



Webinar Series



Presented By: John Lee



Preventative Maintenance

More than Just a Grease Gun

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Topics/Sections Covered

- Definition of Preventative Maintenance (PM)
- Benefits of PM
- Reasons for Preventative Maintenance (PM)
- Types of PM
- How to Document PM
- OSHA Requirements/Safety Considerations
- Lubrication
- Drive Belts



Definition of PM

The planned:

- Inspection,
- Monitoring, cleaning
- Adjusting and/or
- Servicing

Performed to maintain and restore the equipment before failure occurs and maintain optimum performance





REASONS FOR PREVENTATIVE MAINTENANCE

Benefits of PM

- Planning down time
- Avoiding breakdown during busy times
- Maintaining compliance
- Optimize performance of machinery
- Controlling product and process safety
- Controlling cost
- Avoiding disasters



Real time video of an explosion

Eureka Elevator West Side
and East Side Combined



Bearing Failure: #1 Most Common Ignition Source (My experience)

Pillow Block Bearing failed causing this explosion



Types of Maintenance

1. Breakdown Maintenance/Run-to-Failure/Fire-Fighting
2. Preventive Maintenance/Planned/Time-Based/Calendar-Based
3. Predictive Maintenance/Condition-Based/Condition Assessment
4. Proactive Maintenance/Precision/Reliability-Based



Run to Failure or Reactive Maintenance

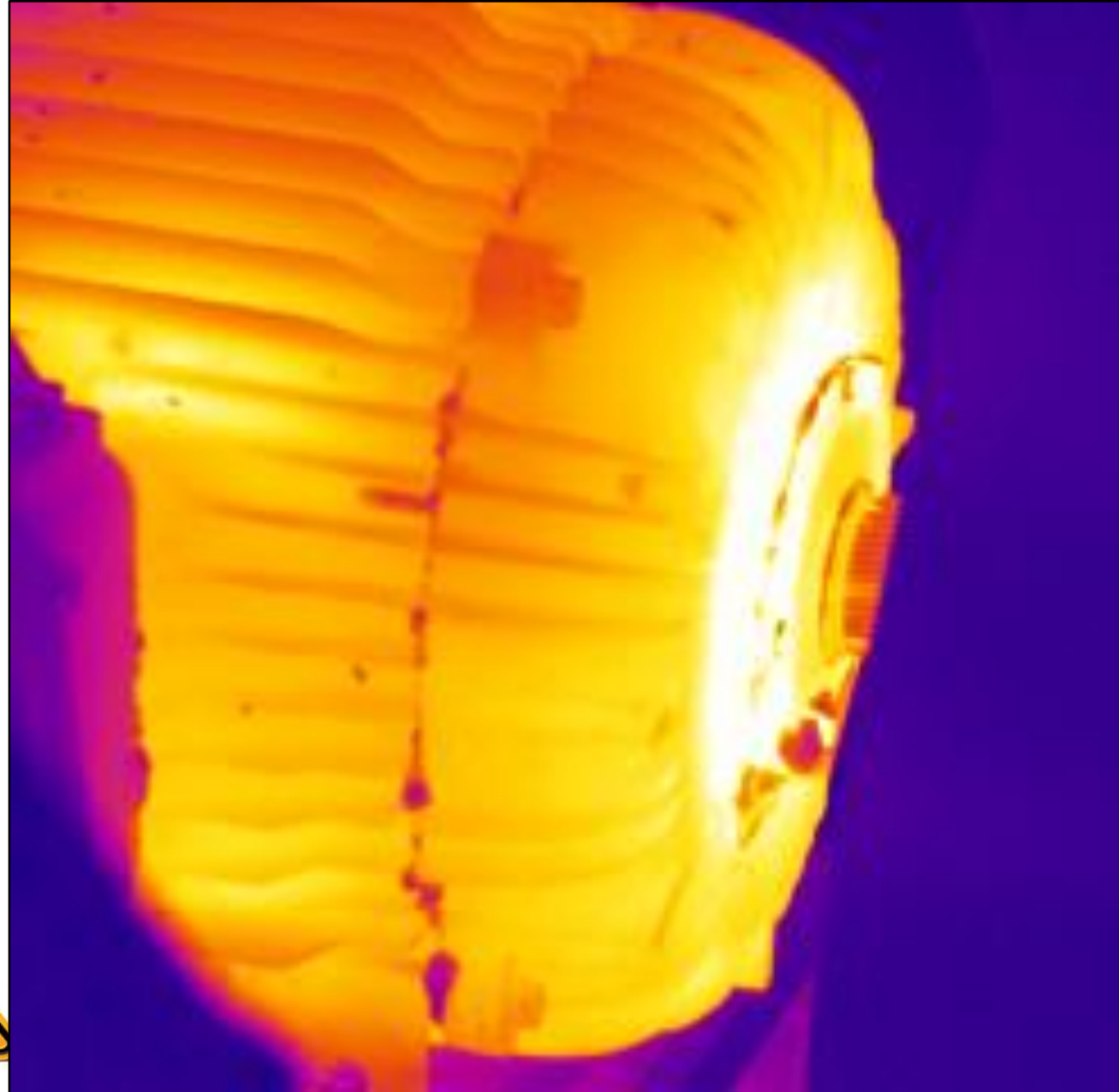
- Run it until it breaks, then fix or replace it = Very high maintenance costs
- Safety & production problems



IR Applications



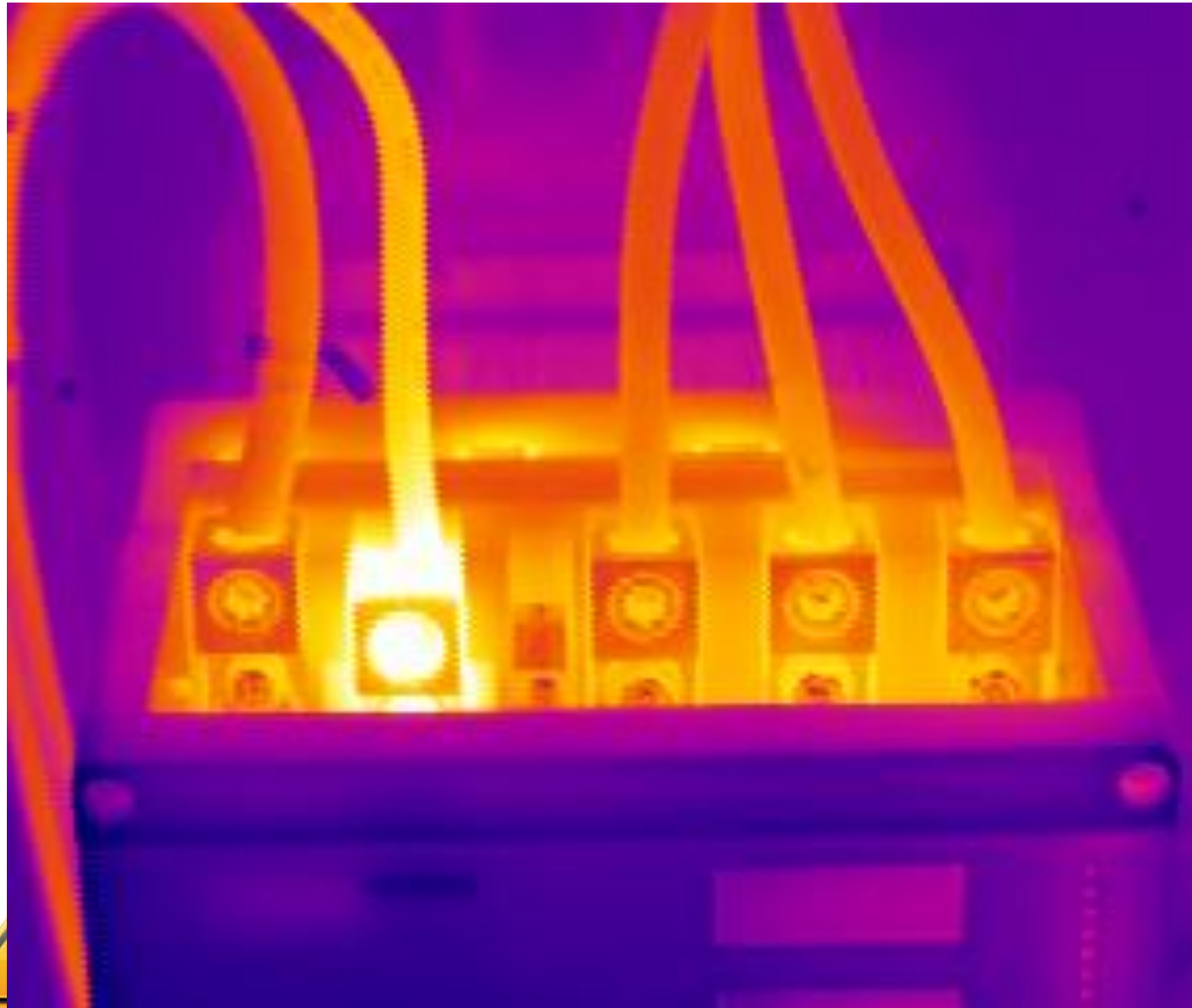
- Electric motor bearing heating
- The bearing temperature should be monitored until the situation can be investigated further



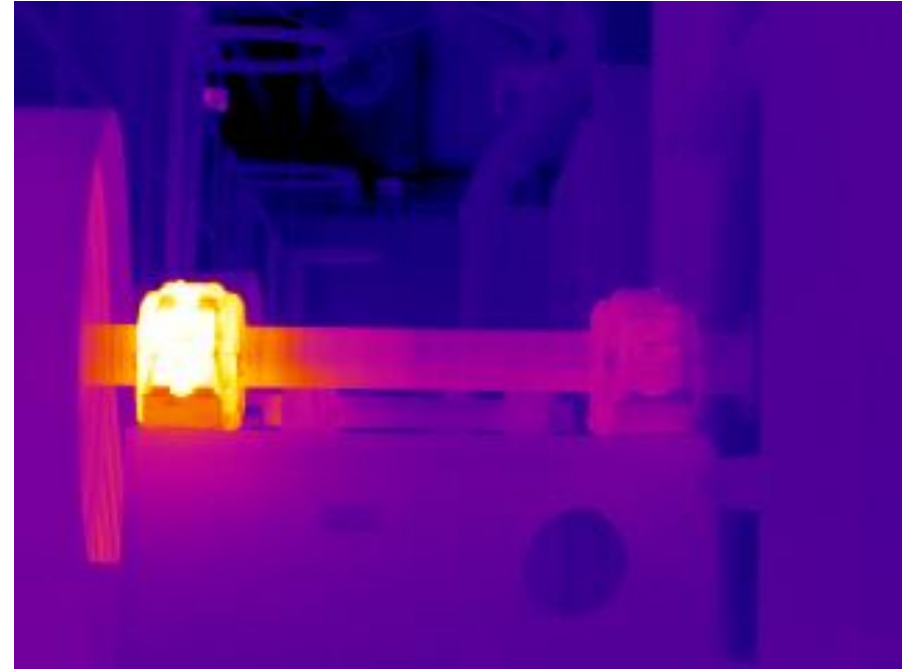
IR Applications



- Variable speed DC drive unit
- The 2nd connection from the left is deficient and requires repair



IR Applications



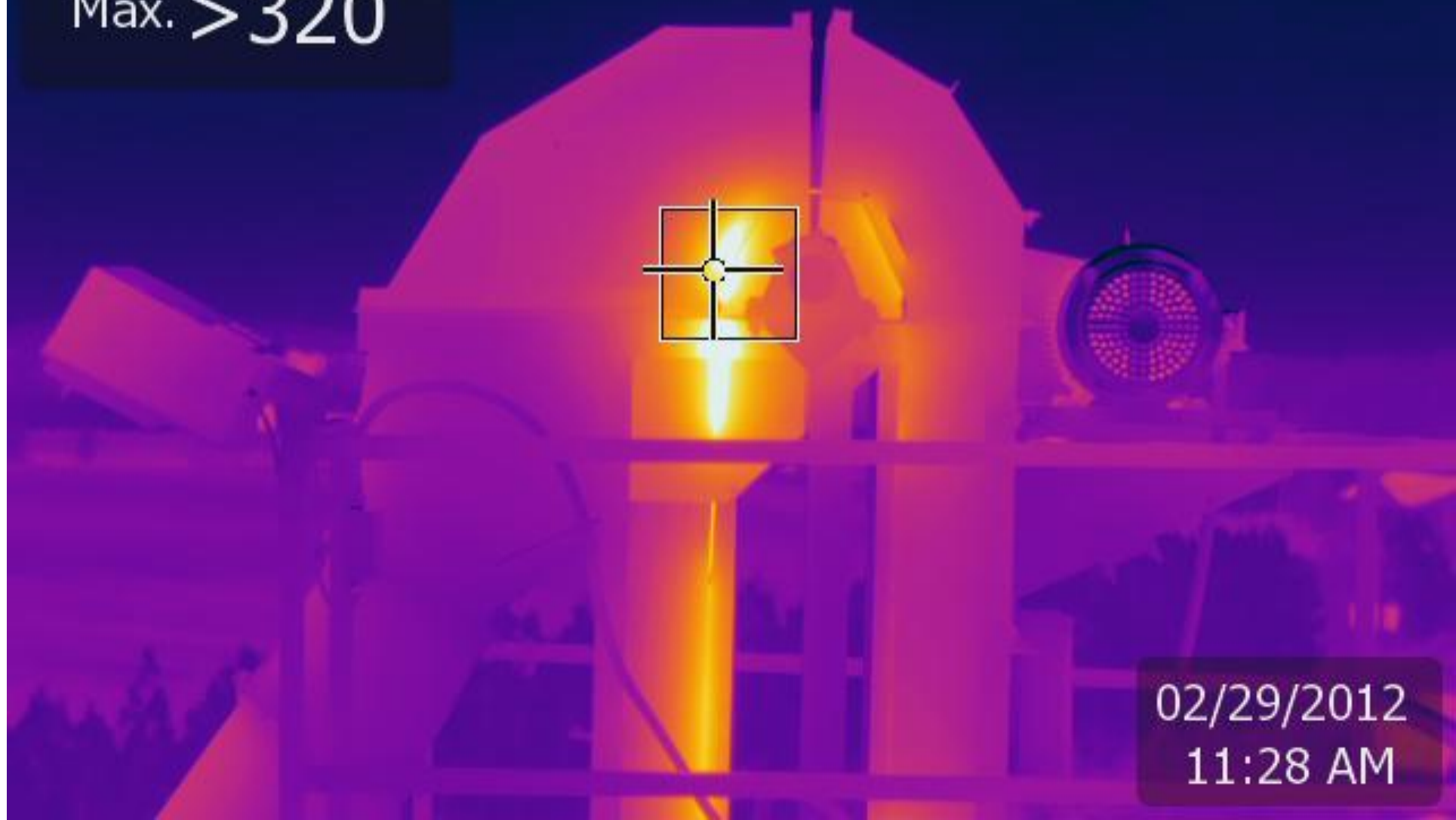
- The left pillow block bearing is operating at a higher temperature than the right one
- Lubrication and alignment should be checked. Also check to ensure proper bearings are installed.



Spot 169 °F

Box

Max. >320



02/29/2012
11:28 AM





OSHA REGULATIONS/SAFETY CONCERNS

Preventative Maintenance 1910.272(m)

- Regularly scheduled inspections of at least the mechanical and safety control equipment associated with **dryers**, **grain stream processing equipment**, **dust collection equipment** including filter collectors, and **bucket elevators**
- Lubrication and other appropriate maintenance in accordance with manufacturers' recommendations, or as determined necessary by prior operating records

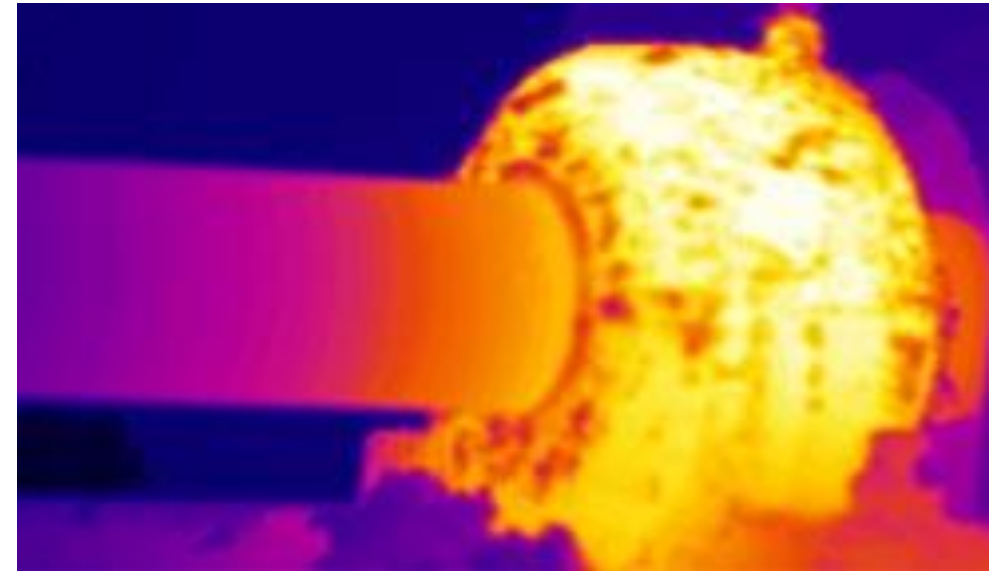


Preventative Maintenance 1910.272(m)

Promptly correct dust collection systems which are malfunctioning, or which are operating below designed efficiency.

Promptly correct, or remove from service, overheated bearings and slipping or misaligned belts associated with inside bucket elevators.

FIX THIS ON ALL EQUIPMENT!!



Preventative Maintenance 1910.272(m)

Certification record for each inspection:

- Containing the date of the inspection
- The name of the person who performed the inspection
- Serial number, or other identifier, of the equipment
- Date-Name-Identifier






Preventative Maintenance 1910.272(m)

Osha Wants:

- Equipment list
- List of work to be done
- Frequency of Inspection / Maintenance
Calendar reminder or similar

Machine: Lower Belt

Machine Type: Basement Belt Conveyor

Scheduled Job Plans					
		Work Order		Scheduled Date	Frequency
	WO	744311	Maintenance on Falk Type F Steelflex Couplers ...	2/15/2016	3 Years
	WO	1804666	Basement Belt w/ Gearmotor and Trip Wire Inspection ...	2/21/2016	Monthly
	WO	1474446	Oil Testing/Changing for Link-belt, Falk, Rexnord, and Westinghouse Reducers ...	3/24/2016	Annual



78' Unload Leg (Monthly Inspection)

- Inspect and grease bearings [head and tail]
- Check drive belts
- Check elevator belt for tension, alignment and broken or missing cups
- Check gearbox oil
- Note any unusual sounds or concerns and list necessary repairs

Date	Initials	COMMENTS	
		[PM Performed ex. Head bearing drive side .5 oz. of grease]	
6-25-19	SS	<div>Head</div> D-10P I-10P	<div>Tail</div> N-10P S-10P motor- 2 pumps each end
7-29-19	SS	<div>Head</div> D-15P I-10P	<div>Tail</div> N-17P S-10P
8-26-19	BB	<div>Head</div> D 1,2 oz I 1,1 oz	<div>Tail</div> N-15 S-17

Unload Grandpa Overhead (Monthly Inspection)

- Inspect and grease bearings [head and tail]
- Check drive belts
- Check chain tightness and appearance
- Check gearbox oil
- Note any unusual sounds or concerns and list necessary repairs

Date	Initials		COMMENTS	
			[PM Performed ex. Head bearing drive side .5 oz. of grease]	
1-30	BB		<div>Head</div> <div>D 1.2</div> <div>I 1.1</div>	<div>tail</div> <div>D .7</div> <div>I .8</div> <div>motor bearings</div> <div>Sound load</div>
2-28	BB		<div>Head</div> <div>D 1.0</div> <div>I 1.1</div>	<div>tail</div> <div>D .8</div> <div>I .3</div>
1-29	BB		<div>Head</div> <div>D 6.0</div> <div>I 5.3</div>	<div>tail</div> <div>D .7</div> <div>I 1.3</div> <div>Adjusted</div> <div>Bucket Belt</div>
1-29	BB		<div>Head</div> <div>D 8</div> <div>I 3</div>	<div>tail</div> <div>D 7</div> <div>I 3</div> <div>Liter replaced in</div> <div>Distributor</div>

Facility Name _____
Leg inspected _____

Inspected by _____
Date inspected _____

Bucket Elevator Inspection Checklist

Note: *Italics indicate checks are made with leg operating. All other checks performed after leg is locked out, tagged and start switch tested to confirm leg is locked out.*

Drive system

- ___ ***No unusual noise or vibration***
- ___ Motor fan cooling fins clean and free of debris
- ___ Motor bearings greased
- ___ Electrical conduit shows no signs of damage, junction box properly sealed
- ___ Mounting bolts / brackets tight and secure
- ___ Clean reducer and check for leaking oil seals and loose mounting bolts
- ___ Check oil level, drain plug secure
- ___ Check coupling for wear and alignment, coupling greased per mfg. specifications
- ___ Check chain and sprockets for wear, damage, proper tension and lubrication
- ___ Check sprockets for alignment and tightness to the shaft. (For tightness check, look for signs of movement on the shaft.)
- ___ Check v-belts and sheaves for wear, damage, alignment and tension
- ___ Check condition of guards

Head Section

- ___ ***Check belt alignment and tracking on head pulley (belt in center of head pulley while running, no signs of rubbing)***
- ___ Check head pulley lagging for wear and damage (***Listen for clicking or flapping sound while running***)
- ___ Check head pulley for cracks or signs of wear, misalignment or movement on shaft
- ___ Check the bucket wiper for wear and proper setting (Should be set 1/2" to 3/4" from the cup)
- ___ Check the discharge spout for signs of material buildup, loose or worn lining, worn or missing anchor bolts
- ___ Check doors and door seals
- ___ Check shaft dust seals for leakage
- ___ Clean & lubricate bearings, check set screws and mounting bolts for tightness (***Bearings show no signs of unusual noise, vibration or wear***)
- ___ Check vents for plugging
- ___ Check casing for wear, damage, and loose or missing bolts

Leg casing

- ☐ Inspect vents and explosion relief panels
- ☐ Casing has no signs of leakage
- ☐ No signs of belt rubbing
- ☐ Check guy wires, wire rope connections, cross bracing & knee bracing

Bend / Knee Pulley Section

- ☐ ***No signs of unusual noise, vibration, or movement***
- ☐ Check the bend pulley for wear
- ☐ Hub bolts / set screws tight, check for signs of movement on shaft, check for weld cracks on pulley ends
- ☐ Access doors secured, door seals no signs of leakage
- ☐ Check shaft dust seals for leakage
- ☐ Clean and grease bearings, set screws tight, no signs of shaft movement

Boot Section

- ☐ ***Check belt alignment & tracking on tail pulley – with & without load***
- ☐ ***Floating take-up system operating freely***
- ☐ Screw take-up system adjusted and lock nuts secure
- ☐ Check the tail pulley for signs of wear, weld cracks on pulley ends, misalignment or movement of shaft
- ☐ Access doors secured, door seals no signs of leakage
- ☐ Check tail pulley shaft dust seals for leakage
- ☐ Clean & lubricate bearings
- ☐ Check casing for wear, damage, and loose or missing bolts

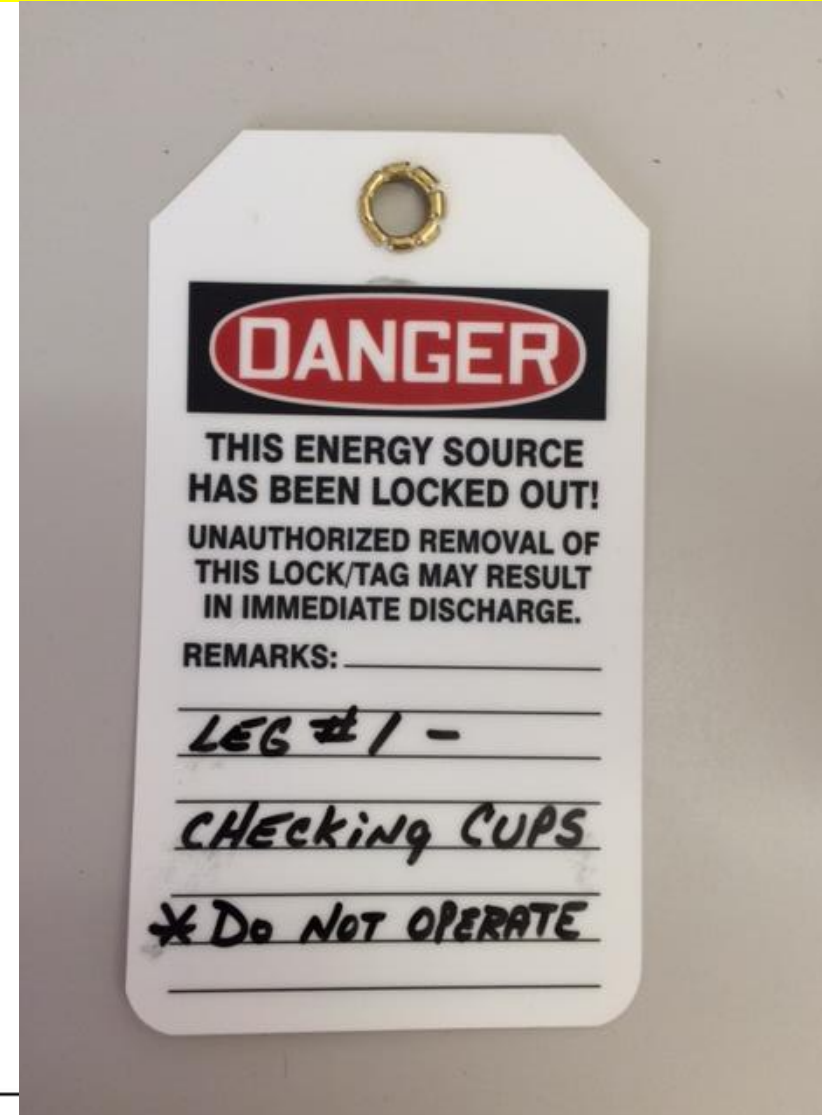
Belt / Buckets

- ☐ Check the belt for wear and damage (front & back side)
- ☐ Check the belt splice for wear and damage (front & back)
- ☐ Check the stretch of the belt (should be performed annually)
- ☐ Check for loose, worn or damaged buckets
- ☐ Check for worn, damaged, or missing bucket bolts

Preventative Maintenance 1910.272(m)

Locks and Tags

- Need a lock out tag-out program
 - prevents the inadvertent application of energy or motion to equipment
 - Removal procedures



Common OSHA Citations

- Failure to keep certification record
- Lubrication and Maintenance not to manufacturers spec.
- Lack of regular inspections
- Lack of LOTO Procedures
- Recently, the highest average OSHA fine per citation (lack of PM program) is \$58,000



Location of accident




Employee lost ends of 3 fingers because the v-belt guard was off and not LOTO



Workers have lost fingers changing v-belts.
Most common cause is unexpected startup.
LOTO eliminates that hazard.





Experienced employee lost two fingers trying to put a cover back on a running drag conv. The lid got caught on a paddle and flung his hand back violently into other equipment.

Lock Out/Tag Out/Try Out

Controls energy sources

- De-energize, isolate **ALL** power sources

Prevents unexpected start-up

When to LOTO

- Before maintenance or service
- **If Guards are removed**

VERIFY DEENERGISED!!





Equipment covers must be removed for maintenance and adjustments. When employees could be in contact with moving equipment it must be LOTO. Or alternative guarding should be used.

For inspection safety a temporary expanded metal guard is bolted in place. So employee can observe the leg while it is operating.

Guarded inspection door

Guarded inspection door

Other LOTO

- Prior to splitting a belt or working on a belt that could spin due to gravity:
 - Clamp or otherwise secure the belt from spinning
 - LOTO is not just for electrical equipment



Access to Equipment



Access to Equipment



Hot Work?



Hot Work: # 3 Most Common Ignition Source



Hot Work 1910.272 (j)

- **HOT WORK** is any work that creates open flames, sparks, or high temperatures (real life – OSHA is more limited)
- Welding, cutting, brazing, soldering, and grinding
- Hot Work can **IGNITE GRAIN DUST**
- Use a **Hot Work Permit system** to control hazards



Hot Work 1910.272 (j)

Exceptions

- No permit needed if the person who would fill out the permit is present
- In the welding shop
- Outside the grain handling facility in authorized area



Permit Procedures

1910.272 (j)

- Inspect the site
- Evaluate the job
- Approve only sound methods
- Ensure precautions are in place before issuing the permit.
- Fill out the permit after full consideration.
- Sign and date to authorize the hot work.
- Retain the permits on file.

HOT WORK PERMIT

Before issuing this permit, have you checked to see if this work can be removed from the hazardous location or if the repairs can be made in a safer manner?

DESCRIPTION OF HOT WORK TO BE PERFORMED: _____

LOCATION: _____

SAFETY REQUIREMENTS

1. Management or its authorized representative has inspected the area where hot work is to be performed.
2. Contractor performing hot work has been advised of hazards.
3. Shut down the grain handling facility and lock out and tag all handling equipment in work area (conveyors, motors, legs, pumps, etc.)
4. Sweep or clean grain dust and other combustible or flammable materials from a 35-foot radius of the hot work area.
5. Shield or cover all exposed combustible materials within 35-foot radius of hot work area to protect from heat and sparks.
6. Wet down or cover floors, walls and surrounding areas where hot work is to be done. Spouts, ducts, floor, wall openings and bin openings tightly covered and sealed.
7. Provide fire extinguisher and/or water supply provided at hot work site.
8. Automatic sprinklers operational (where provided).
9. Welding and cutting equipment checked and in safe condition before use.
10. Personal protection equipment provided to those performing hot work.
11. Fire watch established in hot work area for at least 30 minutes after welding and cutting finished. (Periodic walk-throughs of work area for up to four hours advised).
12. Surfaces cooled before grain handling equipment and plant operations restarted.
13. Final check of area at closing time.

Yes	Not Applicable	Initials
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PERMIT REQUESTED BY _____ DATE _____ TIME _____

WORK AUTHORIZED BY _____ PERMIT EXPIRES _____
(DATE & TIME)

WORK COMPLETED BY _____ DATE _____ TIME _____

Return to Manager upon completion of work.

This checklist prepared by: NATIONAL GRAIN & FEED ASSOCIATION
1201 New York Avenue, N.W., Suite 830
WASHINGTON, DC 20005
PH. 202-289-0873

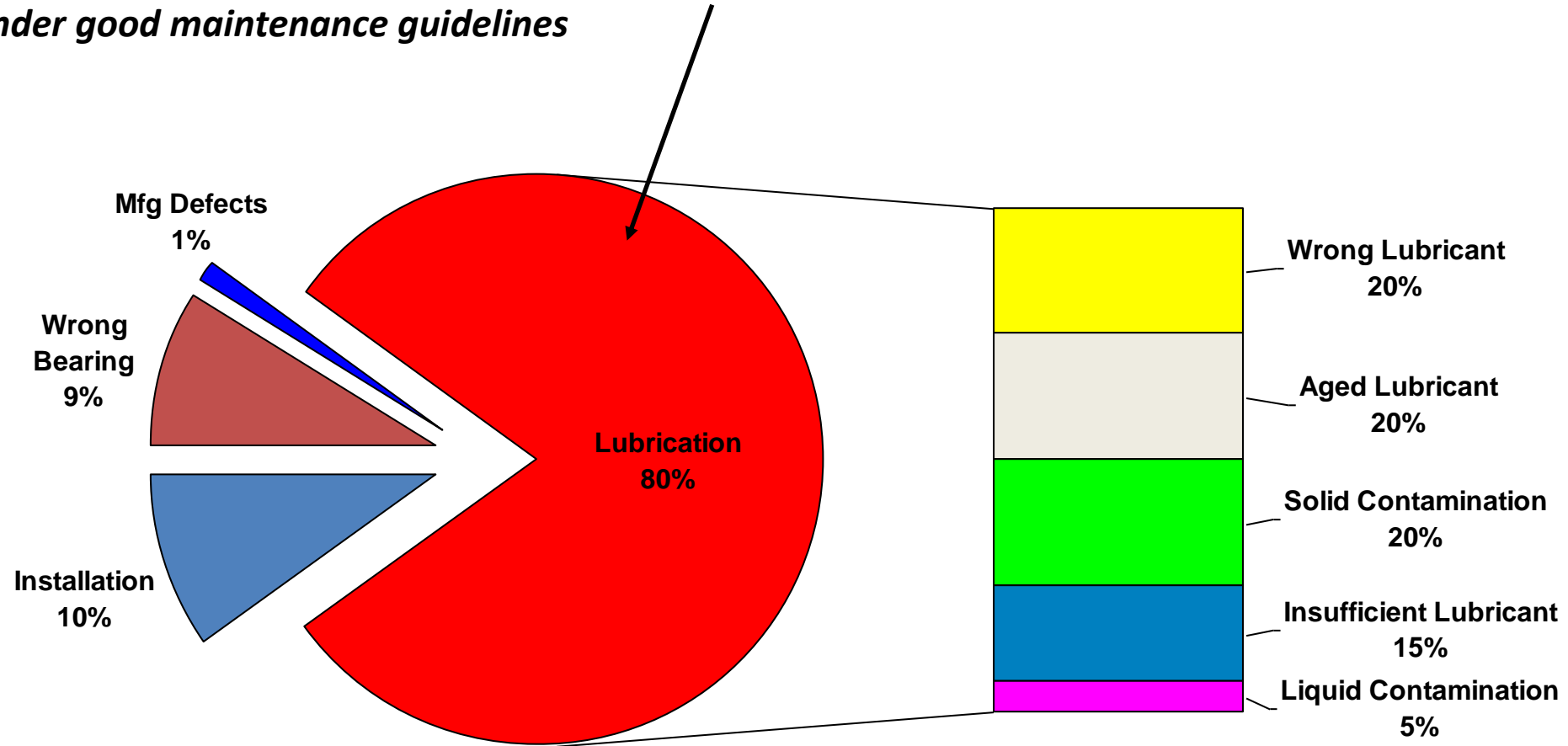
Other NGFA Checklists available.



LUBRICATION

Causes of Bearing Failures

55% of all premature bearing failures are lubricant related and an additional 25% are contamination related and could be minimized under good maintenance guidelines



Sample Company Leg Grease Procedure

- Lockout motor
- Remove the drain plug
- Inspect grease drain and remove any blockage with a mechanical probe.
- Add 20 pumps of new NLGI No. 2 grease at the grease inlet using a **hand operated grease gun**.
- Run the motor for 15-30 minutes with the drain plug removed to allow purging of any excess grease.
- Shut off motor and lockout.
- Replace the drain plug.
- Return motor to service.
- ***Follow manufacturer's instructions for your installation.***



Sample Company Grease Procedure

- For equipment running 8 hours per day and rotating less than 500 rpm, Dodge recommendation is every 12 weeks or quarterly
- For bearings on fans shafts that run over 1000 rpm, the recommendation is to grease monthly.
- Rule of thumb is **one pump for each inch of shaft diameter. 4-inch shaft would get 4 pumps**
- Type of Grease - #2 Lithium base grease or equivalent. **DO NOT MIX DIFFERENT TYPES OF GREASE.**
- Pump grease in slowly while equipment is running. Not more than one pump every 10 seconds. This will help prevent blowing out the seals
- If seals are blown out, additional greasing will be required.
- Clean up excess Grease



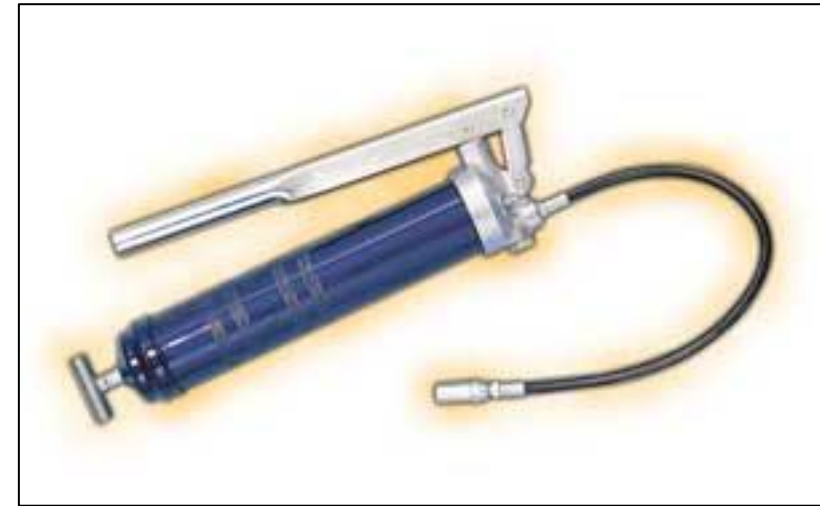
Grease Gun Performance

- Worker needs to know the output per stroke of the grease gun in order to know how much grease is added each time.
- A company surveyed 33 grease guns they varied .56-3.1 grams per pump.
- Age of a grease gun can effect the output too.



Hand Grip
.86 grams per pump

Vs



Lever Grip
1.28grams per pump



Case Study Leg Explosion

- Cause of the explosion was under greased bearing
- Company use the #pumps per shaft size rule.
- Another factor, they had changed brands of grease.
- One of the greases broke down the other.
- Experts said if they would have put more grease in it would have pushed the old grease out not allowing them to mix.



Hot, melted UHMW shaft seal





Grease Compatibility Chart

	Aluminum Complex	Barium Soap	Barium Complex	Bentone (Clay)	Calcium Stearate	Calcium 12 Hydroxy	Calcium Complex	Calcium Sulfonate	Lithium Stearate	Lithium 12 Hydroxy	Lithium Complex	Polyurea	Silica Gel	Sodium Soap
Aluminum Complex		I	I	I	I	C	I	B	I	I	C	I	C	B
Barium Soap	I		I	I	I	I	B	B	B	I	B	I	C	I
Barium Complex	I	I		I	I	C	I	C	I	I	I	I	I	I
Bentone (Clay)	I	I	I		C	C	I	I	I	I	I	I	C	I
Calcium Stearate	I	I	I	C		C	I	C	C	B	C	I	I	I
Calcium 12 Hydroxy	C	I	C	C	C		B	B	C	C	C	I	I	I
Calcium Complex	I	B	I	I	I	B		I	I	I	C	B	I	I
Calcium Sulfonate	B	B	C	I	C	B	I		B	B	C	I	B	I
Lithium Stearate	I	B	I	I	C	C	I	B		C	C	I	C	I
Lithium 12 Hydroxy	I	I	I	I	B	C	I	B	C		C	I	I	I
Lithium Complex	C	B	I	I	C	C	C	C	C	C		I	C	I
Polyurea	I	I	I	I	I	I	B	I	I	I	I		I	I
Silica Gel	C	C	I	C	I	I	I	B	C	I	C	I		I
Sodium Soap	B	I	I	I	I	I	I	I	I	I	I	I	I	

C = Compatible

I = Incompatible

B = Borderline

Why Polyurea Grease Used in Motors?

- This type of grease prolongs the life of electric motors
- Highly resistant to oxidation or rust and corrosion
- Resist water spray off
- Has very low oil separation qualities
- It will not bleed into motor windings



How to prevent mixing greases in motors?

- Use a different style of grease fitting for different greases
- Have one grease gun for electric motors with polyurea grease



Pressure-relief
Vent Fitting



Flush-type
Grease Fitting



Standard
Hydraulic
Grease Fitting



Button-head
Fitting



So how much grease should I put in bearings?

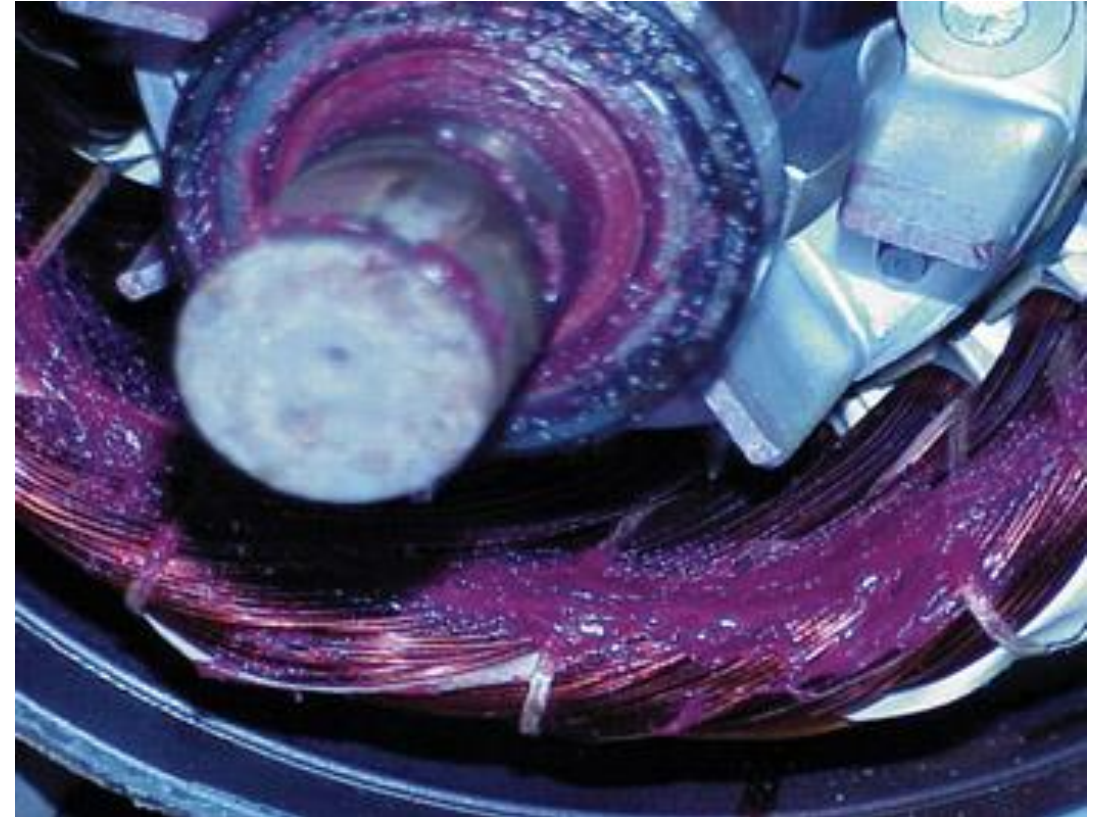


Over greased bearings

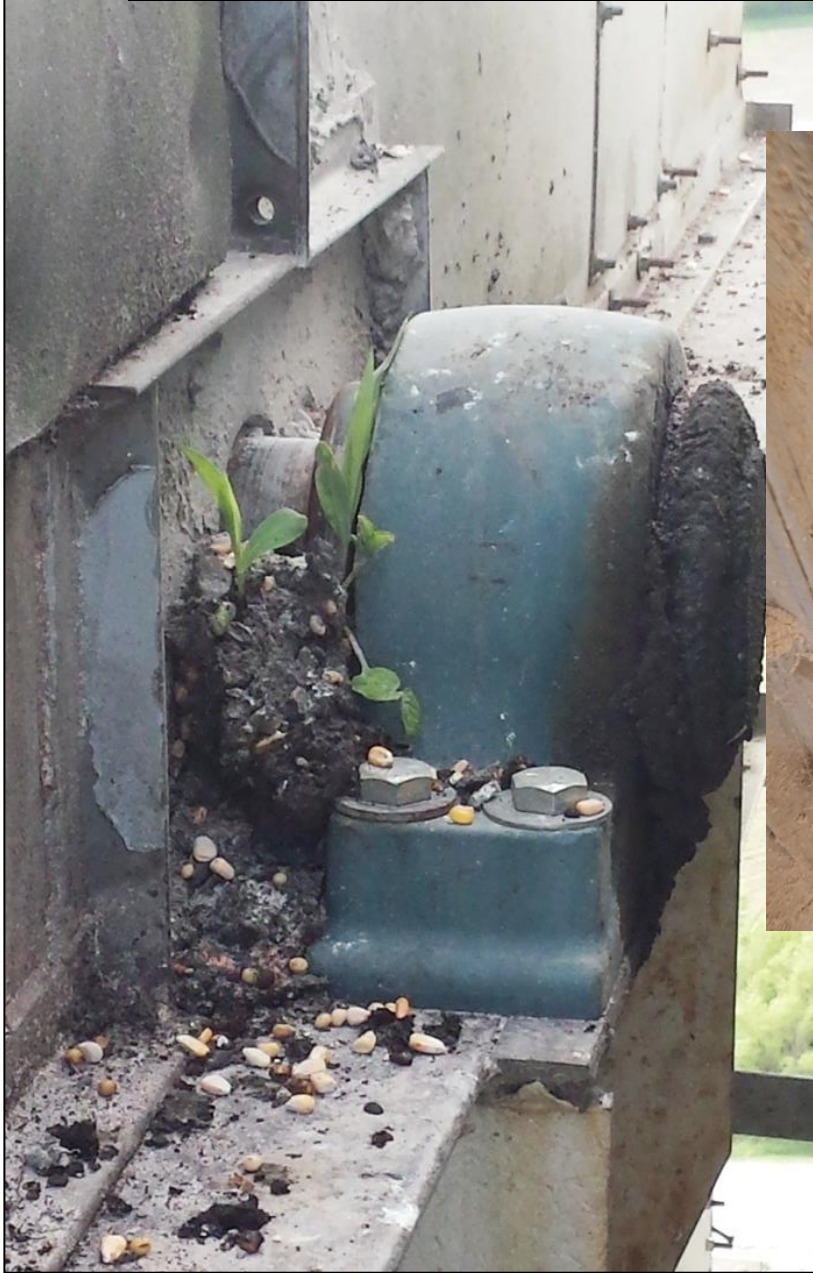


Over greasing Bearings Causes

- Too much grease causes a churning effect, pushing it out of the way
- Creates energy loss & hotter running bearing
- Causes chemical degradation and oil bleed
- Can cause crusty residue that won't allow grease into the bearing.
- Premature failure
- Fuel/fire hazard



Bearings need to be cleaned of debris and excess grease



Greasing Summary

- Grease while the bearing is rotating if it is safe to do so.
- Clean tip of zerk and grease gun.
- Pump proper grease into zerk until fresh clean grease is seen purging under and past the seal lip.
- Clean up excess grease that is around the bearing.
- May need to come back and clean up grease again as it continues to purge.



Make sure employees know how grease gun works?

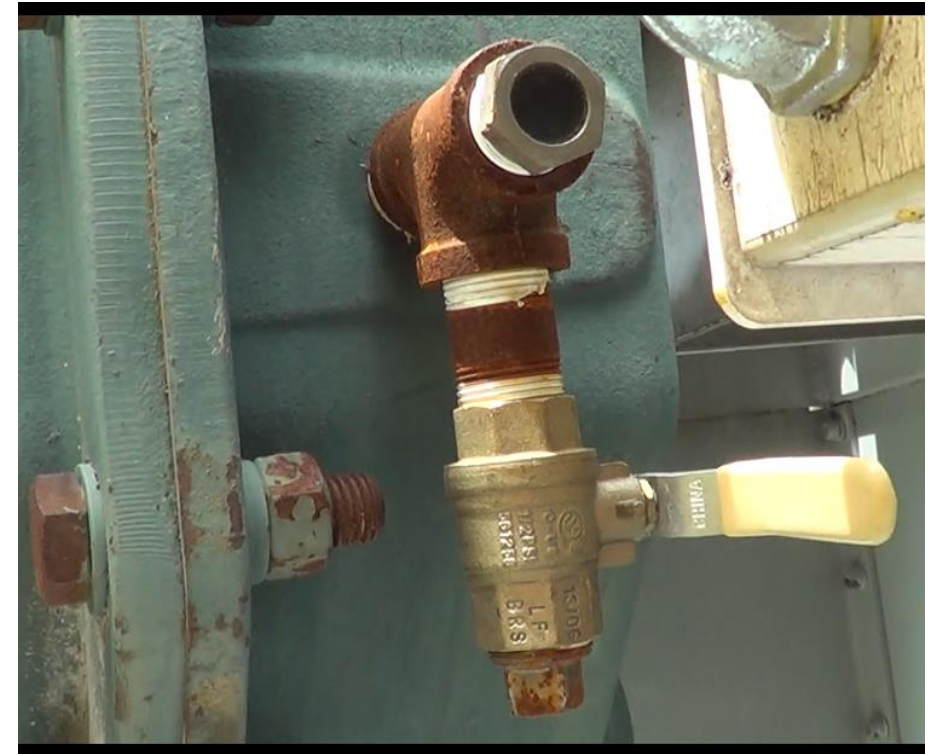


Grease goes in not on the bearing



Gear Box

- Change Oil Annually, Or
- Send oil samples in annually and follow recommendations from tribology report.
- Follow manufacturer recommendation if different from above.



Installing drain valves makes sampling and draining much easier

SAMPLE DATE	PROCESS DATE	EQUIPMENT METER	METER ON FLUID	FLUID CHANGED	MAKE UP FLUID	MAKE UP FLUID UNITS	FILTER CHANGED
12/4/13	12/10/13	0	0	No			Unknown

FIRST SAMPLE/NO TREND ESTABLISHED. NEED TO KNOW MAKE AND MODEL TO PROPERLY EVALUATE DATA. IRON APPEARS HIGH BUT COULD BE NORMAL FOR EQUIP DESIGN/APPLICATION. IF NO ABNORMAL NOISE / PERFORMANCE ARE NOTED AND THERE IS NO ABNORMAL METAL ON THE MAGNETIC PLUG(S) THEN RESAMPLE AT NORMAL INTERVAL TO ESTABLISH A TREND. PLEASE FILL OUT LABELS COMPLETELY. INCLUDE SERVICE METER READING ON ALL SAMPLES.

Drive Belts

V Belts

Check Tension on belts

- Noise can be caused by loose tension or worn belts/sheaves
- Watch for excessive tension on belts
 - Too much and you will break off the input shafts or motor shaft and wear out bearings early
- Watch for overhung loads
 - For every inch out on the shaft it doubles the load on it

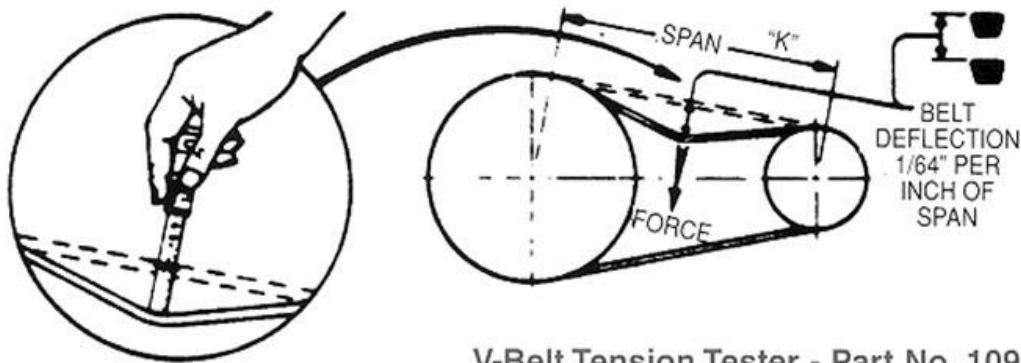


V-belt Tensioning Tool

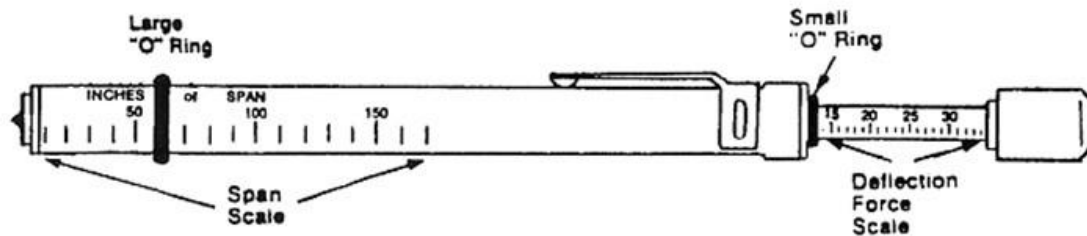
V-Belt Tensioning

Check Tension with Tension Tester

Desired Deflection = $\frac{1}{64} \times \text{Length of Span @ Force From Chart}$



V-Belt Tension Tester - Part No. 109082



V-Belt Tensioning

Table 13-Minimum Belt Deflection Force in lbs. (Consult DODGE for conditions not covered in this table.)

V-Belt Section	Small Sheave		Deflection Force in lbs. for Drive Speed Ratio of:			
	Speed Range	Dia.	1.0	1.5	2.0	4.0+
A (AP)	1800-3600	3.0	2.0	2.3	2.4	2.6
	1800-3600	4.0	2.6	2.8	3.0	3.3
	1800-3600	5.0	3.0	3.3	3.4	3.7
	1800-3600	7.0	3.5	3.7	3.8	4.3
B (BP)	1200-1800	4.6	3.7	4.3	4.5	5.0
	1200-1800	5.0	4.1	4.6	4.8	5.6
	1200-1800	6.0	4.8	5.3	5.5	6.3
	1200-1800	8.0	5.7	6.2	6.4	7.2
C (CP)	900-1800	7.0	6.5	7.0	8.0	9.0
	900-1800	9.0	8.0	9.0	10.0	11.0
	900-1800	12.0	10.0	11.0	12.0	13.0
	700-1500	16.0	12.0	13.0	13.0	14.0
D (DP)	900-1500	12.0	13.0	15.0	16.0	17.0
	900-1500	15.0	16.0	18.0	19.0	21.0
	700-1200	18.0	19.0	21.0	22.0	24.0
	700-1200	22.0	22.0	23.0	24.0	26.0
AX	1800-3600	3.0	2.5	2.8	3.0	3.3
	1800-3600	4.0	3.3	3.6	3.8	4.2
	1800-3600	5.0	3.7	4.1	4.3	4.6
	1800-3600	7.0	4.3	4.6	4.8	5.3
BX	1200-1800	4.6	5.2	5.8	6.0	6.9
	1200-1800	5.0	5.4	6.0	6.3	7.1
	1200-1800	6.0	6.0	6.4	6.7	7.7
	1200-1800	8.0	6.6	7.1	7.5	8.2
CX	900-1800	7.0	10.0	11.0	12.0	13.0
	900-1800	9.0	11.0	12.0	13.0	14.0
	900-1800	12.0	12.0	13.0	13.0	14.0
	700-1500	16.0	13.0	14.0	14.0	15.0
DX	900-1500	12.0	16.0	18.0	19.0	20.0
	900-1500	15.0	19.0	21.0	22.0	24.0
	700-1200	18.0	22.0	24.0	25.0	27.0
	700-1200	22.0	25.0	27.0	28.0	30.0

V-Belt Section	Small Sheave		Deflection Force in lbs. for Drive Speed Ratio of:			
	Speed Range	Dia.	1.0	1.5	2.0	4.0+
3VX	1200-3600	2.2	2.2	2.5	2.7	3.0
	1200-3600	2.5	2.6	2.9	3.1	3.6
	1200-3600	3.0	3.1	3.5	3.7	4.2
	1200-3600	4.1	3.9	4.3	4.5	5.1
	1200-3600	5.3	4.6	4.9	5.1	5.7
	1200-3600	6.9	5.0	5.4	5.6	6.2
5VX	1200-3600	4.4	6.5	7.5	8.0	9.0
	1200-3600	5.2	8.0	9.0	9.5	10.0
	1200-3600	6.3	9.5	10.0	11.0	12.0
	1200-3600	7.1	10.0	11.0	12.0	13.0
	900-1800	9.0	12.0	13.0	14.0	15.0
	900-1800	14.0	14.0	15.0	16.0	17.0
8VX	900-1800	12.5	18.0	21.0	23.0	25.0
	900-1800	14.0	21.0	23.0	24.0	28.0
	700-1500	17.0	24.0	26.0	28.0	30.0
	700-1500	21.2	28.0	30.0	32.0	34.0
	400-1000	24.8	31.0	32.0	34.0	36.0
5V	900-1800	7.1	8.5	9.5	10.0	11.0
	900-1800	9.0	10.0	11.0	12.0	13.0
	900-1800	14.0	12.0	13.0	14.0	15.0
	700-1200	21.2	14.0	15.0	16.0	17.0
8V	900-1800	12.5	18.0	21.0	23.0	25.0
	900-1800	14.0	21.0	23.0	24.0	28.0
	700-1500	17.0	24.0	26.0	28.0	30.0
	700-1200	21.2	28.0	30.0	32.0	34.0
	400-1000	24.8	31.0	32.0	34.0	36.0
Note: 1. Use approximately 130% of above values to tension a new set of belts. 2. Use closest sheave dia. for sizes not shown						

Example:

V-Belt w/60" span using a 5VX Belt w/7.5" Small Sheave,

@ 1750 and a 1.05 Ratio

Length/64" = 60/64 = 0.9"
@ 10 lbs. Force

*If these are new belts add 30%

Therefore:

0.9" @ 13 lbs force

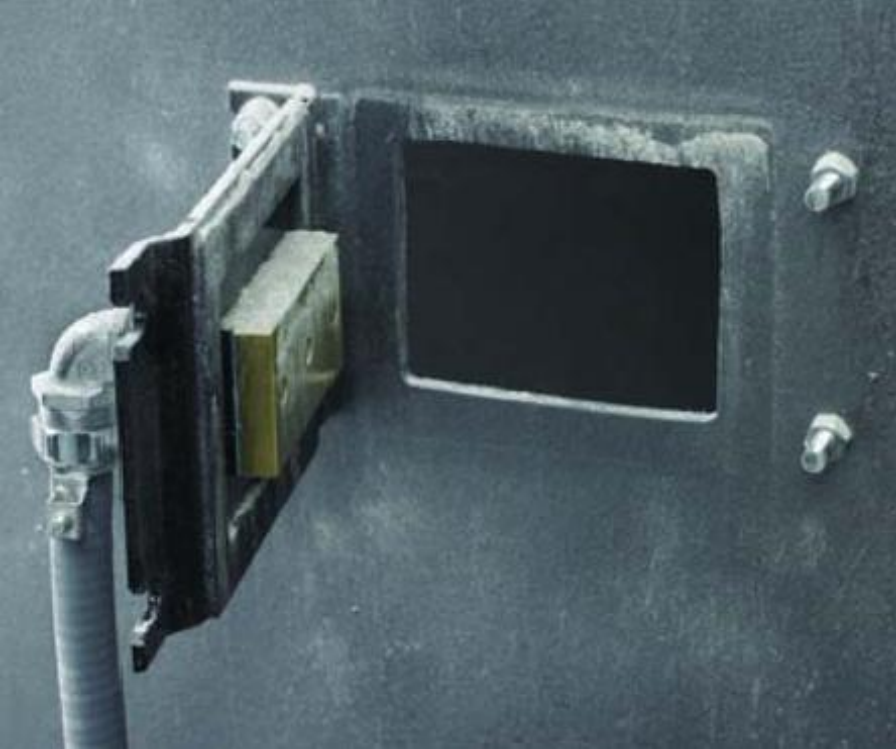
Belt Alignment



Aligning Sheaves



Hazard Monitoring must be installed correctly and operate correctly to be effective



Note: Inside legs are required to have Hazard monitoring



Conclusion

- A good maintenance program will save you money\$\$
 - Less down time and less expensive repairs.
 - Oil and Grease is less expensive than gearboxes and bearings
- Follow the PM program
- Record your findings
- Document
- Your equipment will be running at peak capacity when you need it most.



Protect our most
valuable resource
Our Workers!



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grainsafety.org or
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