wind milling effect.



It is important that VFD's are set up correctly. Also be sure that you are operating your gearbox under manufacturer guidelines.



**Check your oil, analyze your oil, and change your oil.**



Stay away from “EP” additives in your oil.



Monitor gearbox vibration with vibration switches.



# About Us



## A Proven Record:

Cooling Tower Depot (CTD) has been a proven cooling tower supplier for field-erected mechanical draft cooling towers with decades of experience in cooling tower design, engineering, construction, and project management.

## An Innovative Leader in Custom Design

Whether it is fiberglass, wood, or a concrete cooling tower, CTD will provide the right solutions for your inspections, repairs, replacements, upgrades, or new tower construction and design. **With the only custom cooling tower design App in the industry**, you can design and price your own cooling tower! You can rest assured that you are receiving the BEST cooling solutions, for your needs!

## Taking the Guess-Work Out:

We have continuously worked hard to provide you with easy and accessible information. This is why we have created the ONLY on-line warehouse for your cooling tower parts. No guess-work, no hidden costs, just simple pricing.

## Gearbox Resources

### Amarillo Gear Company:

[www.amarillogear.com/downloads](http://www.amarillogear.com/downloads)

### Cooling Tower Depot:

[www.coolingtowerdepot.com/content/parts/amarillo-cooling-tower-gearboxes](http://www.coolingtowerdepot.com/content/parts/amarillo-cooling-tower-gearboxes)

### iGearbox for iPhone:

[www.itunes.com](http://www.itunes.com)