



Mechanical Technologist - Grade 2 Certification Training

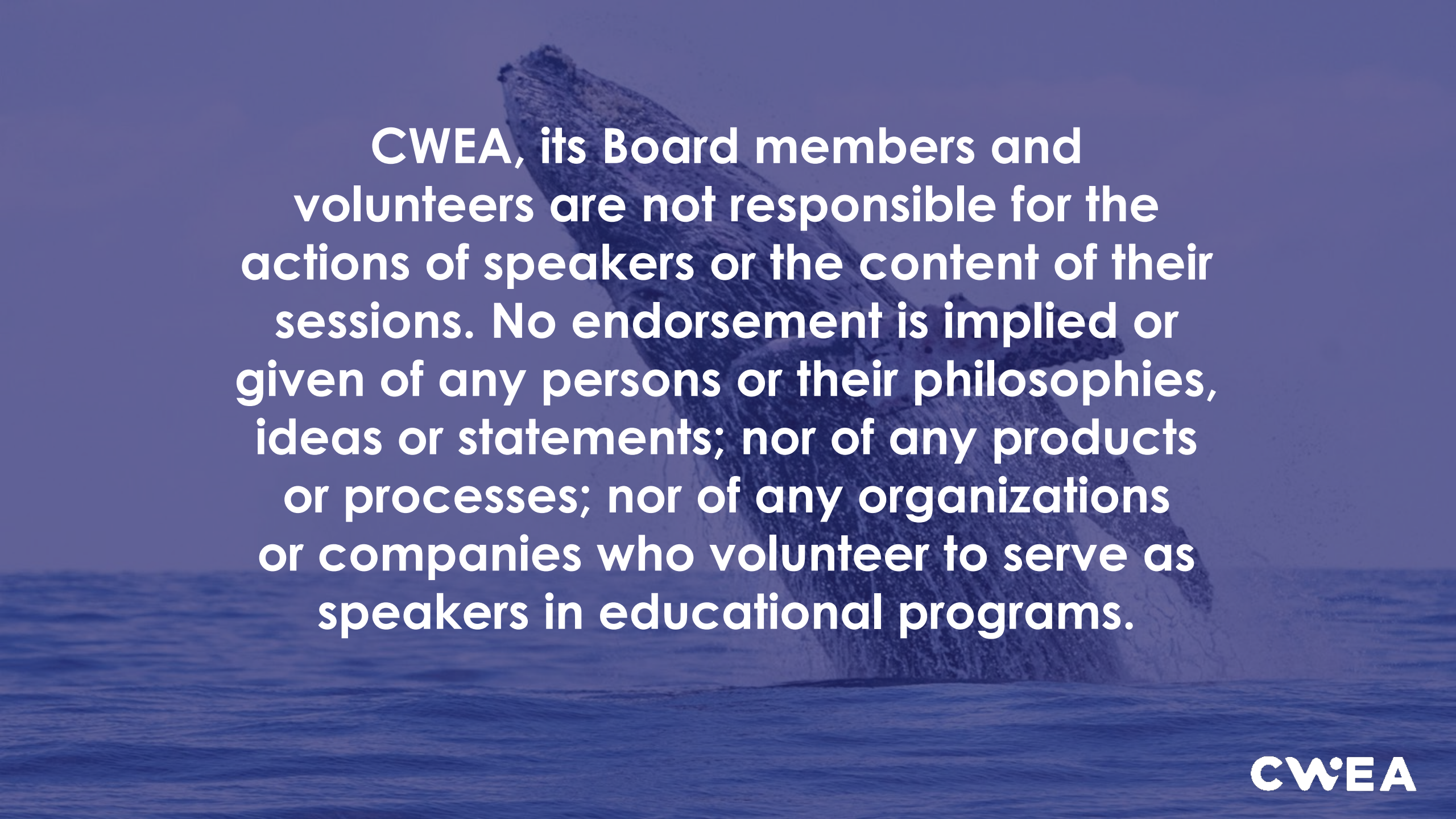
January 20, 2021, 12:00 – 2:00 pm



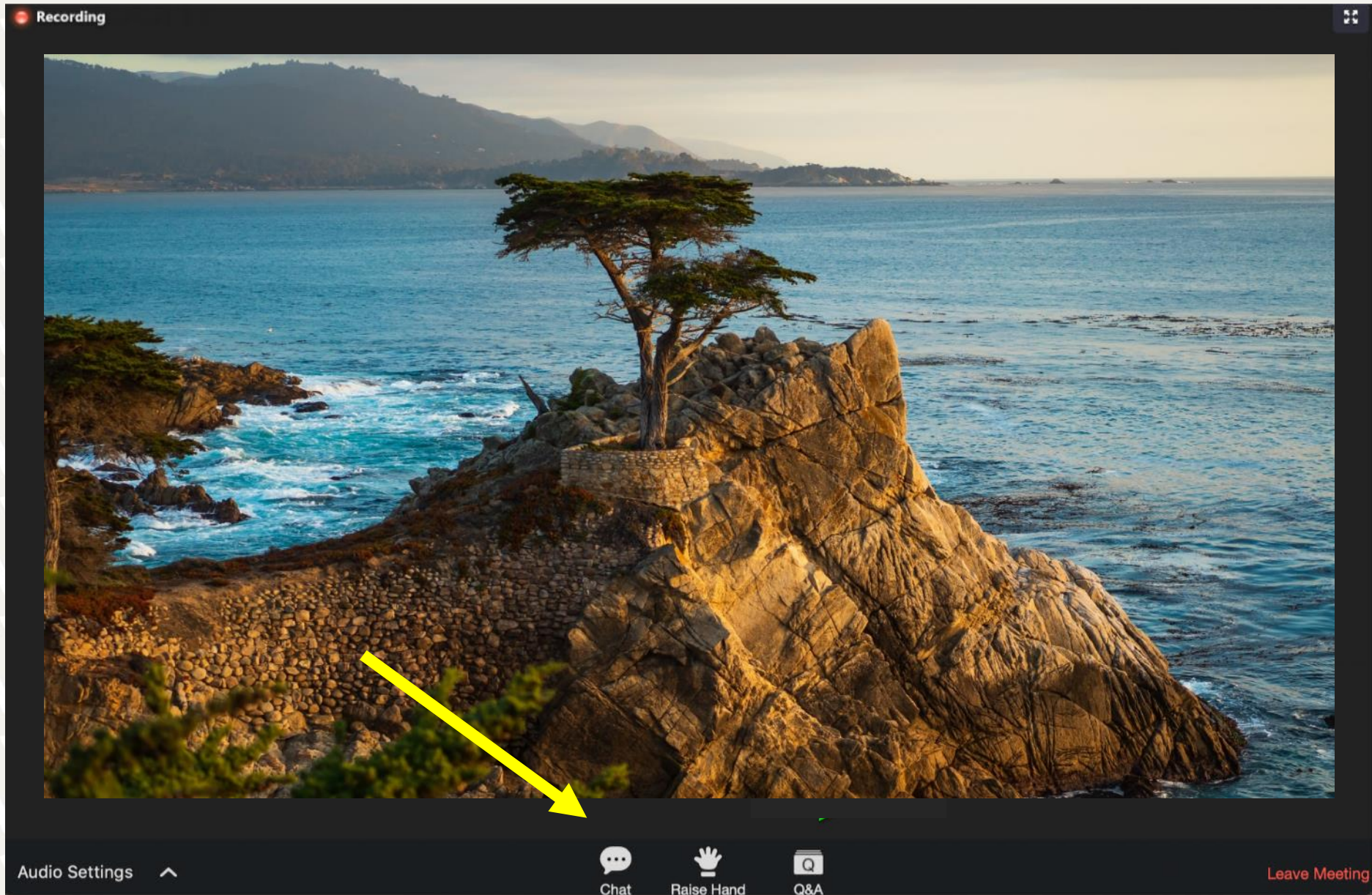
Roy Reynolds

Moderator

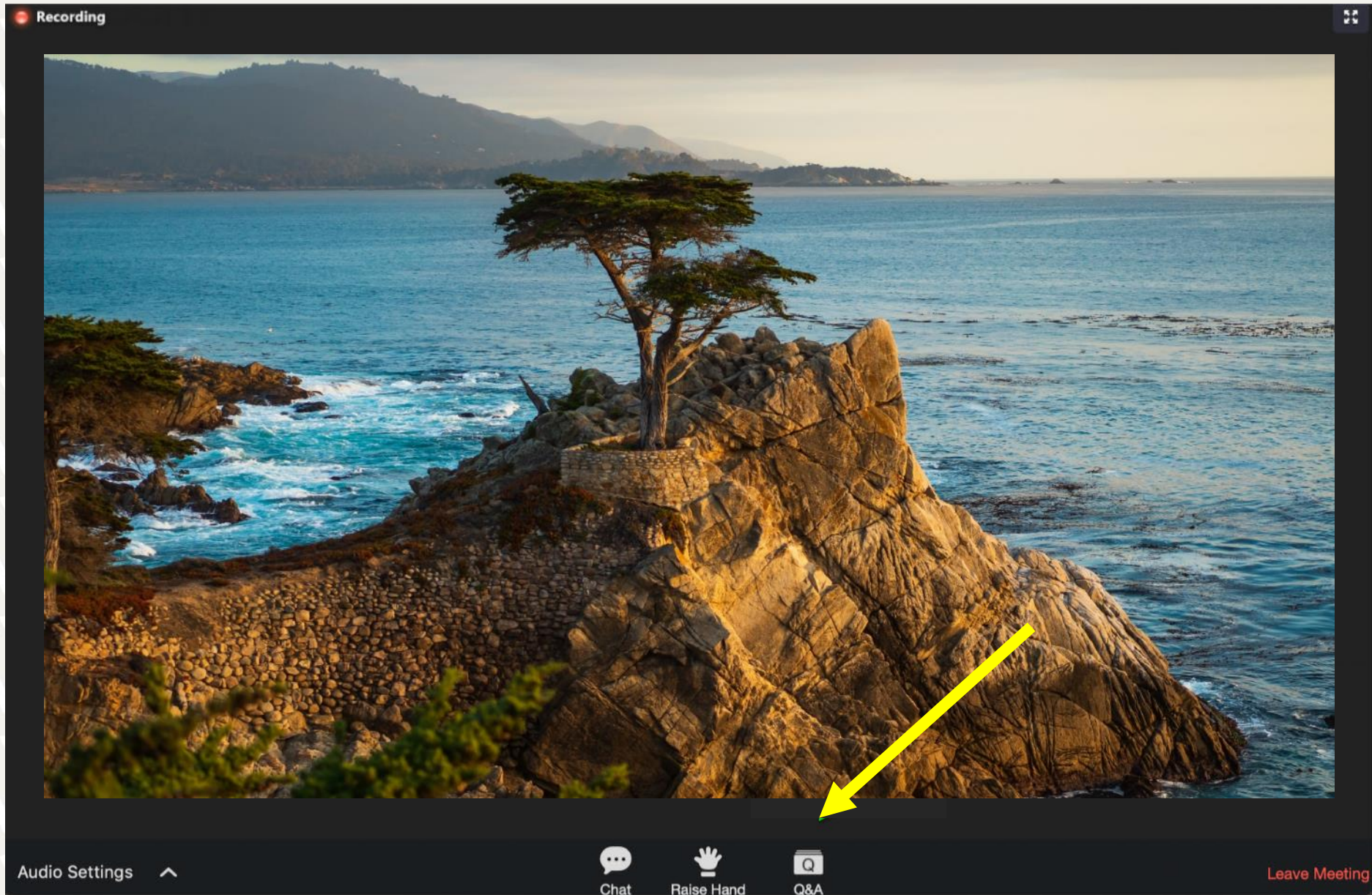
MECHANICAL MAINTENANCE SUPERVISOR
ORANGE COUNTY SANITATION DISTRICT

The background of the slide is a photograph of a large iceberg floating in the ocean. The iceberg is dark and jagged, with a significant portion of its mass submerged below the water's surface. The water is a deep blue with gentle ripples. The overall tone of the image is somber and contemplative.

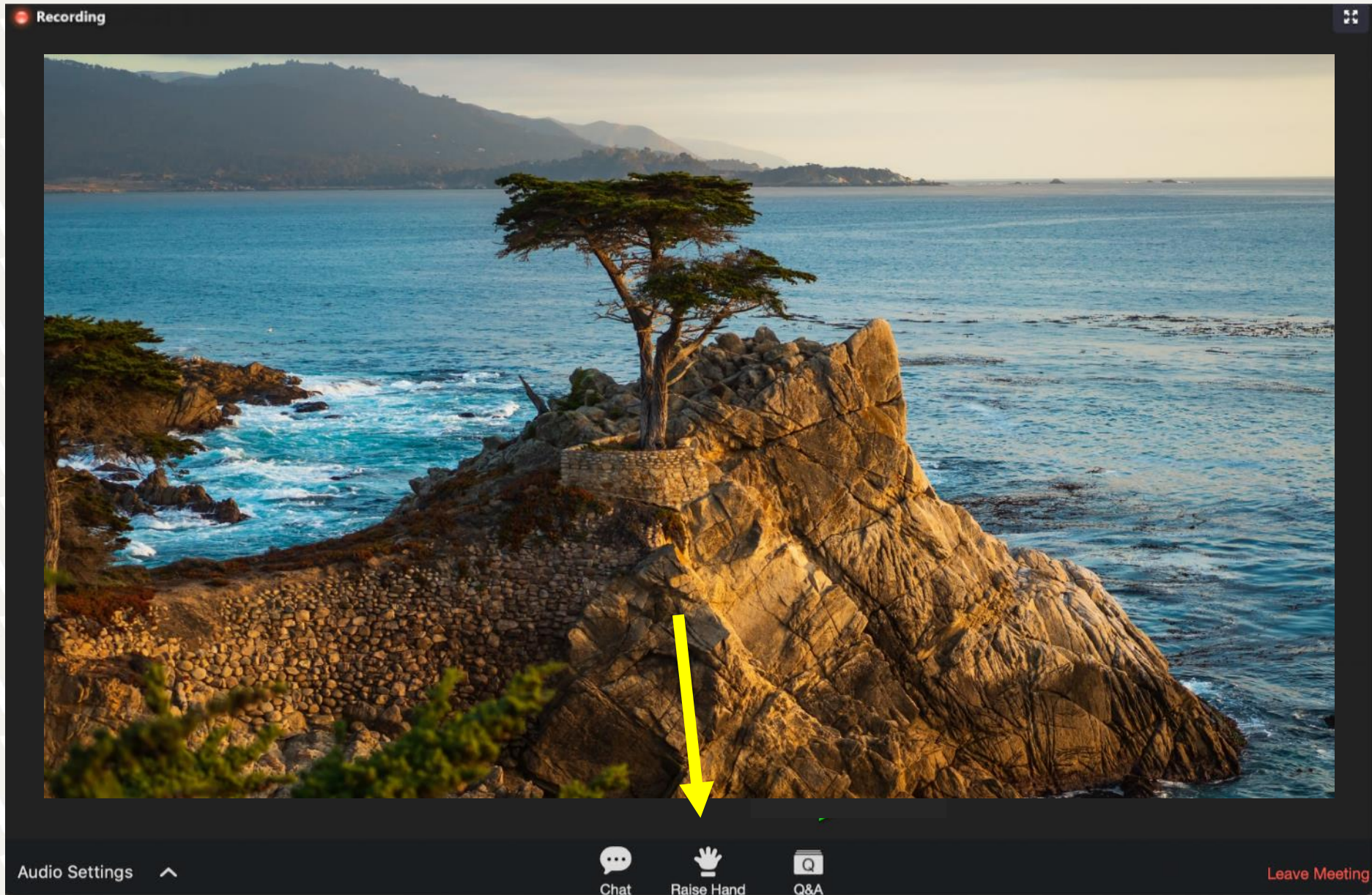
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Zoom Controls: Chat for Comments



Zoom Controls: Q&A for Questions



Zoom Controls: Raise Hand Feature Not Used in Today's Webinar



Robert Delgado

SPEAKER

MANAGER OF OPERATIONS AND MAINTENANCE

INLAND EMPIRE UTILITIES AGENCY

ROAD MAP FOR THIS TRAINING SECTION

- Understanding the KSA's
 - Knowledge, Skills, and Abilities (KSA)
- Knowing the basic math formulas
- Knowing what to study

MECHANICAL TECH. 2

KSA'S - KNOWLEDGE, SKILLS AND ABILITIES

KSA 201: Fabrication and Welding 4%

KSA 202 – Repair & Troubleshoot Engines 5%

KSA 203: Pump Principles 8%

KSA 204: Wet Well Cleaning and Repair 4%

KSA 205: Pipelines and Valves 7%

KSA 206: Compressors and Blowers 7%

KSA 207: Safely and Effective Repair of Process
Equipment 8%

KSA 208: Shop Mathematics 5%

KSA 209: Electrical Principles 3%

KSA 210: Industrial Safety Standards & Regulations 10%

KSA 211: Lifting and Moving Heavy Equipment 4%

KSA 212: Proper use of Tools 10%

KSA 213: Construction Methods and Materials 5%

KSA 214: Interpreting and Applying Information 5%

KSA 215: Relationships in the Workplace 4%

KSA 216: Communications (Verbal and in Writing) 4%

KSA 217: Power Transmission Equipment 7%

KSA 201 – FABRICATION AND WELDING

WELDING SAFETY:

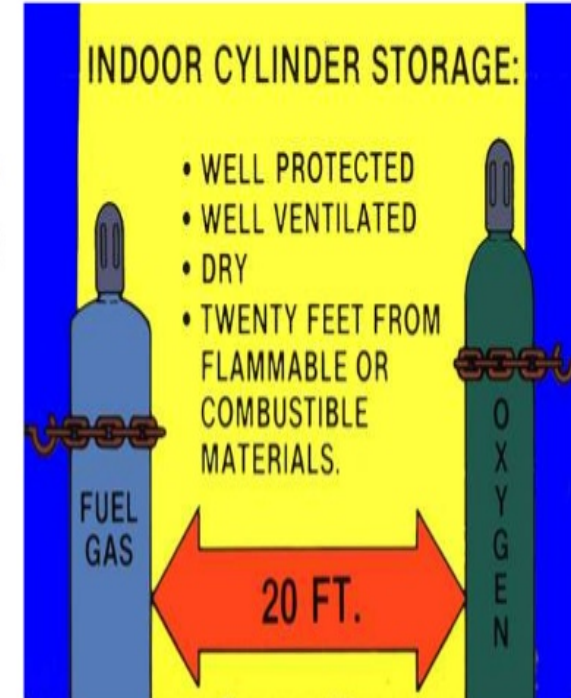
- PPE (fire resistant clothing, leather gloves, approved safety glasses, welding helmet, ventilation, etc.)
- Safety Data Sheets (SDSs)
- Read and follow instructions on O&M manual.
- Wear a safety harness if working at heights
- Do not install or place machine on or over combustible surfaces.
- Read safety information on all equipment
- Use GFCI protection when operating auxiliary equipment in damp or wet locations
- Use only genuine replacement parts

1926.350(a)(10)

Oxygen cylinders in storage shall be separated from fuel-gas cylinders or combustible materials (especially oil or grease), a minimum distance of 20 feet (6.1 m) or by a noncombustible barrier at least 5 feet (1.5 m) high having a fire-resistance rating of at least one-half hour.

1926.350(a)(11)

Inside of buildings, cylinders shall be stored in a well-protected, well-ventilated, dry location, at least 20 feet (6.1 m) from highly combustible materials such as oil or excelsior.



KSA 201 – FABRICATION AND WELDING

Shielding: The word “shielding” is used to describe the creation of an environment of controlled gas or gases around the weld zone to protect the molten weld metal from contamination by the oxygen and nitrogen in the atmosphere.

Arc Welding: Welding process that uses electricity to create enough heat to melt metal. Power creates an electric arc between the metal stick (electrode) and the base material to melt the metals at the point of contact.

Arc welders can use DC or AC current and can use consumable or non-consumable electrodes.

Oxy Acetylene Welding: Oxyacetylene welding, commonly referred to as gas welding, is a process which relies on combustion of oxygen and acetylene. When mixed together in correct proportions within a hand-held torch or blowpipe, a relatively hot flame is produced with a temperature of about 3,200 deg. C. The chemical action of the oxyacetylene flame can be adjusted by changing the ratio of the volume of oxygen to acetylene.

KSA 201 – FABRICATION AND WELDING

Common Arc Welding Methods

Shielded Metal Arc Welding (SMAW): Also known as "stick welding", uses an electrode that has flux, the protectant for the puddle, around it.

Gas Tungsten Arc Welding (GTAW): Also known as TIG (tungsten, inert gas), uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas such as Argon or Helium.

Gas Metal Arc Welding (GMAW): Commonly termed MIG (metal, inert gas), uses a wire feeding gun that feeds wire at an adjustable speed and flows an argon-based shielding gas or a mix of argon and carbon dioxide (CO₂) over the weld puddle to protect it from atmospheric contamination.

Flux-cored arc welding (FCAW): Almost identical to MIG welding except it uses a special tubular wire filled with flux; it can be used with or without shielding gas, depending on the filler.

Submerged arc welding (SAW): Uses an automatically fed consumable electrode and a blanket of granular fusible flux. The molten weld and the arc zone are protected from atmospheric contamination by being "submerged" under the flux blanket.

KSA 201 – FABRICATION AND WELDING

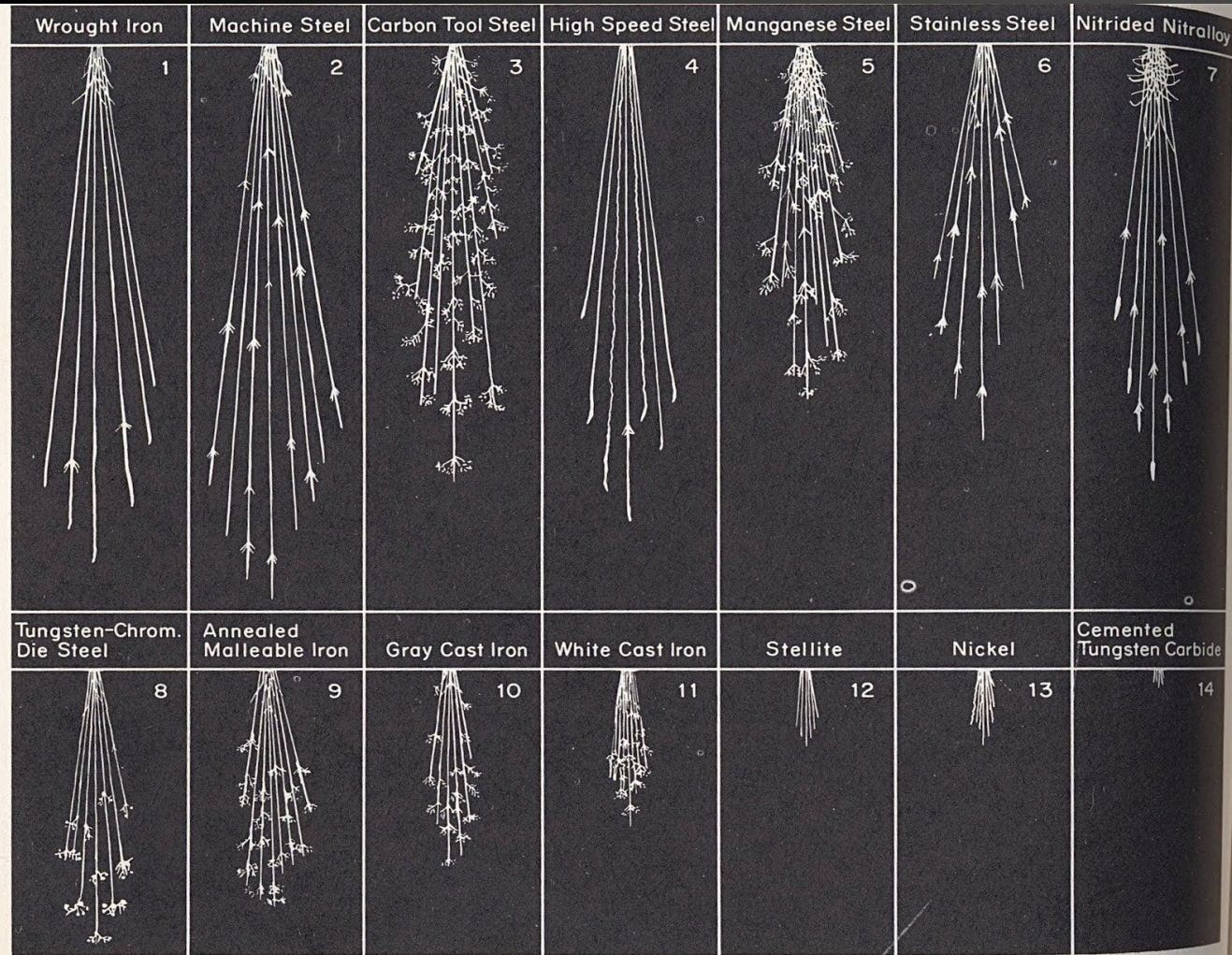


Fig. 10-8 Spark patterns produced by various metals and alloys when held against a carborundum grinding wheel.

Nonferrous metals are generally grouped according to their alloying elements. Examples of these groups are:

- Brass, bronze, copper-nickel, and nickel-copper.

Specific designations of an alloy are described by the amounts and chemical symbols of the alloying elements. For example, a copper-nickel alloy might be described as copper-nickel, 70 Cu-30 Ni. The 70 Cu represents the Percentage of copper, and the 30 Ni represents the percentage of nickel.

Aluminum . . . Al	Nickel Ni
Carbon C	Phosphorus P
Chromium Cr	Silicon Si
Cobalt Co	Sulphur S
Copper Cu	Tin Sn
Iron. Fe	Titanium Ti
Lead Pb	Tungsten W
Manganese Mn	Vanadium V
Molybdenum . . . Mo	Zinc Zn

KSA 202 – REPAIR & TROUBLESHOOT ENGINES

- LO/TO - Remember that communications are vital with Plant Operators, coordinate any and all lock-out / tag-out with Plant Operations
- An engine is defined as a machine designed to convert energy into useful mechanical motion.
- Engine oil pumps are positive displacement which makes a fluid move by trapping a fixed amount and forcing (displacing) that trapped volume into the discharge pipe.
- A maintenance program consists of two major parts: scheduling tasks and performing tasks.
- A battery (especially emergency batteries) should be tested monthly.
- When charging a battery make sure the area is well ventilated. It is best to slow charge a battery

KSA 202 – REPAIR & TROUBLESHOOT ENGINES

- Key concepts:
- If a belt is squeaking what is the best product to use to remove the glaze that is present. Chalk - it is abrasive and will remove the glaze.
- The most common failure of gear fuel pumps are seals leaking from worn shafts and or bushings.
- Heat Exchanger are devices that transfer heat from on fluid to another.
- A battery should never get below 12.45 volts (75%) before recharging and a charging voltage of 1 ½ to 2 volts greater than the battery voltage should be used. Once fully charged and rested a battery should read 12.7 to be considered fully charged.
- Practice Questions
 - Is a Radiator a heat exchanger? Why or Why Not?
 - If I use the word atomization, what part of the diesel or gasoline engine am I talking about?

KSA 202 – REPAIR & TROUBLESHOOT ENGINES

INSPECTING, TESTING, AND REPAIRING VALVES AND VALVE ASSEMBLIES: Regardless of differences existing in engine construction, there are certain troubles common to all assemblies.

Sticking Valves:

- Sticking valves will produce unusual noise at the cam followers, pushrods, and rocker arms and may cause the engine to misfire. Sticking is usually caused by resinous deposits left by improper lube oil or fuel.
- To free sticking valves without having to disassemble the engine, use one of several approved commercial solvents.
- If the engine is disassembled, use either a commercial solvent or a mixture of half lube oil and half kerosene to remove the resins. Do NOT use the kerosene mixture on an assembled engine, since a small amount of this mixture settling in a cylinder could cause a serious explosion

KSA 202 – REPAIR & TROUBLESHOOT ENGINES

Bent Valves:

- Bent or slightly warped valves tend to hang open. A valve that hangs open not only prevents the cylinder from firing, but also is likely to be struck by the piston and bent so that it cannot seat properly. Symptoms of warped or slightly bent valves will usually show up as damage to the surface of the valve head.
- To lessen the possibility that cylinder head valves will be bent or damaged during overhaul, NEVER place a cylinder head directly on a steel deck or grating; use a protective material such as wood or cardboard. Also, NEVER pry a valve open with a screwdriver or similar tool.

Weak Springs:

- Valves may close slowly, or fail to close completely, because of weak springs. At high speeds, valves may “float,” thus reducing engine efficiency.
- Valve springs wear quickly when exposed to excessive temperatures and to corrosion from moisture combining with sulfur present in the fuel.

Burned Valves:

- Burned valves are indicated by irregular exhaust gas temperatures and sometimes by excessive noise. In general, the principal causes of burned valves are carbon deposits, insufficient tappet clearance, defective valve seats, and valve heads that have been excessively reground

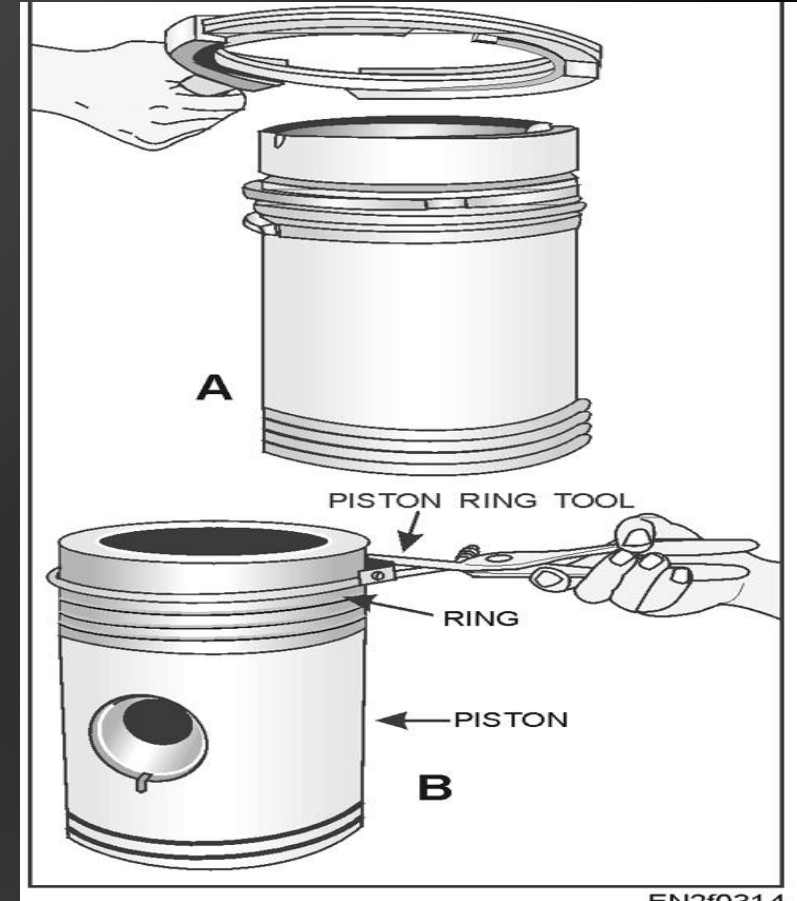
KSA 202 – REPAIR & TROUBLESHOOT ENGINES

Piston Rings:

- Over a period of time all piston rings wear. Some stick and may even break.
- While you may be able to free stuck rings and make them serviceable, you must replace excessively worn or broken rings with new ones.

Insufficient Compression:

- Proper compression pressures are essential if a diesel engine is to operate satisfactorily.
- Insufficient compression may cause an engine to fail to start. If you suspect low pressure as the reason, check the compression with the appropriate instrument. If the test indicates pressures below standard, disassembly is required for complete inspection and correction.



KSA 202 – REPAIR & TROUBLESHOOT ENGINES

Inoperative Engine Governor:

- There are many troubles that may cause a governor to become inoperative. The most frequent trouble associated with starting an engine is generally caused by bound control linkage or, if the governor is hydraulic, by low oil level.
- Whether the governor is mechanical or hydraulic, binding of linkage is generally due to distorted, misaligned, defective, or dirty parts.
- If you suspect binding, move the linkage and governor parts by hand and check their movement. Eliminate any undue stiffness or sluggishness in the movement of the linkage.

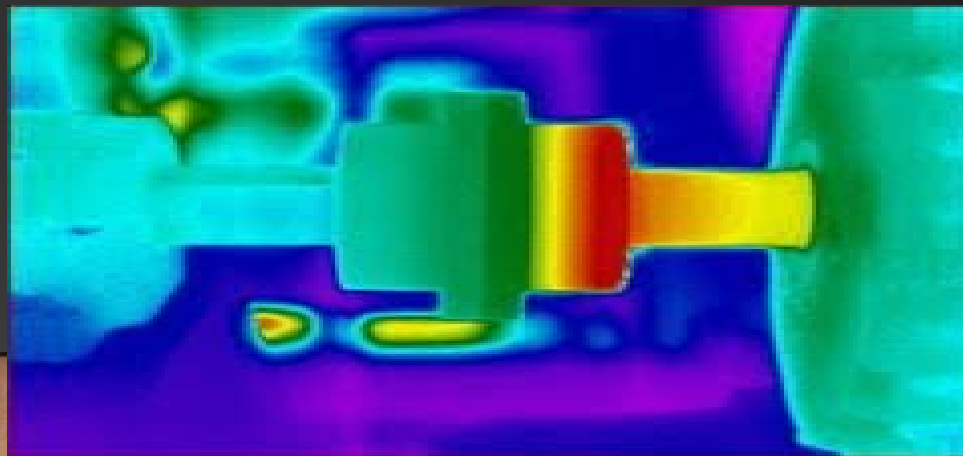
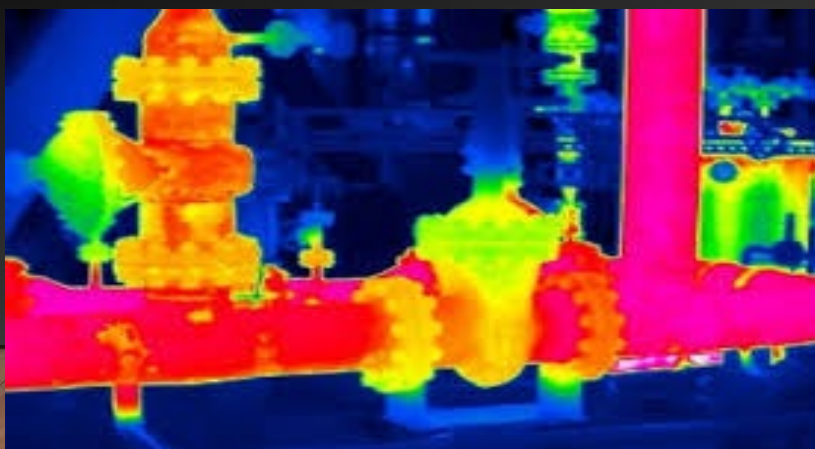
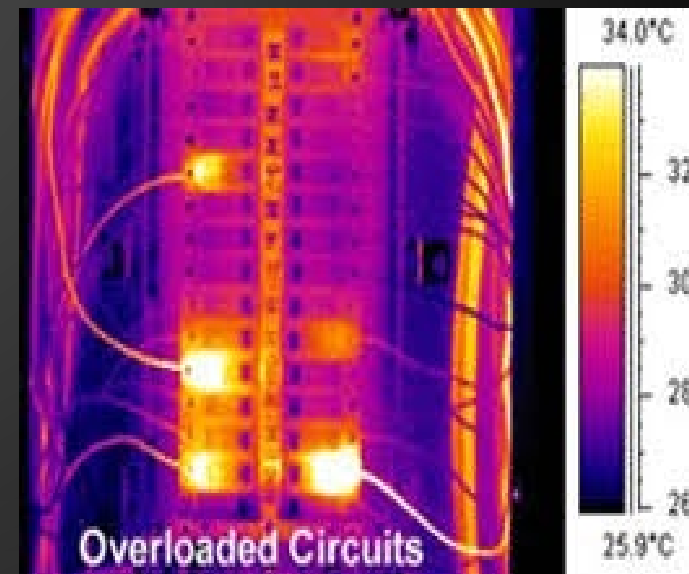
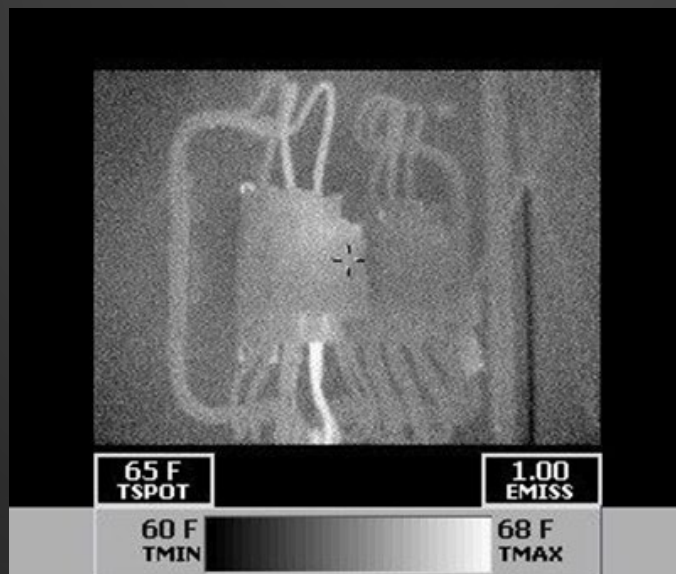
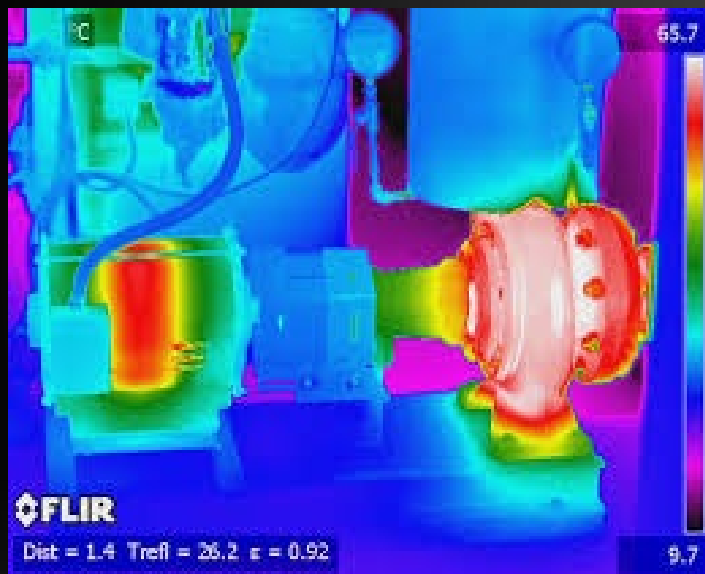


KSA 202 – REPAIR & TROUBLESHOOT ENGINES

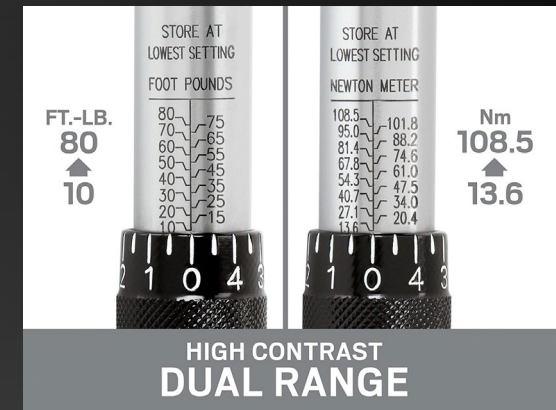
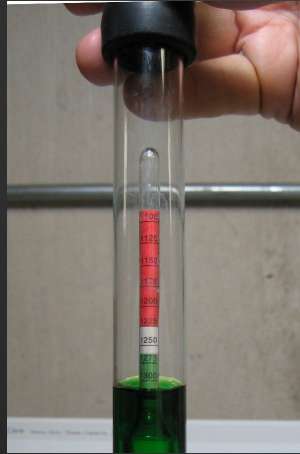
Engine Stalls Frequently or Stops Suddenly:

- Look for troubles such as:
 - Air in the fuel system
 - Clogged fuel filters
 - Unsatisfactory operation of fuel injection equipment
 - Incorrect governor setting
 - Misfiring
 - Low cooling water temperature
 - Improper application of load
 - Improper timing
 - Obstruction in the combustion space or in the exhaust system
 - Insufficient intake air
 - Defective auxiliary drive mechanisms.

KSA 203 – PUMP PRINCIPLES

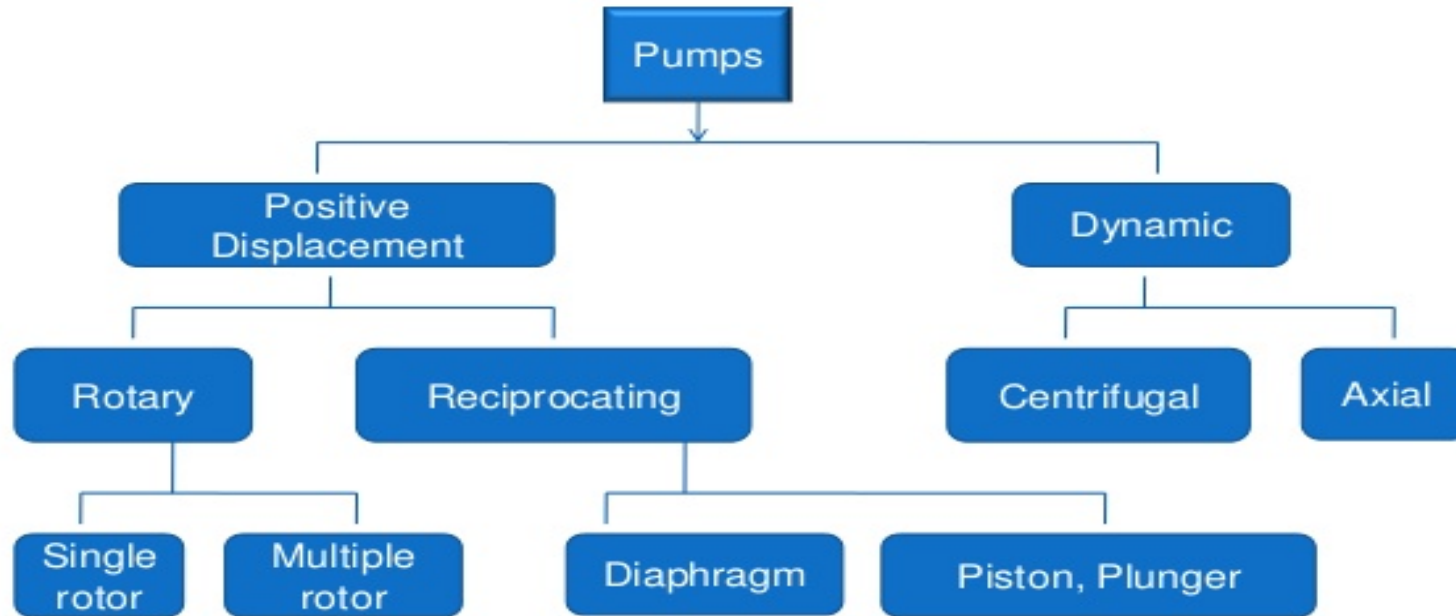


KSA 203 – PUMP PRINCIPLES



KSA 203 – PUMP PRINCIPLES

□ Pump Classification



KSA 203 – PUMP PRINCIPLES

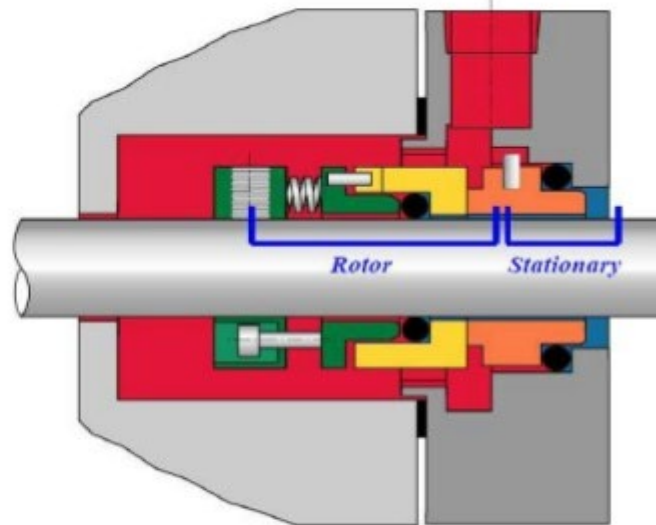
- **Progressive Cavity Pumps** consist of a screw-shaped rotor snugly enclosed in a “non-moving Stator” or housing.
- The rotor is manufactured of chrome steel and makes contact with the stator which is made primarily of synthetic rubber.
- The gaps between the rotor threads are called “cavities.” These pumps are recommended for materials that contain high concentrations of suspended solids and are used primarily on sludges.
- They should never be started or ran with liquid or with a closed discharge valve.



KSA 203 – PUMP PRINCIPLES

How Mechanical Seal Works !

- The seal is comprised of a rotating (yellow) and stationary (orange) face. The faces are flat within 11 millions of an inch. This creates the primary sealing point in the seal.
- Process fluid provides lubrication for the seal faces.
- Closing forces (spring pressure + process pressure) keep the seal faces together.
- Small amount of opening force allows process liquid to migrate between the seal faces. This liquid is critical to seal performance. It provides cooling and lubrication.



Additional Facts:

- AKA-Spring Loaded Check Valve
- Provides the best sealing for pressures and speeds.
- Costs are much higher than packing, but less than cartridge seals and split seals
- Special care needs to be administered when installing
- Seal face flatness is critical to prevent leakage, one face is carbon the other is a harder material like ceramic, tungsten carbide or silicon carbide.
- Flatness is measured in "Light Bands."

KSA 203 – PUMP PRINCIPLES

Centrifugal Pumps -

- **Maintenance Rule #1:** Never pump a liquid that the pump was not designed for.
- **Maintenance Rule #2:** Keep the right amount of the “right” lubricant in the bearings at all times.
- **Maintenance Rule #3:** See that pump and motor connections are parallel vertically and axially (aligned) and that they are kept that way.
- **Maintenance Rule #4:** See that suction piping puts absolutely no strain on the pump casing.
- **Maintenance Rule #5:** Never allow a pump to run dry, water is a lubricant between the rings and impeller.
- **Maintenance Rule #6:** Packing should be replaced periodically, don't push additional packing to stop leakage. Never overtighten the packing gland, excessive pressure will wear shaft sleeves.
- **Maintenance Rule #7:** 75% of centrifugal pump problems come from the suction side of the pump from too high of a suction lift, air entering the suction side and or cavitation which will cause the pump to be noisy and vibrate, it might also sound like rocks are in the casing.

KSA 203 – PUMP PRINCIPLES

Pump Troubleshooting:

Centrifugal Pump loss of suction:

- Air leak in suction line (Repair & replace)
- Suction lift too high (Lower suction lift, install foot valve and prime)
- Insufficient inlet pressure or suction head (Increase inlet pressure by adding more water to tank or increasing back pressure)
- Clogged foot valve check valve or strainer (Unclog)
- Defective foot valve or check valve (Replace)
- Defective priming hose bibb on suction pipe (Replace)

Pump vibrates and/or makes excessive noise:

- Mounting plate or foundation not rigid enough (Reinforce)
- Foreign material in pump (Dismantle pump and clean)
- Impeller damaged (Replace impeller)
- Worn motor bearings (Replace bearings)
- Suction lift too high (Lower suction lift, install foot valve and prime)

KSA 203 – PUMP PRINCIPLES

Pump will not prime:

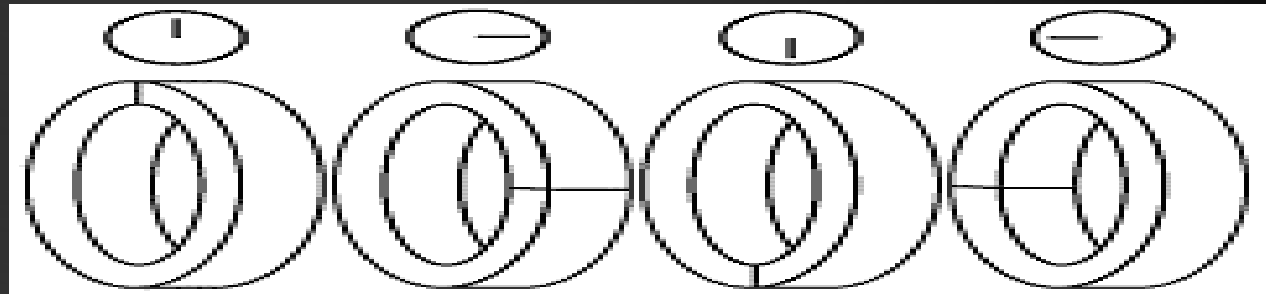
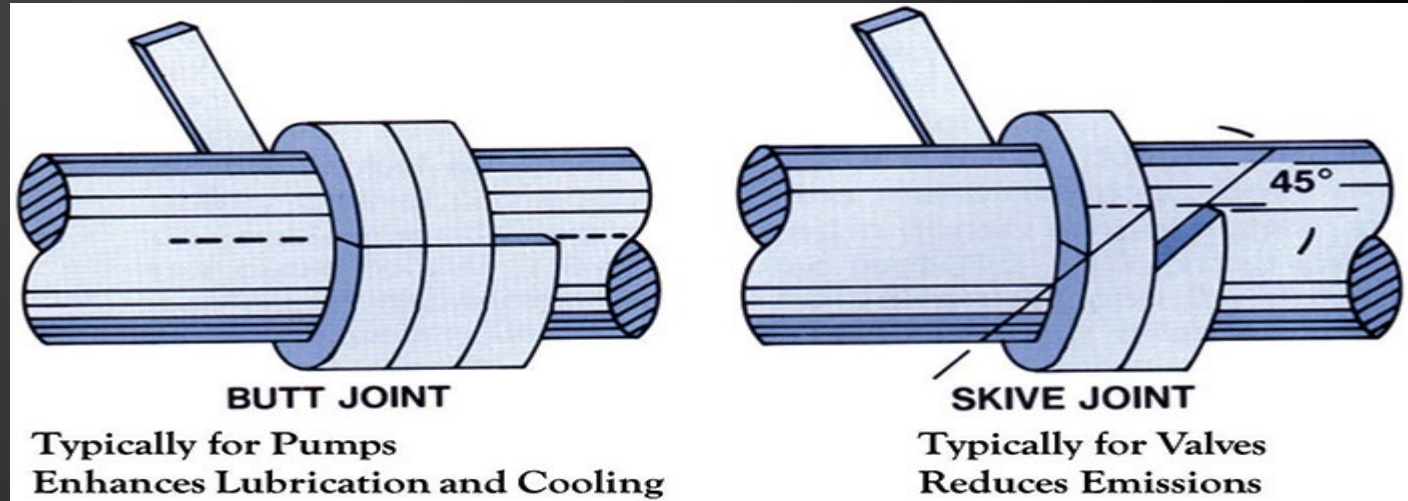
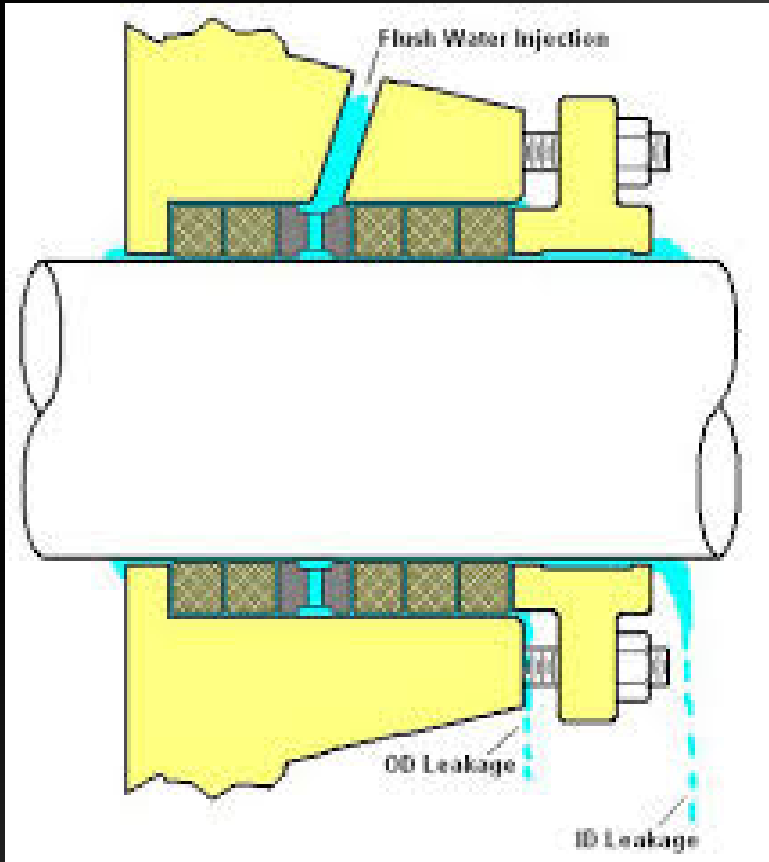
- No priming water in casing (Fill pump casing)
- Mechanical seal leaking (Replace mechanical seal)
- Leak in suction line (Repair or replace)
- Discharge line is closed and priming air has nowhere to go (Open)
- Suction line or valve is closed (Open)
- Pump is down (Replace worn parts)
- Foot valve or check valve is leaking (Replace valve)
- Suction screen clogged (Clean or replace)

KSA 203 – PUMP PRINCIPLES

Cavitation:

- The condition of cavitation is essentially an indication of an abnormality in the pump suction system, whereas the condition of low flow indicates an abnormality in the entire pumping system or process. The two conditions are also inter-linked such that a low flow situation can also induce cavitation.
- Cavitation is a common occurrence but is the least understood of all pumping problems.
- When cavitating, the pump not only fails to serve its basic purpose of pumping the liquid but also may experience internal damage, leakage from the seal and casing, bearing failure, etc.

KSA 203 – PUMP PRINCIPLES

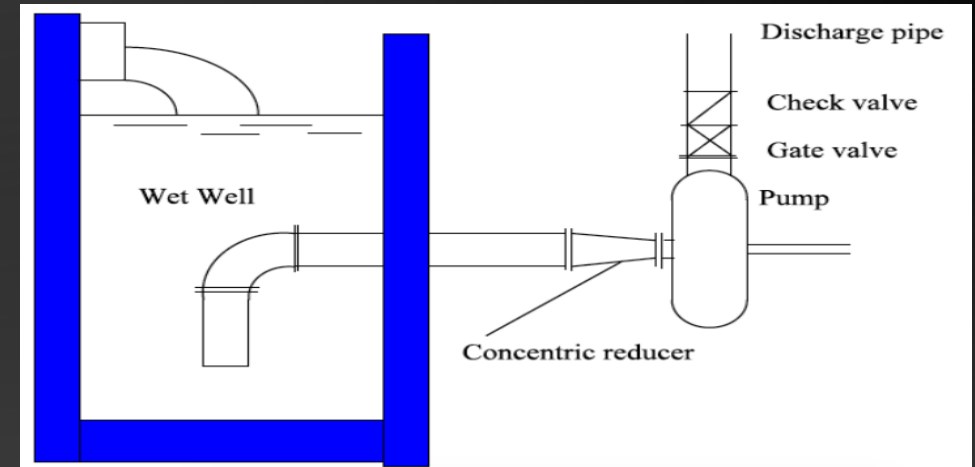
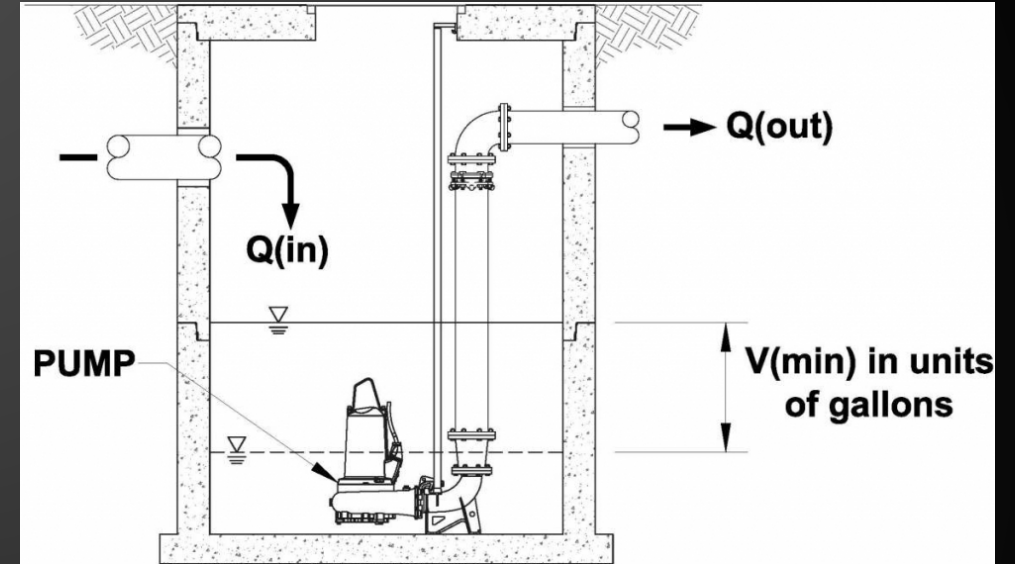


KSA 203 – PUMP PRINCIPLES

- The function of the multiple rings of packing in a stuffing box is to brake down the pressure of fluid being sealed so that it approaches zero gage pressure or atmosphere at the follower end of the stuffing box.
- It is better to have to much leakage from the stuffing box than not enough.
- The lantern ring or seal cage (as it is sometimes called) provides additional lubricant or fluid directly to the interface of packing and shaft.
- The lantern ring must be positioned between the packing rings so that its front edge is in line with the inlet port, as the packing wears and the follower is tightened, the lantern ring will move forward, when the packing is fully compressed, the lantern ring should still be inline with the inlet (flush) port.
- Packing **should not** be rolled out flat and cut with square ends, this will create a wedge-shape void.

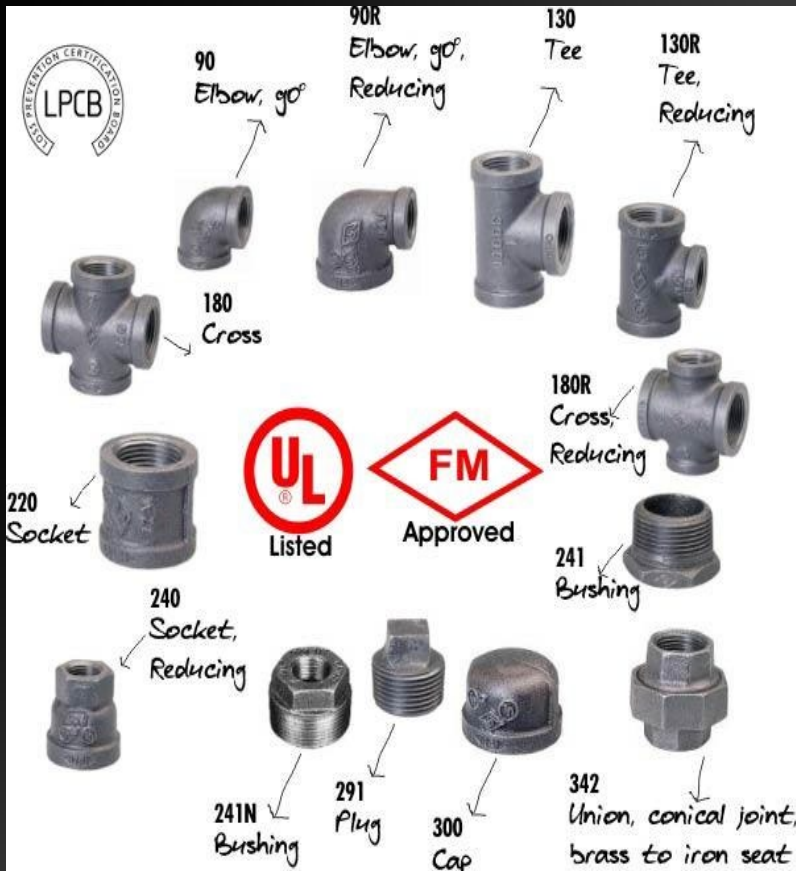
KSA 204 – WET WELL CLEANING AND REPAIR

- Wet Wells are used in a sewer collection system. Typically known as Pump Stations.
- Wet Wells can have fully submersible pumps or dry submersible.
- Pump Stations of today require redundancy with additional pumps or bypass pumping capabilities and emergency power generator.
- Level controllers can be either float activated, submersible elements, non-contact Ultrasonic or radar level transmitters.
- The Air Quality Management District (AQMD) is the regulatory agency that permits odor control systems.



KSA 205 – PIPELINES AND VALVES

Know the different names of fittings by look and description.



Flux: A paste used to assist melting when soldering or brazing.

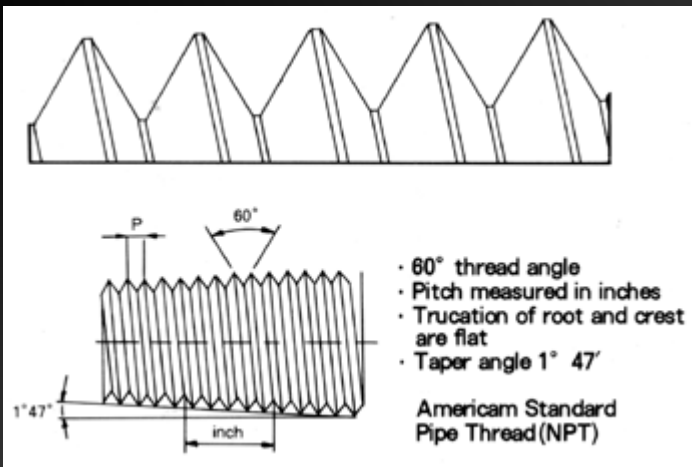
Solvent Weld: A chemical process used to join two PVC connections.

TYPES OF VALVES

1. GATE VALVES O/C
2. GLOBE VALVES Throttling
3. PLUG VALVES O/C
4. DIAPHRAGM VALVES Throttling
5. BALL VALVES O/C
6. BUTTERFLY VALVES Throttling
7. NEEDLE VALVES Throttling
8. CHECK VALVES O/C
9. PRESSURE RELIEF VALVES O/C
10. CONTROL VALVES O/C or throttling

KSA 205 – PIPELINES AND VALVES

- Standard pipe is made in different wall thicknesses and to standardized dimension. The actual outside diameter in these various wall thicknesses does not change, the internal diameter however does.
- The ANSI B36-10 standard gives a meaning of specifying wall thicknesses by a series of “schedule numbers” which indicate the approximate strength of the pipe.
- The lower numbers have the least strength, with the strength increasing as the numbers do.
- Pipe threads (American Standard) has an angle of 60° and a slight flat at the crest and root. The threads are cut on a taper of 1/16 in. per inch measured on the diameter.



KSA 205 – PIPELINES AND VALVES

Item	Abnormal Condition	Possible Cause	Maintenance Response
Pipe	Corrosion	Condensate	Install additional traps, flush pipe, coating piping, remove standing water from around pipe
	Sludge in pipe	Vacuum operation by blower operating in reverse	Flush pipe and install check valves on blower or repair current check valve
	Dirt	No or inefficient air filtration	Install filters or increase filter cleaning frequency
Valves	Difficult to operate or frozen	Hardened grease	Remove old grease and apply seizing inhibitors. Operate valves monthly
		Corrosion	Drain condensate traps daily. Apply seizing inhibitor

KSA 205 – PIPELINES AND VALVES

Piping Layouts:

Start with a basic sketch of your project, including general dimensions. For projects using flanged or precut threaded pipe, layout planning is much more critical.

- Take some time to research various fittings.
- Consider using sweeps or a pair of spaced 45s instead of close elbows to cut down on total dynamic head.
- Include clean-outs and flushing points in your layout.
- For threaded assemblies allow for twisting the pipes and fittings together — you will probably need to include a union or flanged joint to complete the assembly.

KSA 205 – PIPELINES AND VALVES

Pipe support or pipe hanger:

Element that transfer the load from a pipe to the supporting structures. The load includes the weight of the pipe, the content that the pipe carries, all the pipe fittings attached to pipe, and the pipe covering such as insulation.

The four main functions of a pipe support provides are: Anchoring, Guiding, Shock Absorption and Support

Primary Load - these are typically steady or sustained types of loads such as internal fluid pressure, external pressure, gravitational forces acting on the pipe such as weight of pipe and fluid, forces due to relief or blow down, pressure waves generated due to water/steam hammer effects.

Secondary Load - Just as the primary loads have their origin in some force, secondary loads are caused by displacement of some kind. For example, the pipe connected to a storage tank may be under load if the tank nozzle to which it is connected moves down due to tank settlement. Similarly, pipe connected to a vessel is pulled upwards because the vessel nozzle moves up due to vessel expansion. Also, a pipe may vibrate due to vibrations in the rotating equipment it is attached to.

KSA 205 – PIPELINES AND VALVES

Rigid Support:

Rigid supports are used to restrict pipe in certain direction(s) without any flexibility (in that direction). Main function of a rigid support can be Anchor, Rest, Guide or both Rest & Guide.

Spring Support:

Spring supports (or Flexible supports) use helical coil compression springs (to accommodate loads and associated pipe movements due to thermal expansions). Types of spring supports include: Variable Spring Hanger or Variable Effort Support and Constant Spring Hanger or Constant Effort Support.

Shock Absorber:

It is designed to absorb and transfer sudden increases in load from the pipe into the building structure and to deaden any opposing oscillation between the pipe and the structure. Types of restraints are: Hydraulic Snubber, Mechanical Snubber, shock absorber, insulated pipe support (also called pre-insulated pipe support) and engineered spring support upholds a specific load.

KSA 206 – COMPRESSORS AND BLOWERS

- An air compressor should be selected to run $\frac{1}{3}$ to $\frac{1}{2}$ of the time, based on average air consumption of a system.
- Average air consumption is expressed in standard cubic feet per minute – SCFM.
- Compressors are rated in SCFM at a given tank pressure, usually 80-110 psig.
- Sizing a compressor is matching the compressor capacity to a system's requirement. The consumption of each air-using device in a system is taken into consideration.
- Relays, thermostats, switches, transmitters, and all devices that use air must be considered, and the compressor should be sized so that when operating, $\frac{1}{3}$ to $\frac{1}{2}$ of the time it will deliver enough air to satisfy the average air requirement of a system.
- If a change in air volume output is required, it is accomplished by changing the motor to one with a higher or lower RPM or by changing out the sheaves to increase or decrease blower lobe or rotor rotation (rpm).

KSA 206 – COMPRESSORS AND BLOWERS

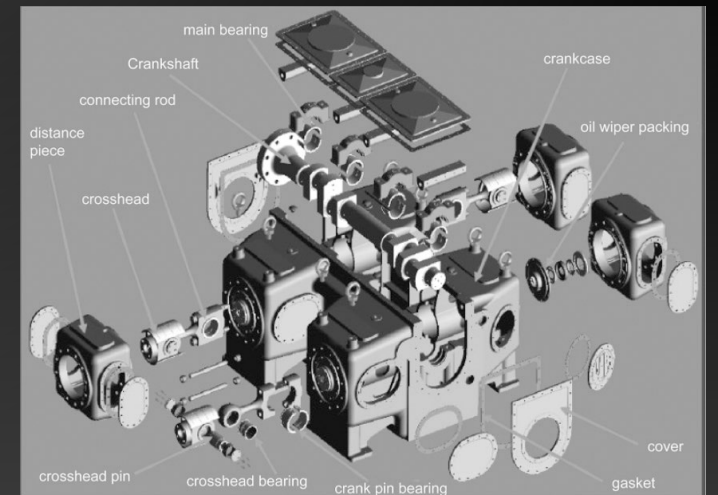
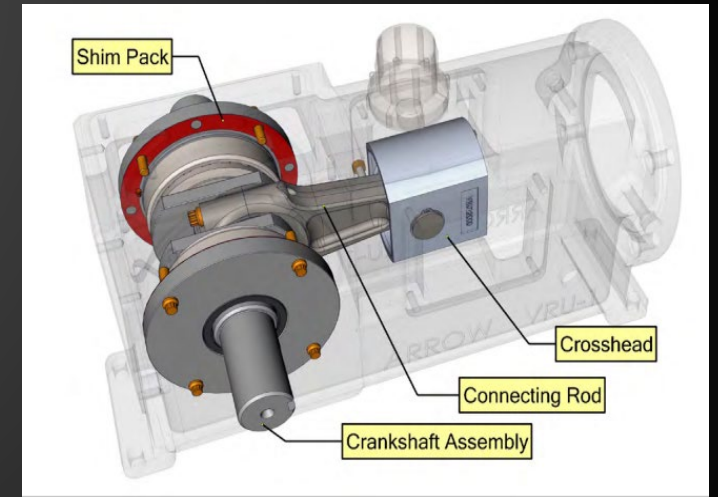
Air Compressor Troubleshooting:

- **Delivery Below Rate Capacity** – Excessive system leaks, restrictions of air intake, intake air filters clogged, broken or worn valves, valves not seated in cylinder, unloader defective or improperly set, worn or broken piston rings, cylinder or piston worn or scored, slipping belts.
- **Noisy or Knocking Compressor** – Pulley or flywheel loose, anchor bolt loose or foundation uneven, excessive crankshaft endplay, piston or piston nut loose, bearings loose, liquid in cylinder, inadequate lubrication.
- **Motor overheat** – motor too small, wrong connections, low voltage, excessive number of starts, belts too tight, speed too low, High ambient temperature, poor ventilation, unloader set incorrectly, compressor mechanical problem.
- **Compressor overheats** – Pressure setting above rating, restricted intake or clogged filters, broken or worn internal parts, insufficient water temperature too high, speed too high, belts misaligned bearing are worn and need replacing, poor ventilation, wrong rotation.
- **Low oil pressure** – defective gauge, insufficient or wrong type of lubricant, defective oil relief valve, worn or defective oil pump, excessive clearances.

KSA 206 – COMPRESSORS AND BLOWERS

Reciprocating Compressor:

- Crankshafts rotary motion provided by the driving power unit is converted into reciprocating motion by the crankshaft.
- The connecting rod connects to the crankshaft to the crosshead, transforming the rotating reciprocation at the crank to a straightline reciprocation at the crosshead. Crosshead acts like a sliding joint between the connecting rod and the piston rod.
- Valves are the critical part of the compressor and perform on one of the most rugged operations.
- Valves must have the ability to function satisfactorily for long periods of time.
- Valves are one-way, or check-type, valves.



KSA 207 – SAFELY & EFFECTIVE REPAIR OF PROCESS EQUIPMENT

Chlorinators - leaks around chlorinators will cause corrosion of equipment, check everyday for leaks. Large leaks will be detected by odor, small may go unnoticed until damaged results. A green or reddish deposit on metal indicates a chlorine leak.

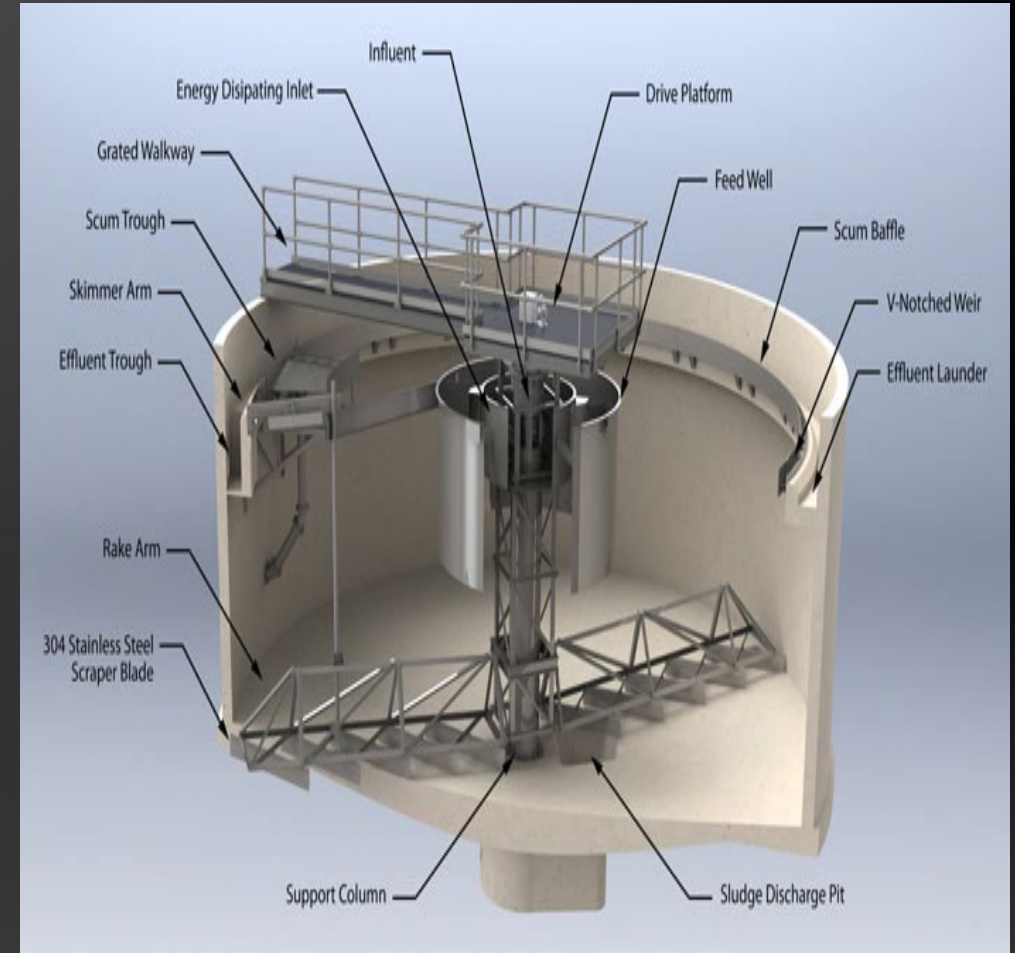
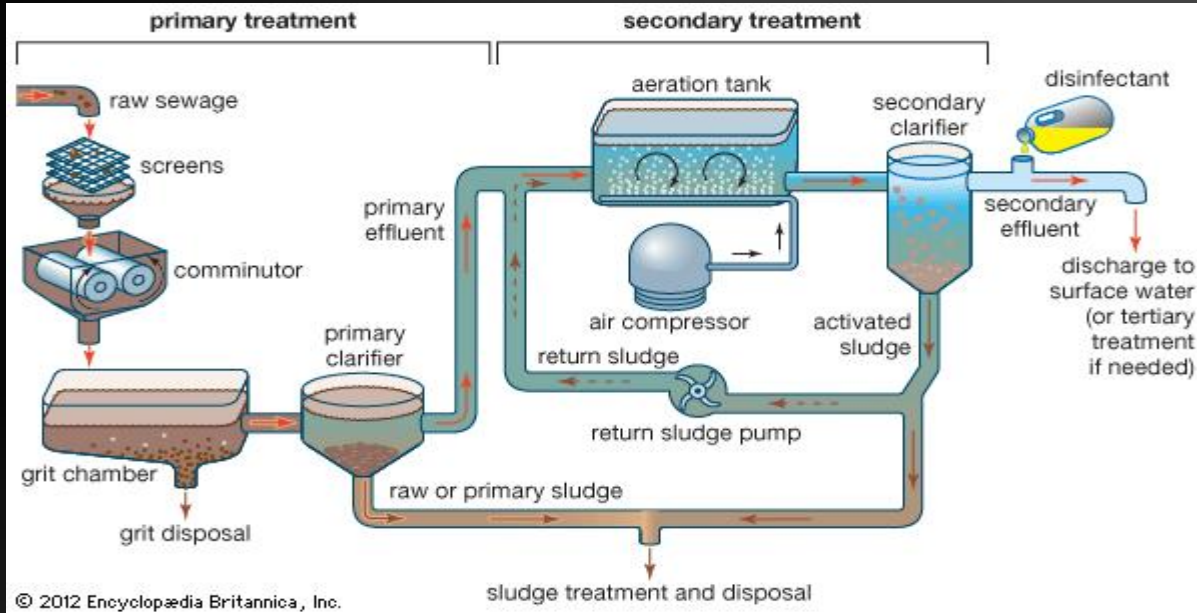
Digesters and their related equipment include many hazards and fall under NFPA 820 Fire Protection in Wastewater Plants and Collection Facilities, which lists the requirements for electrical classifications, ventilation, gas detection, and fire control methods in sludge and gas handling areas.

Note: standard Electrical systems are “PROHIBITED” on anaerobic digesters under this statute. All electrical systems within 5 ft. of this Digester “MUST” be rated a Class 1, Division 1 location.

Aerators should have at least two people doing the work. US Coast Guard approved life preservers must be provided with at least 90 feet of hand line and be located no more than 200 feet apart.

Note: If you work in areas where the danger of drowning exists, you MUST wear a US Coast Guard –approved life jacket or buoyant work vest.

KSA 207 – SAFELY & EFFECTIVE REPAIR OF PROCESS EQUIPMENT



KSA 207 – SAFELY & EFFECTIVE REPAIR OF PROCESS EQUIPMENT

Different Types Of Weirs....



Weir (WEER)

A wall or plate placed in an open channel and used to measure the flow of water. The depth of the flow over the weir can be used to calculate the flow rate, or a chart or conversion table may be used to convert depth to flow.

A wall or obstruction used to control flow (from settling tanks and clarifiers) to ensure a uniform flow rate and avoid short-circuiting.

KSA 207 – SAFELY & EFFECTIVE REPAIR OF PROCESS EQUIPMENT

Venturimeter

It is a device, which is used for measuring the rate of flow of fluid through a pipe.

It consists of an

- Inlet section followed by
- Convergent section
- A cylindrical throat and
- A gradually divergent cone.

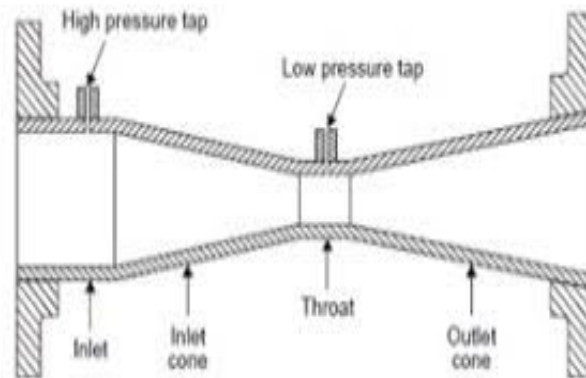
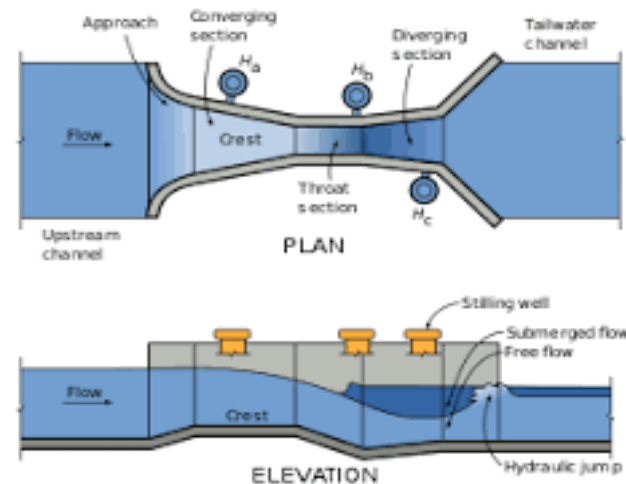


Fig 5.19 Short-form Venturi Tube

Short Throated Flumes

Parshall Flume is most well-known example of short throated flumes

- Developed by Ralph Parshall at Colorado Agricultural College (now Colorado State University)
- ASAE Historic Landmark



Measures flows in open channels

KSA 208 – SHOP MATHEMATICS

Grade 2 math problems are pump and motor efficiency, horsepower (brake/motor), flow rates, measurements, drive ratios and pressure.

What is the area of a triangle with a base of 13 feet and 7 inches and a height of 9 feet and 8 inches.



Base: 13 ft. 7 in.

$$\text{Area} = \frac{1}{2} \times B \times H$$

$$\text{Area} = \frac{1}{2} \times 13' 7'' (7/12=.58) \times 9' 8'' (8/12= .667)$$

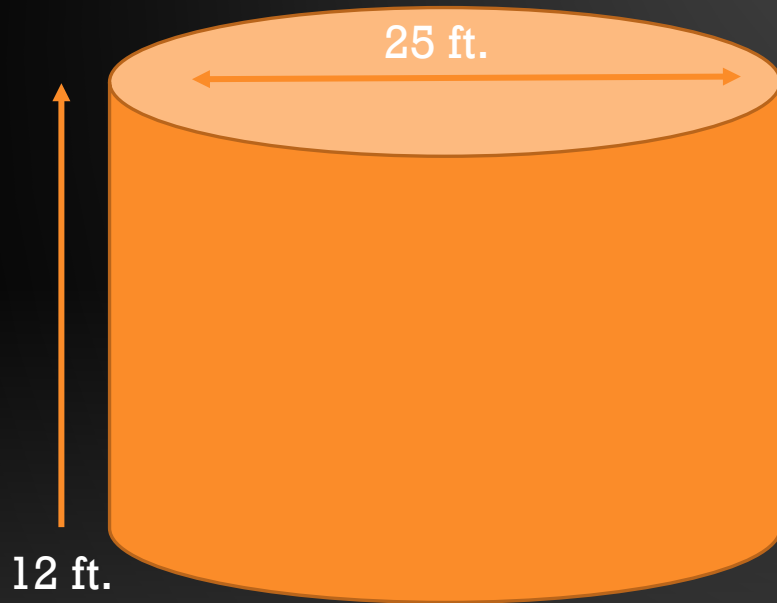
$$\text{Area} = \frac{1}{2} \times 13.58 \times 9.67$$

$$\text{Area} = \frac{1}{2} \times 131.3$$

$$\text{Area} = 65.66 \text{ sq. ft.}$$

KSA 208 – SHOP MATHEMATICS

The exterior walls of an open top tank are to be painted. If the tank is 25 feet in diameter and 12 feet high, what is the total surface work area of the tank in square feet?



$$\begin{aligned}\text{Area of a circle} &= \pi \times d \times h \\ \text{Area Circle} &= 3.14 \times 25 \times 12 \\ \text{Area Circle} &= 78.5 \times 12 \\ \text{Area Circle} &= 942 \text{ sq. ft.}\end{aligned}$$

KSA 208 – SHOP MATHEMATICS

How much more water will a 6-inch diameter pipe carry compared to a 3-inch diameter pipe under the same conditions.

3 inch diameter

$$\begin{aligned}\text{Area} &= \pi \times r^2 \\ \text{Area} &= 3.14 \times 1.5 \times 1.5 \\ \text{Area} &= 7.065\end{aligned}$$

$$\begin{aligned}\text{Area} &= .785 \times d \times d \\ \text{Area} &= .785 \times 3 \times 3 \\ \text{Area} &= .785 \times 9 \\ \text{Area} &= 7.065\end{aligned}$$

6 inch diameter

$$\begin{aligned}\text{Area} &= \pi \times r^2 \\ \text{Area} &= 3.14 \times 3 \times 3 \\ \text{Area} &= 28.26\end{aligned}$$

or

$$\begin{aligned}\text{Area} &= .785 \times d \times d \\ \text{Area} &= .785 \times 6 \times 6 \\ \text{Area} &= .785 \times 36 \\ \text{Area} &= 28.26\end{aligned}$$

$$28.26 / 7.065 = 4.00 \text{ times}$$

KSA 208 – SHOP MATHEMATICS

What is the decimal equivalent of 13/16 of an inch?

Decimal = 13/16

Decimal = 0.8125

What is the fraction equivalent of 0.875

Fraction = 0.875 x 4 or 8 or 16

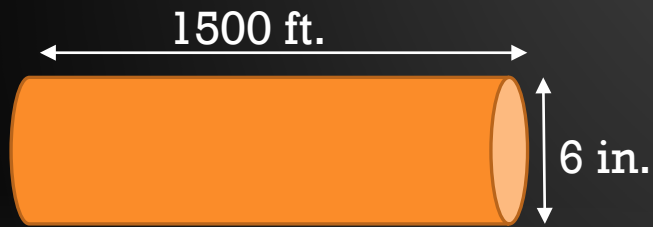
Fraction = 0.875 x 4 = 3.5 x common denominator 2 = 2 x 3.5 / 2 x 4 = 7/8

Fraction = 0.875 x 8 = 7/8

Fraction = 0.875 x 16 = 14 x common denominator 2 = 14/2 / 16/2 = 7/8

KSA 208 – SHOP MATHEMATICS

How many gallons of wastewater is in a 1,500 foot long 6-inch pipe?



$$6 \text{ in.} / 12 \text{ in.} = 0.5 \text{ ft.}$$

Formula = Volume cylinder = $3.14/4 \times \text{diameter}^2 \times \text{length}$

$$\text{Volume} = .785 \times .50 \times .50 \times 1500$$

$$\text{Volume} = .785 \times 0.25 \times 1500$$

$$\text{Volume} = .785 \times 375$$

$$\text{Volume} = 294.37 = 294.4 \text{ ft}^3$$

1 cubic foot = 7.48 gallons

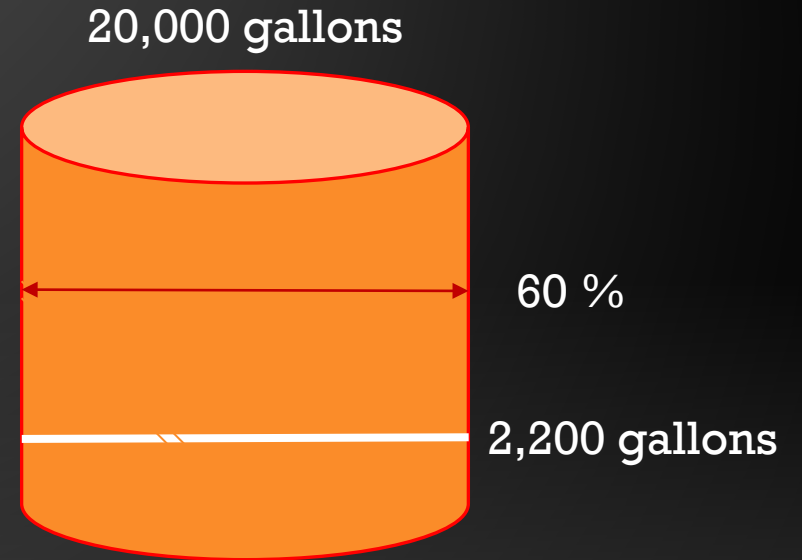
$$294.4 \text{ ft}^3 \times 7.48 \text{ gallons} = 2,202.1 \text{ gallons}$$

KSA 208 – SHOP MATHEMATICS

A Bioxide tank has a full working capacity is 20,000 gallons. Its current level is at 2,200 gallons. How many gallons does the delivery driver need to add to bring it to 60% capacity?

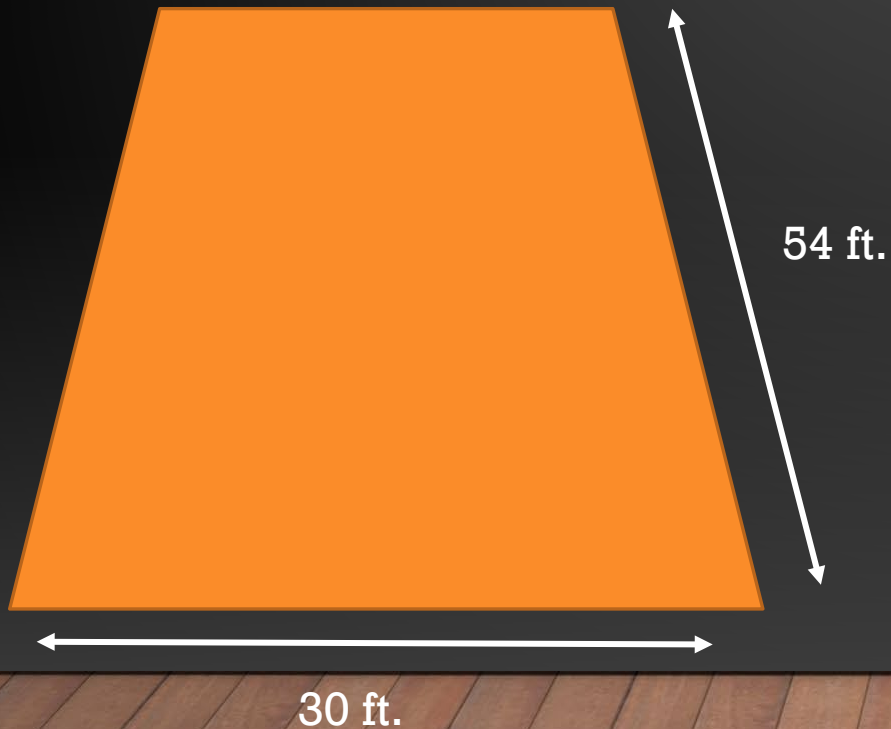
- A. 10,800 gal.
- B. 16,100 gal.
- C. 9,800 gal.
- D. 15,800 gal.

$20,000 / 100\% \text{ capacity} = 200 \text{ gallons in } 1\%$
 $200 \text{ gallons} \times 60\% = 12,000 \text{ gallons}$
 $12,000 \text{ gallons} - 2,200 \text{ gallons} = 9,800 \text{ gallons}$



KSA 208 – SHOP MATHEMATICS

The training room at your plant needs new carpet. If the room is rectangular in shape and measures 30 feet by 54 feet, how much carpet is needed in square yards?



Formula:

Area rectangle = (length x width)

$$AR = (30 \times 54)$$

$$AR = 1620 \text{ sq. ft.}$$

Square yards = 3 ft. x 3 ft.

Square Yards = 9

$$AR (\text{Sq. Yards}) = 1620 / 9$$

$$AR (\text{Sq. Yards}) = 180$$

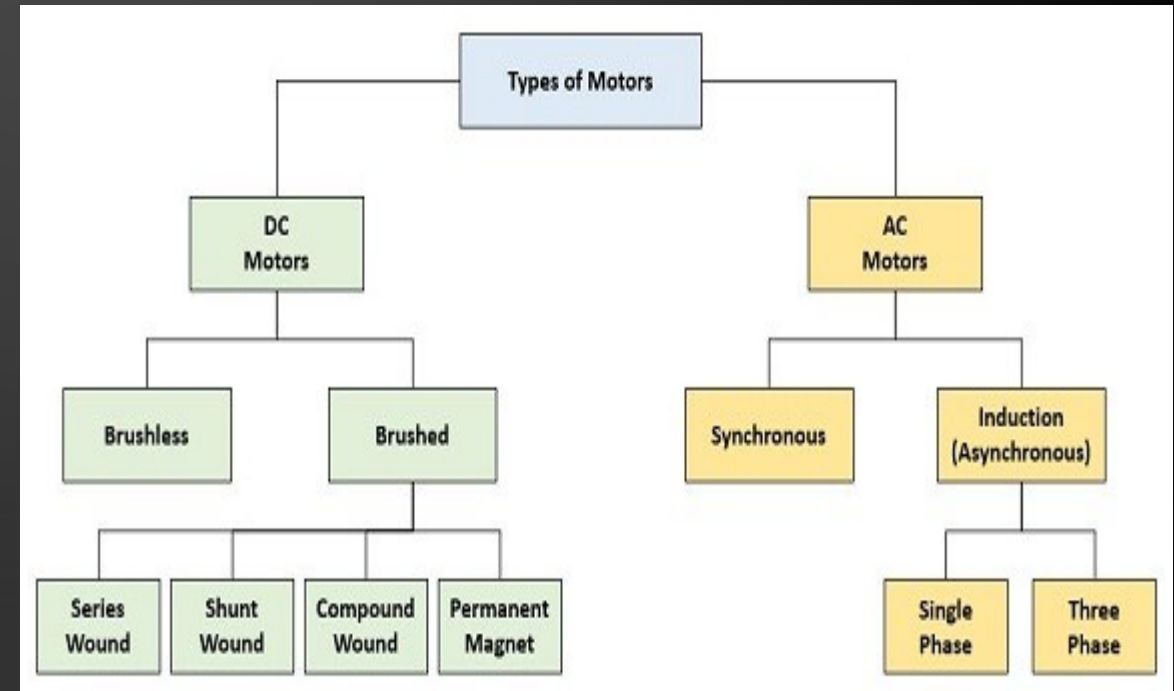
KSA 209 – ELECTRICAL PRINCIPLES

Electric motors are machines most commonly used to convert electrical energy into mechanical energy.

Motor Types:

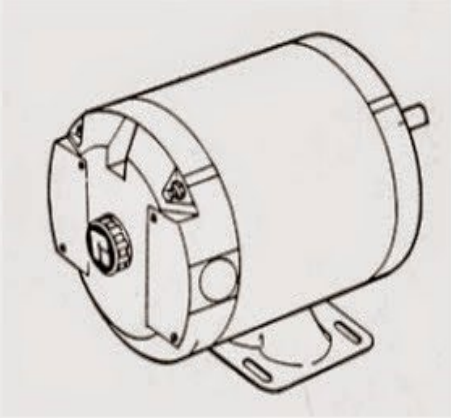
- Alternating Current (AC)
- Direct Current (DC)

The **most common** motor is the AC induction motor.

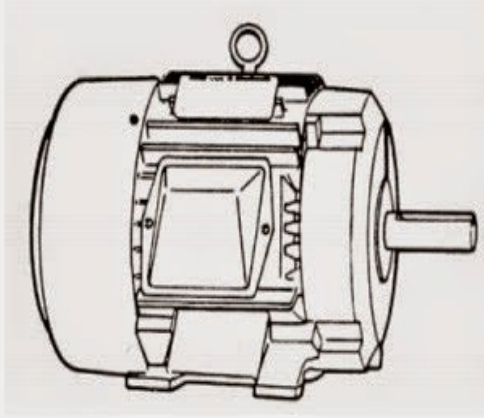


KSA 209 – ELECTRICAL PRINCIPLES

Synchronous vs Induction Motors



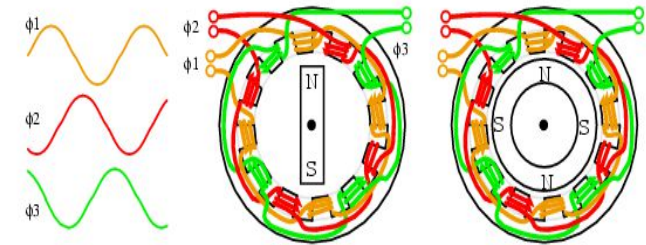
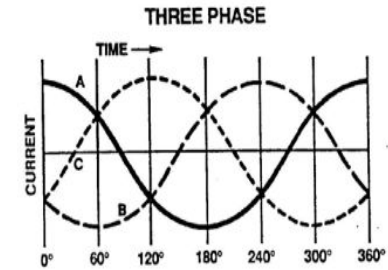
- Synchronous Motors
 - Turn at exactly the same speed as the rotating magnetic field.
 - 3600 rpm, 1800 rpm, etc.



- Induction Motors
 - Turn at less than synchronous speed under load.
 - 3450 rpm, 1740 rpm, etc.

Poles & Speed

- Motor speed is determined by number or North & South Coils in the motor (+/-)
- These always occur in twos 2-pole/4-pole/6-pole
- Formula for figuring speed in RPM
 - $120 \times \text{Frequency} / \text{Number of poles}$
 - 120 is constant
 - $120 \times 60 = 7200$
 - $7200 / 4 = 1800\text{RPM}$



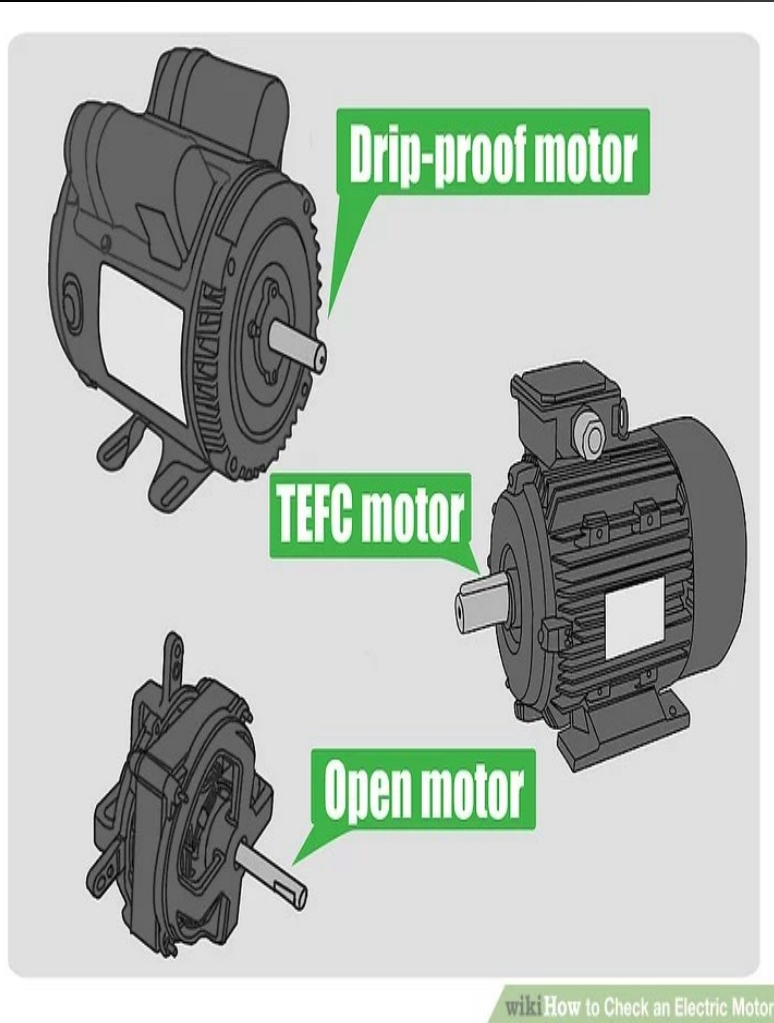
Two & Four Pole Three Phase Motors

KSA 209 – ELECTRICAL PRINCIPLES

Motor Nameplate Data:

- **Serial Number** – This is a unique number assigned by the manufacture based on their numbering system to identify that specific motor.
- **Type** – This maybe a combination of letters and numbers, to identify the enclosure and or modifications
- **Model Number** – Manufacture assigned identification number.
- **Frame** – This identifies the frame size in accordance with established NEMA Standards and does not vary from manufacturer to manufacturer.
- **Horsepower** – Rated Horsepower is the horsepower that the motor is designed to produce at the shaft when power is applied at a rated frequency, voltage and service factor of 1.00
- **Service Factor** – Service factors of 1.0 and 1.15 means that a motor can be operated at its rated horsepower without causing damage to the insulation system. A 1.15 SF can be operated occasionally at the rated horsepower times the service factor with no insulation damage.
- **Class of Insulation** – Classes A,B,E,F and H determine the operating temperature of the motor
- **Duty** – Continuous (24 hours a day, 365 days a year) or Intermittent (specified time of on and off cycle)
- **Ambient Temperature** – Maximum surrounding ambient air temp, exceeding this temp will damage insulation

KSA 209 – ELECTRICAL PRINCIPLES



- Drip-proof motors can be installed in damp or wet locations, so long as they are installed in such a way that water (and other liquids) can not enter due to gravity and must not be subjected to a stream of water (or other liquids) directed at or in it.
- TEFC motors on the other hand, can be used in all the previously mentioned areas but must not be submerged unless designed specifically for the purpose.
- Open motors are, as the name implies, completely open. The ends of the motor have rather large openings and the windings in the stator windings are plainly visible. These motors should not have these openings blocked or restricted and should not be installed in wet, dirty or dusty areas.

KSA 209 – ELECTRICAL PRINCIPLES

“Class I” Hazardous Areas

- Flammable Gasses and Vapors
- Present During Normal Operation
- Possibly Present During Breakdown Conditions
- Long List of Gasses in NEC
- Example Fuels – Gasoline & Propane
- Example Process Chemicals – Hexane & Ammonia

“Class II” Hazardous Areas

- Combustible Dust
- Present During Normal Operations
- Could be Present During a Breakdown
- Example – Corn, Wheat, Soybean Dust
- Example – Flour
- Example – Dust from Wood or Plastic

“Class III” Hazardous Areas

- Easily Ignitable Fibers and Materials that Produce Flammable Flyings
- Present Where Materials are Handled, Manufactured or Used
- Example – Where Raw Cotton is Handled and Stored

KSA 209 – ELECTRICAL PRINCIPLES

“Class I, Division 1”

- Ignitable Concentrations of Flammable Gasses & Vapors Exist During Normal Operations
- Ignitable Concentrations are Present Frequently Because of Repair, Maintenance, or Leakage
- Ignitable Concentrations Present During a Breakdown or Faulty Operation
- Example – Where Process is being Conducted with Hexane or Ammonia
- Example -Where Delivery Trucks are Unloaded

“Class I, Division 2”

- Where Flammable Gasses and Vapors are Handled but Normally Enclosed
- Would only be Present During Accidental Rupture or Breakdown
- Concentrations are Present but Below Ignitable Concentrations Because of Positive Ventilation
- Example – Areas or Rooms Adjacent to Class I, Division 1 Areas

KSA 209 – ELECTRICAL PRINCIPLES

“Class II, Division 1”

- Combustible Dust Present in the Air During Normal Operating Conditions in Quantities Sufficient to Produce Explosive or Ignitable Mixtures
- Where Mechanical Failure or Abnormal Operations Might Produce Explosive or Ignitable Mixtures
- Contains Dust of Electrically Conductive Nature
- Example -Areas by Open Conveyors or Open Top Bins
- Example - Dust of Magnesium or Aluminum

“Class II, Division 2”

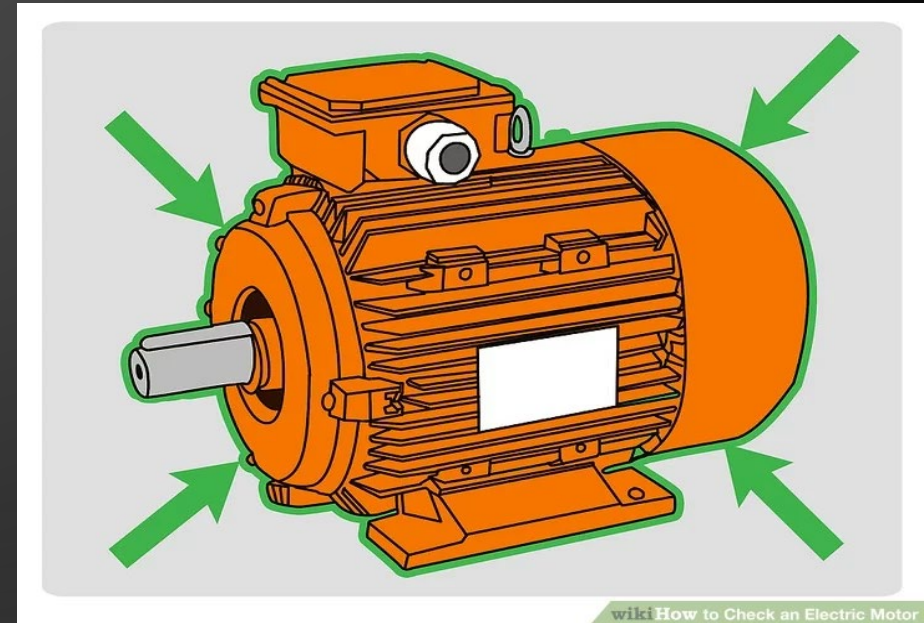
- Where Combustible Dust Present During Infrequent Malfunction but Not Normally Present in Ignitable Concentrations
- Areas Near Electrical Equipment Where Abnormal Operations May Cause High Heat
- Example – Areas Around Closed Conveyors
- Example – Areas Around Enclosed Process Equipment

KSA 209 – ELECTRICAL PRINCIPLES

Check the outside of the motor. If the motor has any of the following issues on the outside, they may be problems that can shorten the life of the motor because of previous overloading, wrong application, or both.

Look for:

- Broken mounting holes or feet
- Darkened paint in the middle of the motor (indicating excessive heat)
- Evidence of dirt and other foreign matter having been pulled into the motor windings through openings in the housing



KSA 209 – ELECTRICAL PRINCIPLES

What does NEC stand for?

- A. National Electrical Code
- B. National Engineering Code
- C. Natural Electronic Computers
- D. National Electronics Code

What does EMT stand for?

- A. Electrical Metal Tubing
- B. Electrical Measurement Timing
- C. Electrical Meter Timing
- D. Electrical Metal Transmitting

What device would be used to measure AC current flow in a large diameter conductor?

- A. A solenoid type tester
- B. A clamp-on type ammeter
- C. An ohmmeter
- D. A potentiometer

Which of the following can burn the insulation on the supply connections at the motor starter?

- A. Having the incorrect insulation
- B. The voltage running through the connections is too high
- C. The connections are loose or have poor contacts
- D. The voltage through the connections is too low

What does GFI stand for?

- A. Ground Fault Indicator
- B. Great Failure Indicator
- C. Ground Fault Interrupter
- D. Great Fault Interrupter

KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

Lock-out/Tag-out Procedures:

- Notification of all affected employees that a lockout or tagout is going to be performed and the reason why.
- Operate switches, valve, or other energy isolating device(s) so that the equipment is isolated from its energy source(s).
- Sometimes stored energy from flywheels, hydraulic systems, air gas and steam or water pressures need to be dissipated or restrained by methods such as repositioning, blocking or bleeding down.
- LO/TO the energy isolating device with assigned individual lock or tag.
- Make sure all affected staff is away from the equipment and conduct a start-up process in a normal sequence to verify that the system is disconnected/isolated.
- After the work is completed, confirm all tools have been removed, guards have been reinstalled, and employees are in the clear, remove all lockout or tag out devices.
- Energize the equipment and restore to operation.
- Locking and tagging devices shall only be removed by the person issued the devices.

KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

- **Authorized** employee shall receive training in the recognition of applicable hazardous energy sources....,
- **Affected** employee shall be instructed in the purpose, application, and use of....,
- **All other** employees, shall be instructed about the procedure, and about the prohibition relating to attempts to restart or reenergize machines or equipment which are locked out or tagged out.
- **Everyone** must understand the consequences of not following proper lockout procedures!

Per CCR8 Title 7 Section 3314 requires annual inspection of The lockout/tagout program to determine its continuity and if any changes are needed to procedures. This inspection needs to be performed by an “Authorized Employee or a person other than the one(s) utilizing the hazardous energy control procedures being inspected.”

The employer must certify that the periodic inspections have been performed. The certification shall:

- Identify the machine or equipment on which the hazardous energy control procedure was being utilized,
- The date of the inspection,
- The employees included in the inspection, and
- The person performing the inspection.

KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

Confined space:

- (1) Is large enough and so configured that an employee can bodily enter and perform assigned work; and
- (2) Has limited or restricted means for entry or exit; and
- (3) Is not designed for continuous employee occupancy”

Permit-required confined space: Means a confined space that has one or more of the following characteristics:

- (1) Contains or has a potential to contain a hazardous atmosphere;
- (2) Contains a material that has the potential for engulfing an entrant;
- (3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or
- (4) Contains any other recognized serious safety or health hazard”

- When testing for atmospheric hazards, test first for oxygen, then for combustible gases and vapors, and then for toxic gases and vapors.
- The employer shall retain each canceled entry permit for at least 1 year to facilitate the review of the permit space program.

KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

- The California Manual on Uniform Traffic Control Devices for Streets and Highways, defines the standards used by road managers in the State of California to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public travel.

Traffic Flaggers are required to wear the following:

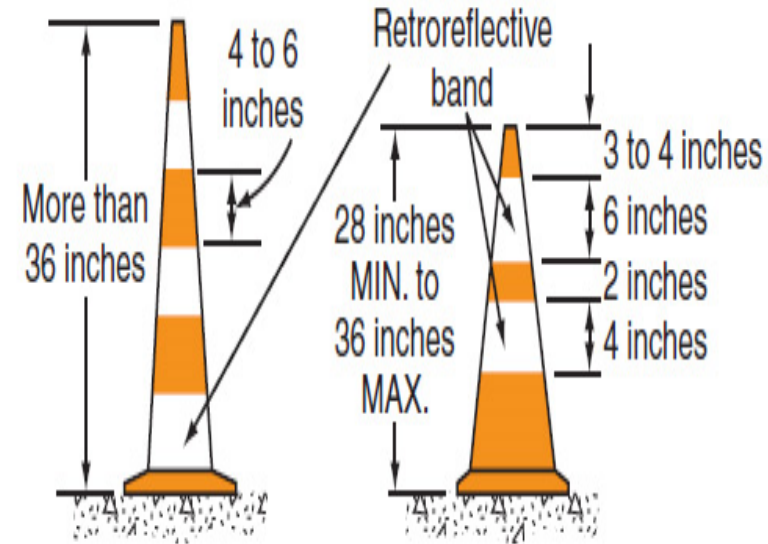
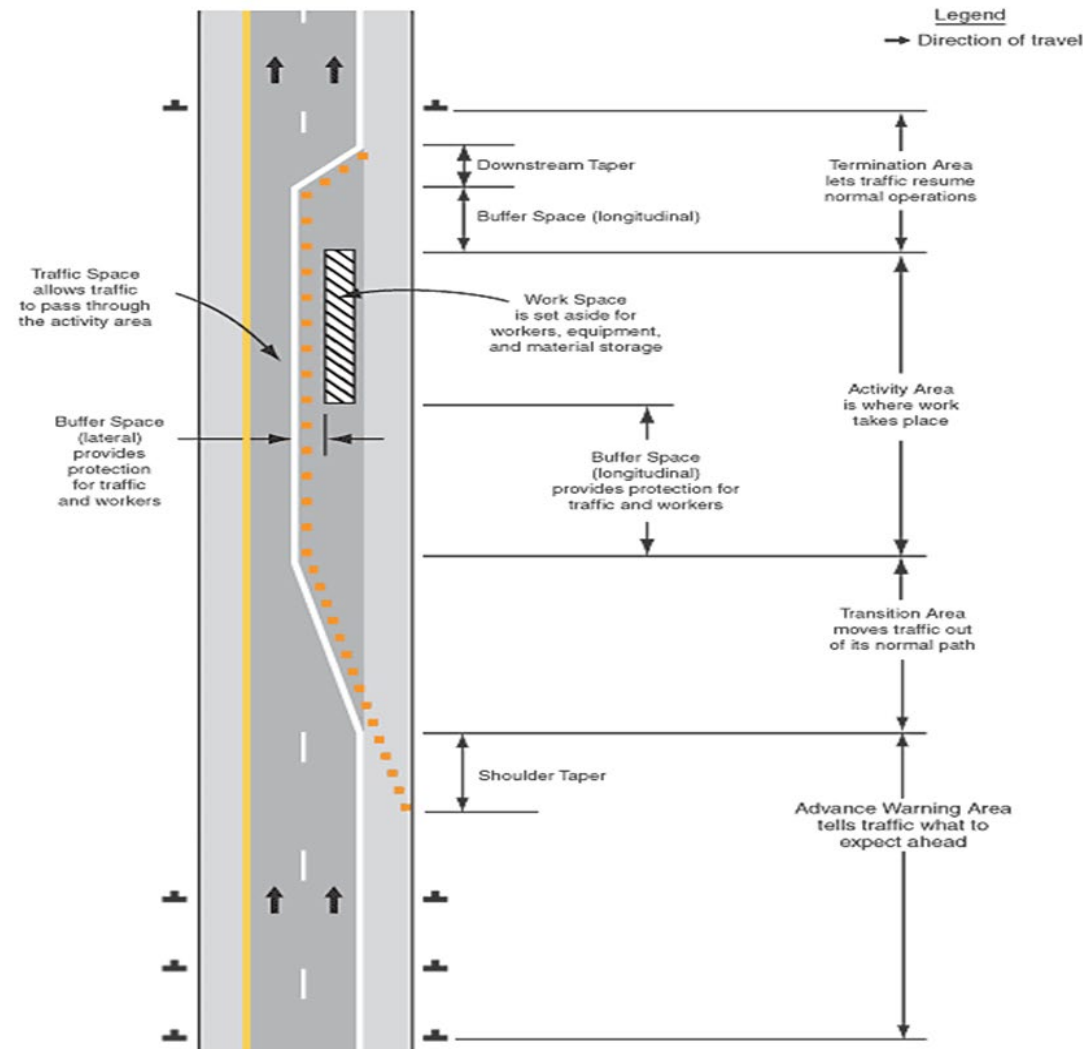
- The apparel background (outer) material color shall be fluorescent orange-red, fluorescent yellow-green, or a combination of the two (Class 2 or 3) as defined in the ANSI 107-2004 standard.
- The retroreflective material shall be orange, yellow, white, silver, yellow-green, or a fluorescent version of these colors, and shall be visible at a minimum distance of 1,000 feet.
- The retroreflective safety apparel shall be designed to clearly identify the wearer as a person.

The traffic control zone is the area between the first advanced warning sign and the point beyond the work area where traffic is no longer affected.

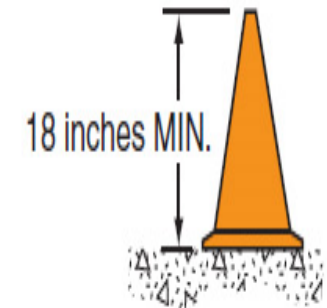
Traffic control zones are divided into these specific areas: Advanced Warning, Transition, Buffer Zone, Work, and Termination Area

KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

Figure 6C-1. Component Parts of a Temporary Traffic Control Zone



Night and/or freeway
High-speed roadway
(≥ 45 mph)

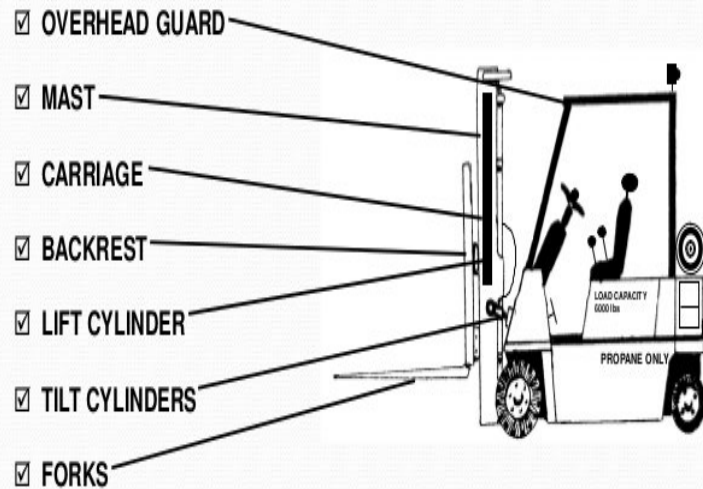


Day and low-speed
roadway (≤ 40 mph)

CONES

KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

BASIC FORKLIFT PRINCIPLES



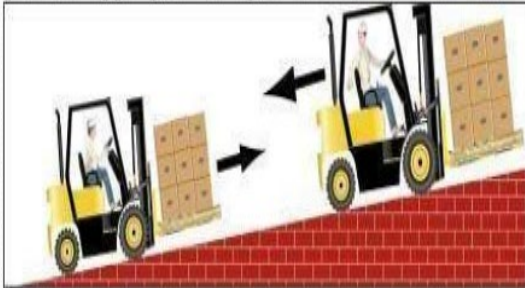
Safety Practices for the Operator

- Only trained authorized personnel are permitted to operate a forklift.
- The operator should not drive the truck up to a person standing in front of a bench or other object.
- The operator should not carry loads heavier than those for which the truck is rated.
- The operator should avoid making fast starts, sudden stops and quick turns.
- The operator should report all accidents involving personnel, building structures and other equipment immediately.
- Operation on main roads outside the facility should be permitted only with proper authorization from local transport authority.

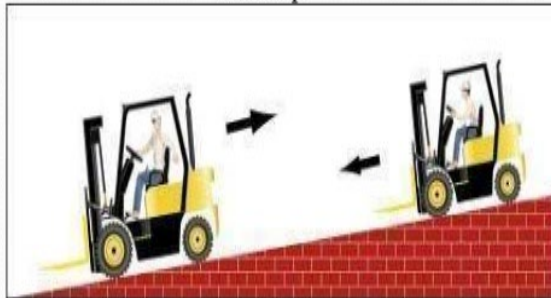
KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

DRIVING ON AN INCLINED

Always drive with the load on the uphill side - go backwards driving down the incline and frontwards going up the incline to prevent tipping or losing control of the forklift.



If no load on the forklifts, do the opposite with forks pointing down the ramp



MORE REASONS WHY FORKLIFTS TIP OVER

- Driving too fast around a corner
- Driving off edge of platform, ramp, road or other surface
- Driving an indoor forklift outdoors on rough, uneven ground
- Turning on an incline or hill



WHAT DO IN CASE OF A TIPPING OVER



- Do not jump
- Hold onto the steering wheel
- Brace your feet
- Lean away from the fall



KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

FORKLIFTS AND PEDESTRIANS

- ❖ Slow down and sound horn at intersections, corners, and wherever your vision is obstructed.
- ❖ When provided, use flashing warning light or backup alarms when traveling in reverse.
- ❖ Always look in the direction of travel.
- ❖ Signal to pedestrians to stand clear.
- ❖ Do not allow anyone to stand or walk under upraised forks.
- ❖ When possible, make eye contact with pedestrians or other forklift operators before moving in their path



FORKLIFT DO'S AND DON'TS

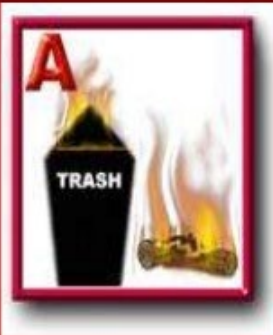
- No one else on the forklift except the operator, unless the forklift has a seat for a rider.
- Always drive with the forks lowered and lower forks to floor when parking the forklift.



Watch overhead clearances – especially entering or exiting buildings or when you are raising a load on the forks.

KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

🔥 How fires are classified 🔥



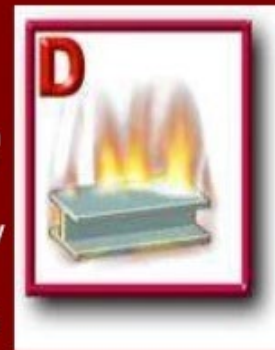
Ordinary combustibles or fibrous material, such as wood, paper, cloth, rubber and some plastics.

Flammable or combustible liquids such as gasoline, kerosene, paint, paint thinners and propane.



Energized electrical equipment, such as appliances, switches, panel boxes and power tools.


















Certain combustible metals, such as magnesium, titanium, potassium and sodium. These metals burn at high temperatures and give off sufficient oxygen to support combustion. They may react violently with water or other chemicals, and must be handled with care.



KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

(g) Safety Data Sheet Format

1. Identification of the substance or mixture and of the supplier
2. Hazards identification
3. Composition/information on ingredients
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information (non-mandatory)
13. Disposal considerations (non-mandatory)
14. Transport information (non-mandatory)
15. Regulatory information (non-mandatory)
16. Other information, including date of preparation or last revision

OLD			NEW		
Symbols	Description		GHS-Symbols	Description	Hazard statement examples
	E	Explosive		GHS01 Exploding bomb	Explodes due to fire, shock, friction or heat; danger due to fire, blast and projectiles.
	F+	Extremely flammable		GHS02 Flame	Flammable; catches fire spontaneously if exposed to air; in contact with water releases flammable gases which may ignite spontaneously.
	O	Oxidizing		GHS03 Flame over circle	May cause fire or explosion; strong oxidizer.
No equivalent				GHS04 Gas cylinder	Contains gas under pressure; may explode if heated; contains refrigerated gas; may cause cryogenic burns or injury.
	C	Corrosive		GHS05 Corrosion	May be corrosive to metals; causes severe skin burns and eye damage.
	T+ T	Very toxic Toxic		GHS06 Skull and crossbones	Small quantities are harmful or fatal.
	Xn	Harmful	No direct equivalent		
	Xi	Irritant			
No equivalent				GHS07 Exclamation mark	Harmful, irritates eyes, skin or respiratory system; large quantities are fatal.
No direct equivalent				GHS08 Health hazard	Causes allergic reactions; may cause cancer, may cause genetic defects; may damage fertility or the unborn child; causes damage to organs.
	N	Dangerous for the environment		GHS09 Environment	Harmful, toxic or very toxic to aquatic life with long lasting effects.

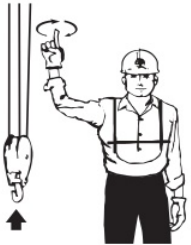
KSA 210 – INDUSTRIAL SAFETY STANDARDS & REGULATIONS

PERSONAL PROTECTION INDEX							
A				G	+ +		
B	+			H	+ + +		
C	+ +			I	+ +		
D	+ +			J	+ + +		
E	+ +			K	+ + +		
F	+ + +			X	Consult your supervisor or S.O.P. for "SPECIAL" handling directions		
A		n		o		p	
Safety Glasses		Splash Goggles		Face Shield & Eye Protection		Gloves	
t		u		w		y	
Dust Respirator		Vapor Respirator		Dust & Vapor Respirator		Full Face Respirator	
				z		Additional Information	
				Airline Hood or Mask			

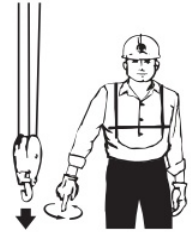
Facility Results™ Electrical System Reliability & Safety Solutions		
FlashTrack™ Change Management Compliance Tool		
Electrical Personal Protective Equipment Chart NFPA 70E 2012 Table 130.7 (C)(16) Protective Clothing & Personal Protective Equipment (PPE) <small>*For More Detailed Information or Other Options Refer to NFPA 70E 2012 Edition, Table 130.7 (C)(16)</small>		
Hazard/Risk Category 0	Untreated natural fiber Shirt (long sleeve) Pants (long) Safety glasses Hearing protection Heavy duty Leather gloves (as needed)	
Hazard/Risk Category 1 4 cal/cm ²	Arc-rated long-sleeve shirt Arc-rated pants or coverall Arc-rated face shield with hard hat Safety glasses Hearing protection Leather & voltage rated gloves (as needed) Leather work shoes	
Hazard/Risk Category 2 8 cal/cm ²	Arc-rated long-sleeve shirt Arc-rated pants or coverall (New 2012) Arc-rated face shield & balacava or arc flash suit hood with hard hat Safety glasses, Hearing protection Leather & voltage rated gloves (as needed) Leather work shoes	
Hazard/Risk Category 3 25 cal/cm ²	Arc-rated long-sleeve jacket Arc-rated pants Arc-rated flash hood with hard hat Safety glasses, Hearing protection Leather & voltage rated gloves (as needed) Leather work shoes	
Hazard/Risk Category 4 40 cal/cm ²	Arc-rated long-sleeve jacket Arc-rated pants Arc-rated flash hood with hard hat Safety glasses, Hearing protection Leather & voltage rated gloves (as needed) Leather work shoes	
FacilityResults.com Info@FacilityResults.com (888) 762-0090 Facility Results © 2012		

KSA 211: LIFTING AND MOVING HEAVY EQUIPMENT

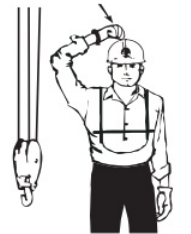
STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS



HOIST. Forearm vertical, forefinger pointing up, move hand in small horizontal circles.



LOWER. Arm extended downward, forefinger pointing down, move hand in small horizontal circles.



USE MAIN HOIST. Tap fist on head; then use regular signals.

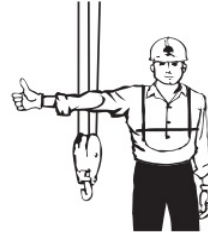


EPC of JIC Cooling Plant 098-C58

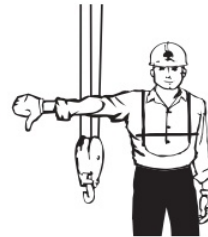
STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS (cont.)



USE WHIPLINE. Tap elbow with one hand; then use regular signals.



RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.

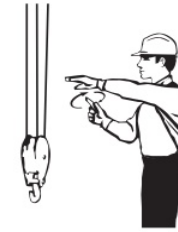


LOWER BOOM. Arm extended, fingers closed, thumb pointing down.

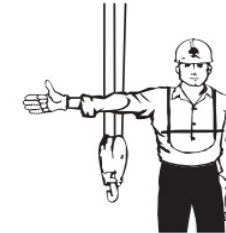


EPC of JIC Cooling Plant 098-C58

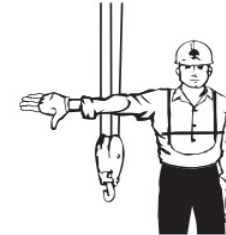
STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS (cont.)



MOVE SLOWLY. One hand gives motion signal, other hand motionless in front of hand giving the motion signal.



RAISE THE BOOM AND LOWER THE LOAD. Arm extended, thumb pointing up, flex fingers in and out.



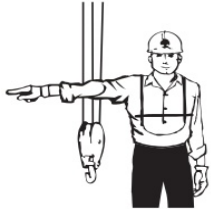
LOWER THE BOOM AND RAISE THE LOAD. Arm extended, thumb pointing down, flex fingers in and out.



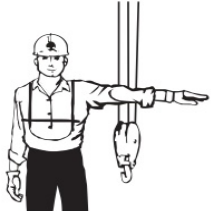
EPC of JIC Cooling Plant 098-C58

KSA 211: LIFTING AND MOVING HEAVY EQUIPMENT

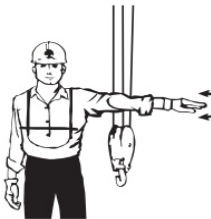
STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS (cont.)



SWING. Arm extended, point with finger in direction of swing.



STOP. Arm extended, palm down, hold.



EMERGENCY STOP. Arm extended, palm down, move hand rapidly right and left.

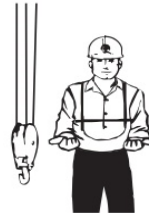


EPC of JIC Cooling Plant 098-C58

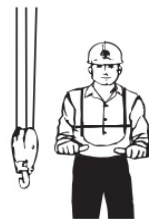
STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS (cont.)



TRAVEL. Arm extended forward, hand open and slightly raised, pushing motion in direction of travel.



EXTEND BOOM. Both fists in front of body with thumbs pointing outward.



RETRACT BOOM. Both fists in front of body with thumbs pointing toward each other.



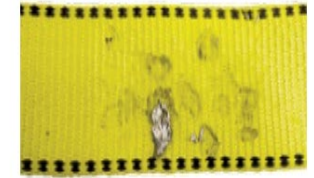
EPC of JIC Cooling Plant 098-C58

EXAMPLES OF WEB SLINGS TO BE REMOVED FROM SERVICE:

SLING KNOT



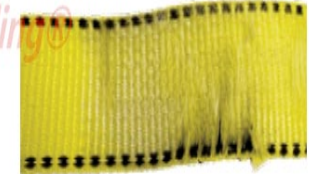
SLING WELD SPLATTERS



SLING CUTS



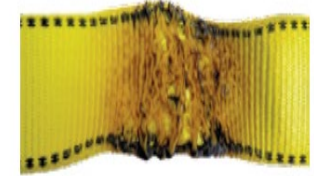
SLING ABRASION



SLING FRAYS AND PULLS



SLING ACID BURN



KSA 212 – PROPER USE OF TOOLS

- **Wrenches – Open-end, Box and Combination**
 - Always try to pull on wrenches that way your body weight and foot are sound.
 - Wrenches between $\frac{1}{4}$ in. to $1 \frac{1}{4}$ IN. are in increments of $\frac{1}{16}$ of an inch.
 - Metric wrenches span from 7mm to 32mm and are stepped in 1-mm increments.
- **Ratchets** are made in $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, and 1-inch square drives, the larger the size the greater the capacity of the ratchet.
- **Sockets** are regular and extra deep, with openings of 12, 8, 6-point, and square.
- **Adjustable wrenches**, sometimes called “fits all” provide a wide range of single tool usage. When using this type of wrench always make sure you apply the force to the fixed jaw.
- **Screwdrivers** are a must for every toolbox, they are intended for one simple use: driving and withdrawing threaded fasteners.

KSA 212 – PROPER USE OF TOOLS

Portable Power Tools: Battery-Powered Tools have made the mechanics job safer in the fact that “electrical tools are not carried by their power cords” and that “extension cords don’t need to be deployed creating a tripping hazard.” The weight and flexibility of these tools are ever advancing with longer battery life and power.

A **hammer drill** is used to drill “blind” holes in concrete that are used as a base for anchors to attach machine base or structural member to the concrete. Hole are drilled to a prescribed depth.

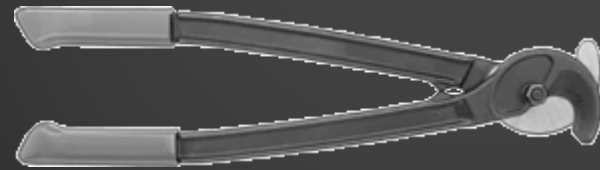
A “**thread chaser**” is used to repair damaged internal threads, while a “tap” repairs external threads.

Hammers come in many styles: ball-peen, cross-peen and straight peen, finishing, claw, sledge, etc. The word “peen” means the end of a hammer head opposite the face when adapted for striking; it is usually shaped for indenting when pointing, conical, hemispherical or wedged shaped.

KSA 212 – PROPER USE OF TOOLS



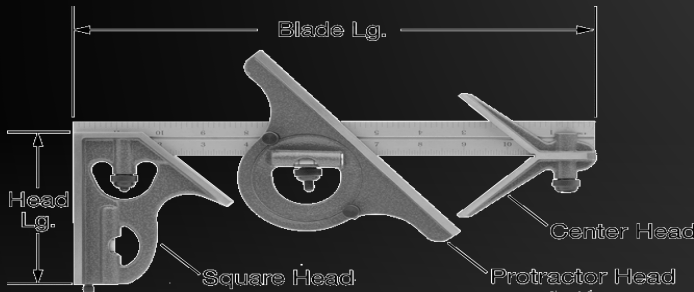
Electric Rotary Hammers



Electrical and Data Cable Cutters



Tube Benders



Combination Squares



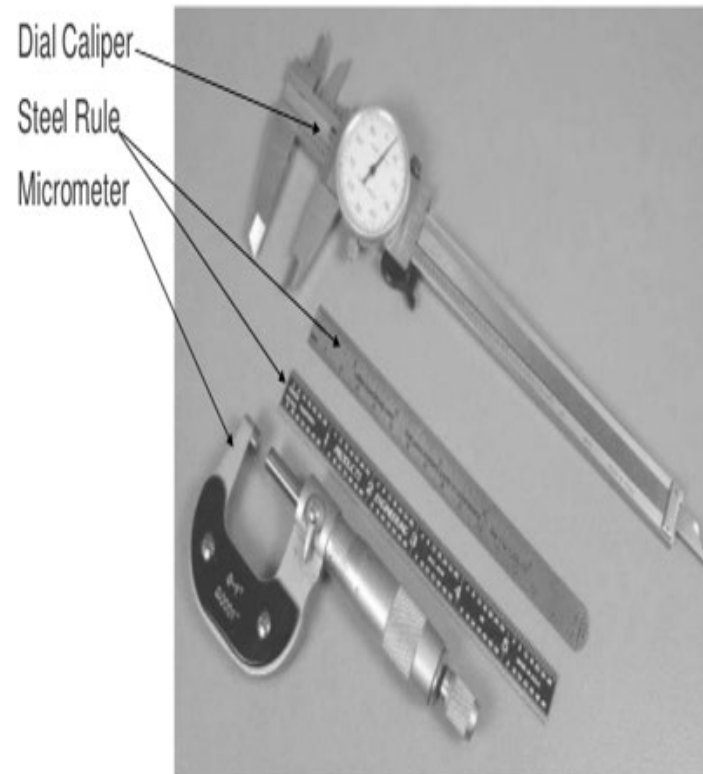
**Threads per Inch and
Thread Pitch Identifiers**



Micrometer

KSA 212 – PROPER USE OF TOOLS

Precision Measurement Tools



Dial Caliper

A dial caliper is a precision measuring device that can measure in thousandths of an inch. The dial caliper functions as an:

- Outside caliper
- Inside caliper
- Depth gauge



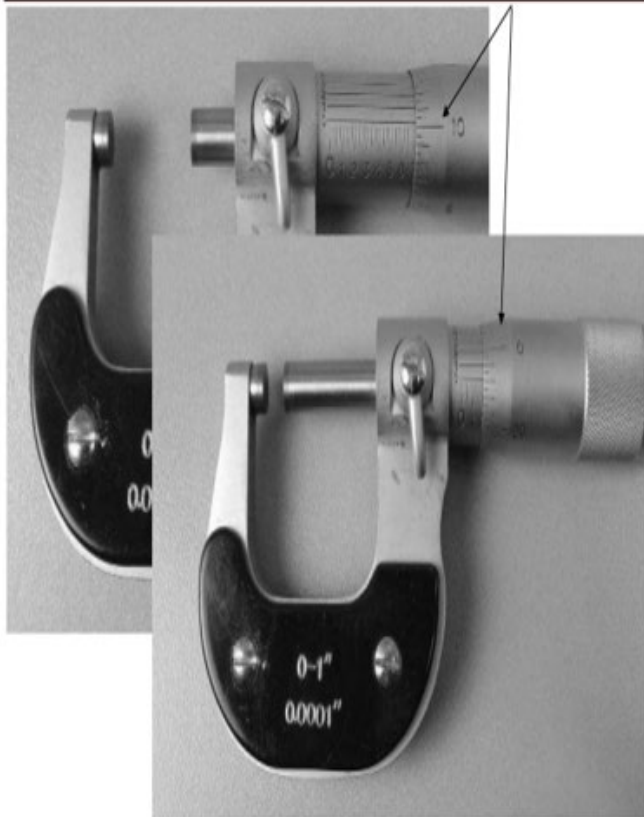
Micrometer



KSA 212 – PROPER USE OF TOOLS

Micrometer - thimble

The thimble has a graduated scale that runs from 0-25.

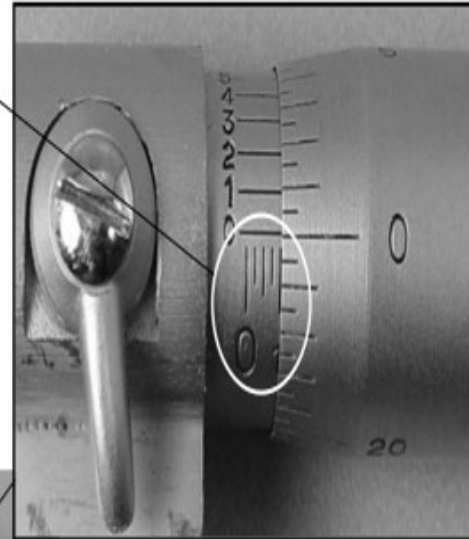


Reading the Micrometer

There are four marks on the barrel.

$$4 \times .025 = .100$$

Zero marks on the thimble.



The micrometer reads
.100 of an inch

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Reading the Micrometer

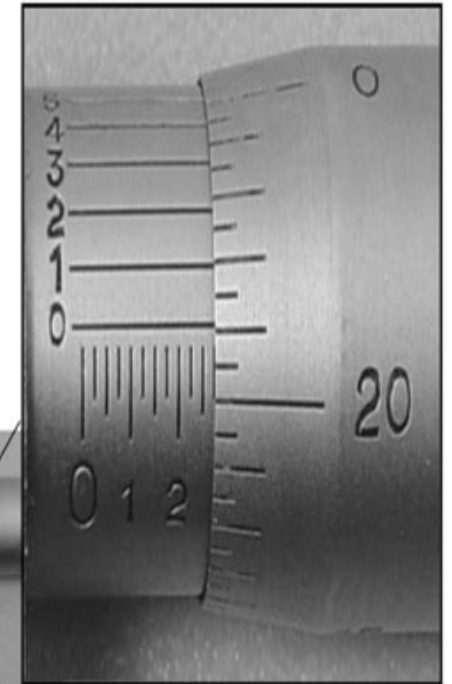
Two numbers on the barrel

$$.200$$

There are almost three lines after the last whole number

$$2 \times .025 = .050$$

21 on the thimble.

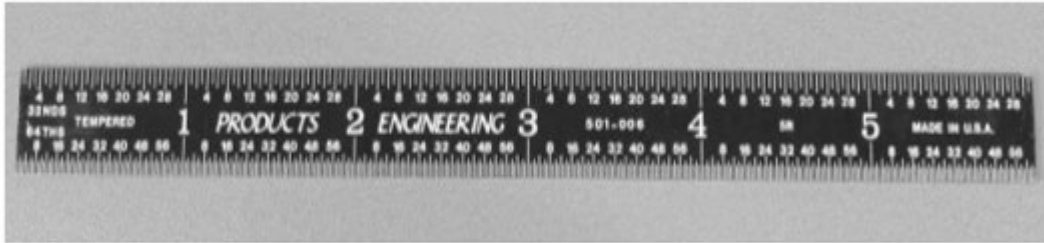


.271 or two hundred seventy one thousandths

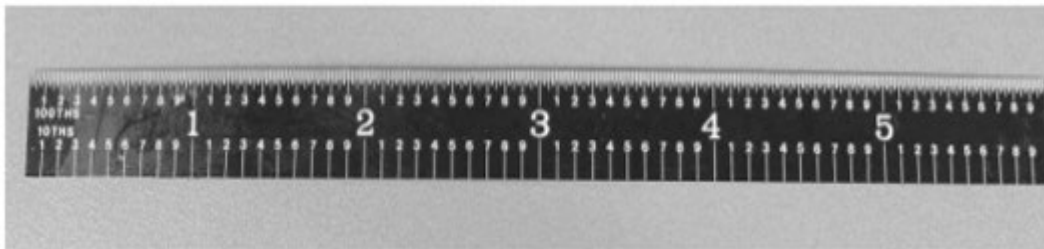
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KSA 212 – PROPER USE OF TOOLS

Steel Rules



The top rule measures in fractional values

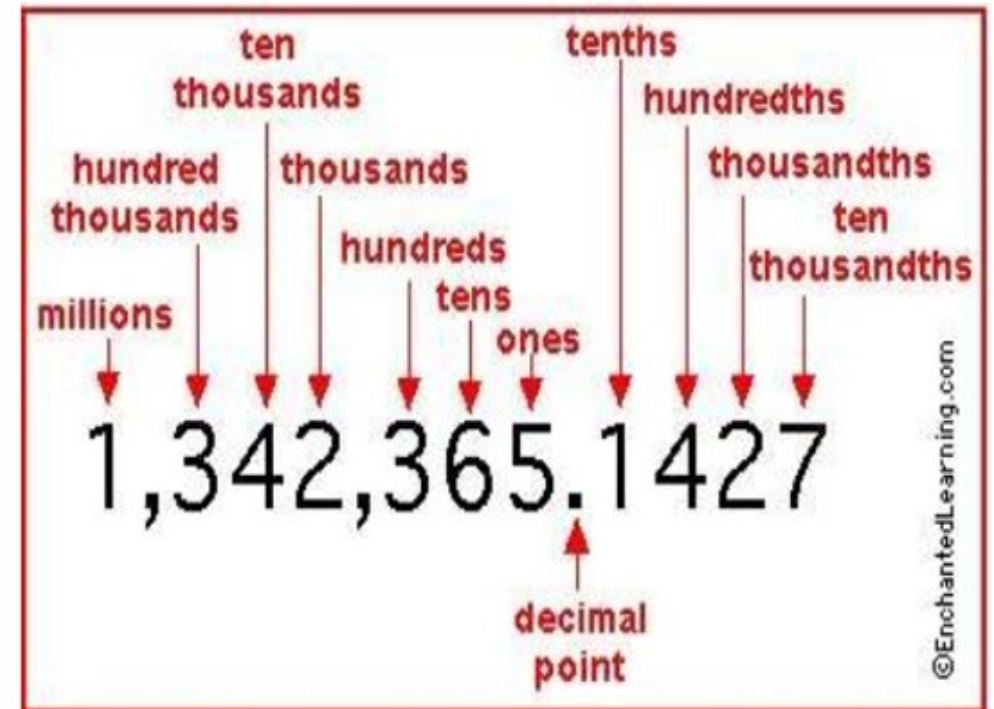


The bottom rule measures in decimal values

Write This Down!

Inches to mm = Multiply by 25.4

Mm to inches = Divide by 25.4



KSA 213 – CONSTRUCTION METHODS AND MATERIALS

Unified Thread designation – When designating a screw thread , the standard method is to specify in sequence the nominal size, number of threads per inch, thread series symbol and thread symbol class.







For example: a $\frac{3}{4}$ in. Unified Coarse series thread for a common fastener would be designated as follows:
 $\frac{3}{4}$ - 10 UNC 2A

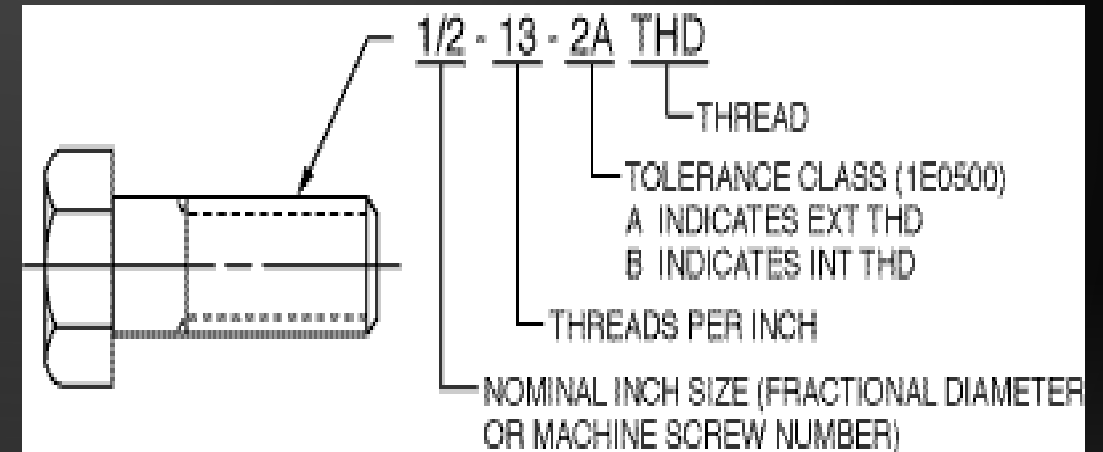
- Coarse-thread series is designated by the symbol UNC and is generally utilized for bolts, screws, nuts and other general applications.
- Fined-threads series is designated by the symbol UNF and applies to the same materials as coarse.
- Extra-fine threads is designated by the symbol UNEF. It is used where even finer pitches of threads are desirable for a short length of engagement and for thin-walled tubes, nuts, ferrules or couplings .
- Thread classes also establishes limit of tolerances called classes. Classes 1A, 2A and 3A apply to external threads only and classes 1B, 2B and 3B apply to internal threads only.
- Classes 3A and 3B provide the closest tolerances and 1A and 1B are used on threaded components where quick and easy assembly is necessary .

KSA 213 – CONSTRUCTION METHODS AND MATERIALS

External Threaded Fastener Grade Markings

Grade Markings are applied to fasteners for obvious reasons. At a quick glance a user can identify the strength of a fastener. A grade marking combined with a reputable identification marking provides confidence to the user. Before 1969, Ford required fasteners of grade 5 or greater strength to bear manufacturer identification markings but not always grade markings. e.g. Most 1955-68 body bolts are heat treated to grade 5 or 5.1 but do not usually have the grade markings to indicate such. For 1969 Ford rewrote "the book" regarding most fasteners. New improved fastener designs like the "UBS" bolt and nut were introduced along with consistent use of grade markings.

		MATERIAL	HARDNESS	TENSILE STRENGTH
	GRADE 2	Low or Medium carbon steel	1/4" - 3/4" dia under 6" Rockwell B80 - B100	1/4" - 3/4" dia under 6" 74,000 PSI Minimum
	GRADE 3	Medium carbon steel	1/4" - 3/4" dia under 6" Rockwell B95 - B104	1/4" - 3/4" dia under 6" 110,000 PSI Minimum
	GRADE 5	Medium carbon steel, quenched & tempered	1/4" - 1.0" dia Rockwell C25 - C34	1/4" - 1.00" dia 120,000 PSI Minimum
	GRADE 5.1	Low or Medium carbon steel, quenched & tempered	1/4" - 1/2" dia Rockwell C25 - C40	1/4" - 1/2" dia 120,000 PSI Minimum
	GRADE 6	Medium carbon steel, quenched & tempered	1/4" - 1.0" dia Rockwell C30 - C36	1/4" - 1.0" dia 140,000 PSI Minimum
	GRADE 8	Medium carbon alloy steel, quenched & tempered	1/4" - 1 1/2" dia Rockwell C33 - C39	1/4" - 1 1/2" dia 150,000 PSI Minimum



KSA 213 – CONSTRUCTION METHODS AND MATERIALS

Concrete Information:

Aggregate: The inert filler material that makes up the bulk of concrete. Usually sand, gravel, and rocks. Fibers and reinforcing bars are not considered aggregate.

Cement: This word can mean several very different things: the dry unreacted powder that comes in a sack, the sticky fluid stuff formed just after water is added, and the rocklike substance that forms later on.

Cement paste: Cement (see above) that has been mixed with water. Usually, the term implies that it has already become hard.

Concrete: A mixture of sand, gravel, and rocks held together by cement paste. The world's most widely-used man-made material.

KSA 213 – CONSTRUCTION METHODS AND MATERIALS

Curing/Hardening: Essentially interchangeable terms that mean the process of continued strength gain after the cement paste has set due to chemical reactions between cement and water.

Fresh: Refers to cement paste or concrete that has been recently mixed and is still fluid.

Hardened: Refers to cement paste or concrete that has gained enough strength to bear some load.

Heat of hydration: Like most spontaneous chemical reactions, the hydration reactions between cement and water are exothermic, meaning that they release heat. Large volumes of concrete can warm up considerably during the first few days after mixing when hydration is rapid. This is generally a bad thing, for reasons that will be discussed.

Hydration: The chemical reactions between cement and water. Hydration is what causes cement paste to first set and then harden.

Mature: Refers to cement paste or concrete that has reached close to its full strength and is reacting very slowly, if at all. An age of 28 days is a very rough rule of thumb for reaching maturity.

Mortar: A mixture of cement paste and sand used in thin layers to hold together bricks or stones. Technically, mortar is just a specific type of concrete with a small maximum aggregate size.

KSA 213 – CONSTRUCTION METHODS AND MATERIALS

Steel trowels purpose: Used after floating to produce a smooth, hard, dense slab surface.

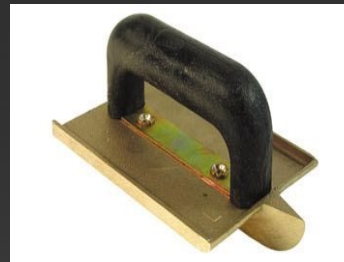


Tampers push the coarse aggregate in the concrete below the concrete surface and consolidate the concrete.



Groovers

Jointing the concrete is accomplished by grooving tools (unless the slab will be sawcut later). The purpose is to control the location of cracks that may form when the slab "contracts" due to drying shrinkage or temperature changes.



Floats purpose: To level ridges, fill voids, and smooth the surface in preparation for troweling. Unlike trowel finishing, floating won't close the surface, which is important at this stage to permit water to bleed out. A float also helps bring paste to the surface by pushing down the coarse aggregate

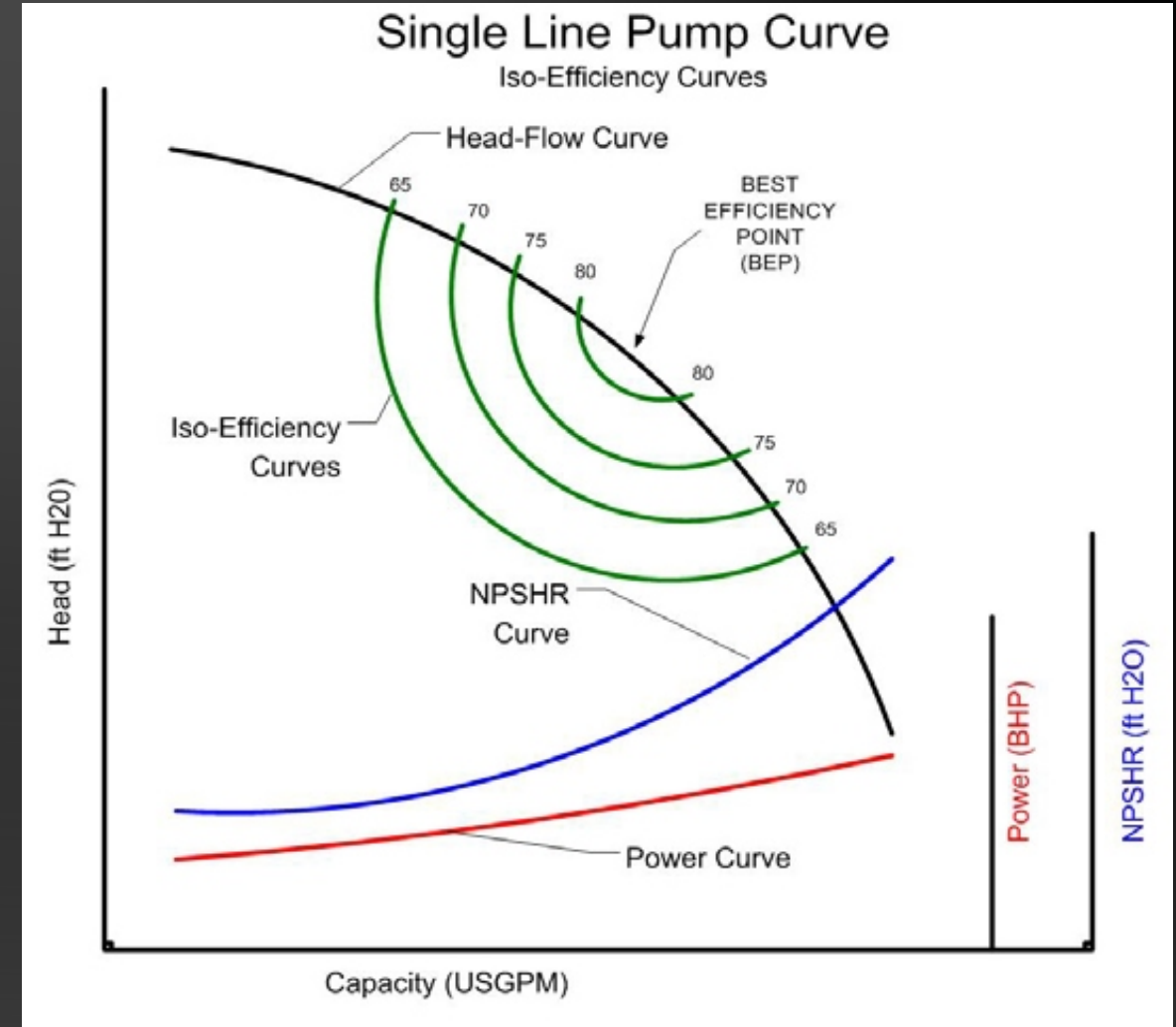
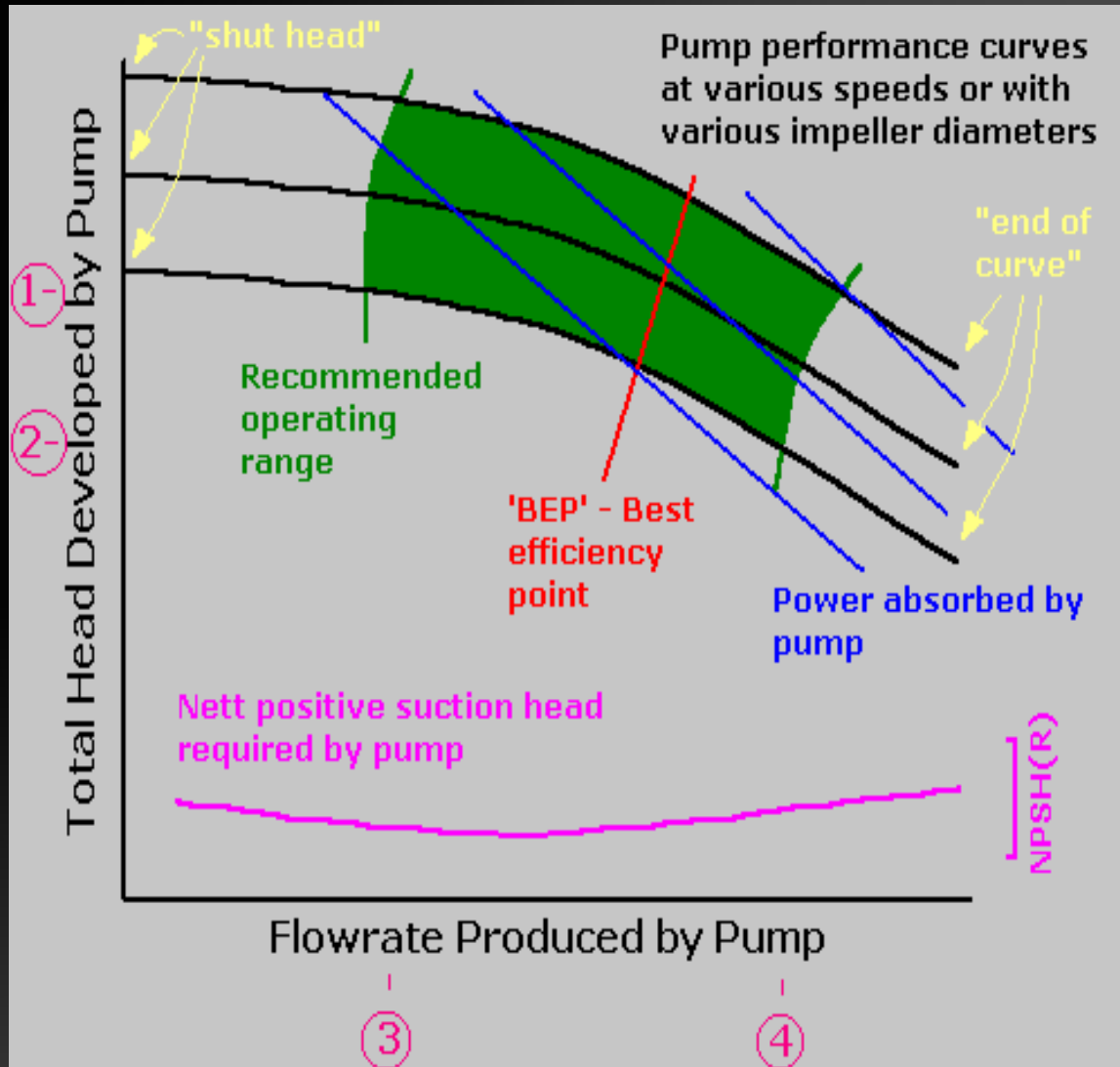


Edgers produce a neat rounded edge along the slab perimeter which helps the slab resist chipping and spalling damage after the forms are removed. Perform edging after the bleedwater disappears from the concrete surface, but before the forms are removed

KSA 214: INTERPRETING & APPLYING INFORMATION

- Collection of data without analysis, interpretation, and use of results is a waste of time and money.
- When reporting data, always write clearly and neatly. Records are not useful unless they are evaluated and used as indicators of plant operations and maintenance.
- Remember these records are public, so what you write needs to be professional.
- An excellent way to review of daily records and detect sudden changes or trends is a prepared chart showing values plotted against days. Unless results are plotted slight changes can go undetected.
- Effective O&M programs are based on knowing what components make up the system, where they are located and the condition of the components. With that information, proactive maintenance can be planned and scheduled, rehabilitation, needs identified and long-term Capital Improvement Programs (CIP) planned and budgeted.
- Wastewater Treatment Plant maintenance can either be proactive or a reactive activity.
- There are three types of maintenance classifications: corrective maintenance, preventative maintenance and predictive maintenance.
- Two types of emergency maintenance involves normal emergencies and extra-ordinary emergencies.
- Normal emergencies are blockages, power failures and can be reduced with an effective maintenance program.
- Extra-ordinary emergencies are those such as high-intensity rainstorms earthquakes, lightning strikes, heavy winds.

KSA 214: INTERPRETING & APPLYING INFORMATION



KSA 215/16: RELATIONSHIPS IN THE WORKPLACE & COMMUNICATION

- If it is not written down “IT DID NOT OCCUR” this must not be taken lightly! At the end of the day your hand should hurt, from logging pertinent information.
- DON’T just look or write down a number from a pressure gauge or other instrument, know what that means.
- Log Books are legal binding documents that need to be treated like such. Clear writing, single line corrections with initials (example: Serviced grit pump, checked ~~v-belt~~ RAD cog-belt tension, deflection of 1 inch recorded.)
- Never ever use correction fluid (white out). It is like saying I am trying to hide something.

KSA 215/16: RELATIONSHIPS IN THE WORKPLACE & COMMUNICATION

Hazardous Communication and Workers Right to Know laws were established to ensure that employers provide their employees with the training and PPE to properly handle and store chemicals. The basic elements of this program are:

- Identify Hazardous Materials – What chemicals are you exposed to on a daily basis in your work environment.
- Obtain Safety Data Sheets – These are provided by the chemical manufacturers and are required by Cal-OSHA. They detail the chemical make-up of the product and all safety aspects that need to be followed to properly used.
- Properly Label Hazards – Specialized identification on the containers that identify their contents.
- Training – Making information available to staff for them to use in everyday maintenance routines.

KSA 215/16: RELATIONSHIPS IN THE WORKPLACE & COMMUNICATION

Conducting meetings:

- **Before the meeting:** Prepare an agenda and distribute it to all participants, find an adequate meeting room, set a beginning and end time.
- **During the meeting:** Start the meeting on time, clearly state the purpose and objectives of the meeting, involve all the participants, do not let one or two individuals dominate the meeting, keep the discussions on track and on time with the agenda, when the group makes a decision or reaches consensus, restate your understanding of the results, make clear assignments for participants and review them with everyone during the meeting.
- **After the meeting:** Send out minutes of the meeting, send out reminders about assignments given, if any.

Communication – Oral and Written

- Communication is a two-part process; information must be given and it must be understood. Good listening skills are as important in communication as the information you need to communicate.
- During oral communication observe your audience of one or many to insure what you are saying is getting across.
- If you are talking to an operator or supervisor, it is a good idea to ask for feedback
- Written communication is more difficult and requires more organization since you cannot clarify and explain ideas in response to the person reading your report or document.

KSA 215/16: RELATIONSHIPS IN THE WORKPLACE & COMMUNICATION

Telephone Contacts: First impressions are extremely important and frequently a person's first contact with a wastewater plant is over the telephone.

A person who answers the phone in a courteous, pleasant and helpful manner goes a long way toward establishing a friendly, cooperative atmosphere.

Answer calls promptly, your conversation will get off to a better start if you answer by the third or fourth ring.

Identify yourself, this adds a personal note and lets the caller know whom he or she is talking to.

Pay attention, don't conduct side conversations, minimize distractions, giving the caller your full attention and take notes so that you have clarity of the call once it ends. Minimize transfers, no body likes to get run-around.

Accident Reporting: should be simple and record all details required by law and all data needed for statistical purpose. The report must show the name of the injured, employee number, division, time of injury, nature of injury, cause of incident, first aid administered and remarks for items not covered elsewhere.

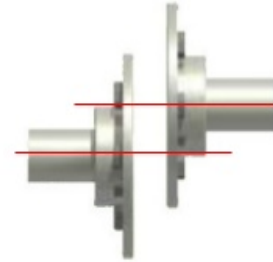
Worker's compensation reports will be required and any other state or federal requirements.

KSA 217: POWER TRANSMISSION EQUIPMENT

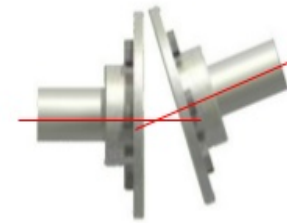
Types of Couplings

- Rigid – usually must be aligned to very close tolerances. Think of it as solidly bolting one shaft to another.
 - Flexible – uses one or more elements to connect the shafts.
 - Mechanical
 - Elastomeric
 - Metallic
- These can tolerate slightly more misalignment, thermal changes, and shock.

Types of Misalignment



Offset, or Parallel – the shafts are parallel to each other, but are not co-planar, or in the same plane. This can be both vertical and horizontal.



Angular – the shafts are not in the same plane, which causes a difference in measurement between measurements made 180 degrees opposite on the coupling faces.

It's almost always a combination of both!

KSA 217: POWER TRANSMISSION EQUIPMENT

Rigid Coupling



Flexible (Disc) Coupling



Roller-Chain Coupling



Spider coupling



Grid
Coupling



Gear Coupling



Grid-align
Coupling



KSA 217: POWER TRANSMISSION EQUIPMENT

Error #3

Not correcting for soft foot

Soft foot...

Soft foot occurs when machine feet do not rest flatly on the machine base.



Soft foot is caused by deformed machine base plates or by deformed machine feet.

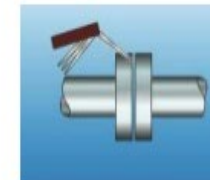
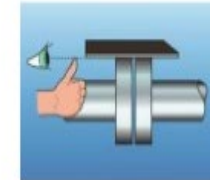


Soft foot can be offset, angular, or both.

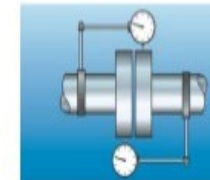
Common alignment methods

FLUKE®

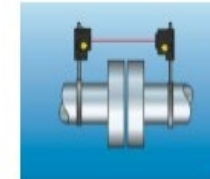
Straightedge/Feeler gauge
Resolution 1/10 mm



Dial indicator
Resolution 1/100 mm

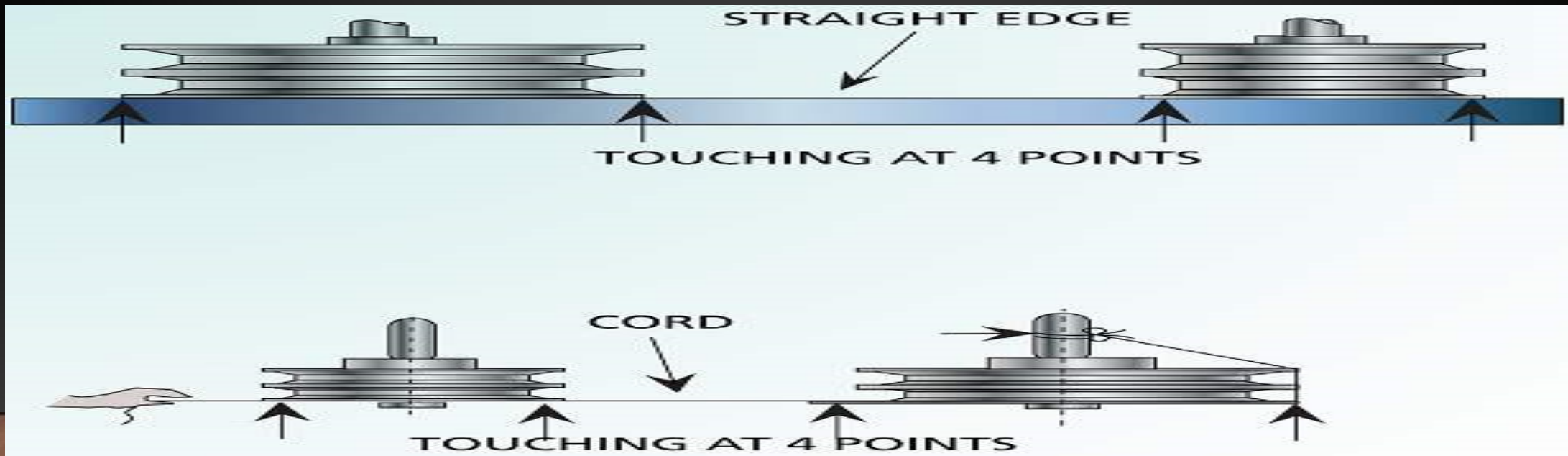
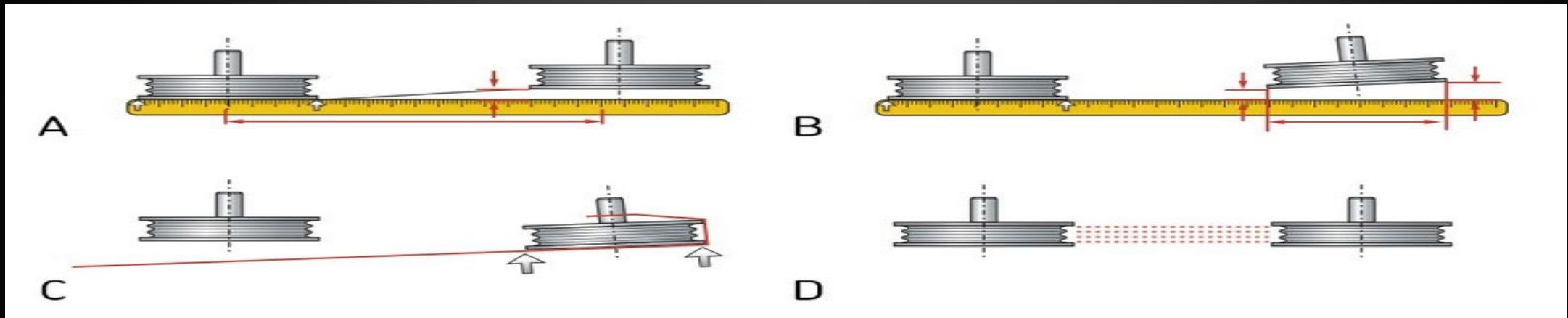


Laser-optical alignment
Resolution 1/1000 mm



TRANSCAT
Better by every measure

KSA 217: POWER TRANSMISSION EQUIPMENT



KSA 217: POWER TRANSMISSION EQUIPMENT

Gear types may be grouped into five main categories:

- Spur
- Helical
- Bevel
- Hypoid, and
- Worm

Belt drives are simple, inexpensive, and do not require axially aligned shafts. Flat belts, Rope drives, Round belts, V belts, Multi-groove belts, Ribbed belt and Film belts.

All v-belts have a 40° angle between the faces, except the V series (aka "Harvester" or "Wedge" belts), which have a 30° angle between the faces. The inside edge of the belt is wider than the base of the V in a v-belt pulley - the belt touches the pulley only on the sides.

Accessory drive belts are of two types, V-belts (conventional, cogged and multi-ribbed) and serpentine (multi-ribbed) belts. A V-belt rides in V-shaped pulleys to rotate various accessories, such as the power steering pump, air conditioner compressor, alternator/generator, water pump, and air pump.

QUESTIONS?

Thank You, Best wishes on your upcoming Test!

Robert Delgado
rdelgado@ieua.org



QUESTIONS & ANSWERS

Contact Hours

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