MECHANICAL TECHNOLOGIST GRADE 3 TEST PREP

CWEA - SARBS TRAINING

SEPTEMBER 17, 2020

ROBERT DELGADO

MANAGER OF OPERATIONS AND MAINTENANCE

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. 3

KSA'S - KNOWLEDGE, SKILLS AND ABILITIES

KSA 301: Welding 5%

KSA 302: Engine Repair and Troubleshooting 4%

KSA 303: Maintenance Management Program 5%

KSA 304: Wet Well Cleaning and Repair 4%

KSA 305: Train and Mentor Staff 5%

KSA 306: Pump Repair and Maintenance 9%

KSA 307: Pipeline and Valves 4%

KSA 308: Compressor, Turbines, Blowers 7%

KSA 309: Process Equipment 9%

KSA 310: Shop Mathematics 5%

KSA 311: Electrical Principles (Safety-Repair) 2%

KSA 312: Field Safety 8%

KSA 313: Crane Operations 5%

KSA 314: Tool Usage (Train and Apply) 6%

KSA 315: Facility Maintenance 4%

KSA 316: Prints, Specifications, Manuals 4%

KSA 317: Working Relationships 3%

KSA 318: Communication 3%

KSA 319: Power Transmission Equipment 6%

KSA 320: Contingencies and Emergency Plans 2%

KSA 301 – WELDING

TWO CATEGORIES OF WELDING PROCESSES

FUSION WELDING:

- Base metal is melted.
- Filler metal may be added.
- Heat is supplied by various means:
  - Oxyacetylene gas
  - Electric Arc
  - Plasma Arc
  - Laser

SOLID STATES WELDING:

- A welding process in which two work pieces are joined under a pressure providing an intimate contact between them and at a temperature essentially below the melting point of the parent material.
- Heat and/or pressure are used to achieve coalescence, but no melting of base metals occurs.
- No filler metal is added.
  - Examples: forge welding, diffusion welding, friction welding.

KSA 301 – WELDING

Cold welding (a.k.a. contact welding): A solid-state welding process in which joining takes place without fusion/heating at the interface of the two parts to be welded.

Pressure welding: A solid-state welding process in which the parts are not melted, although heat is usually required. Recrystallization across the interface occurs. Also referred to as resistance welding and spot welding.

Friction welding (FRW): A solid-state welding process that generates heat through mechanical friction between workpieces in relative motion to one another, with the addition of a lateral force called "upset" to plastically displace and fuse the materials. Because no melting occurs, friction welding is not a fusion welding process in the traditional sense, but more of a forge welding technique

Explosion welding (EXW): A solid state welding process where welding is accomplished by accelerating one of the components at extremely high velocity through the use of chemical explosives. This process is most commonly utilized to clad carbon steel plate with a thin layer of corrosion resistant material (e.g., stainless steel, nickel alloy, titanium, or zirconium)

KSA 301 – WELDING

Brazing	*Soldering*
• Filler metal has the melting point above 400^{0}C.	• Filler metal has the melting point below 400^{0}C.
• More stable joints can be made.	• Less stable joints can be made.
• High pressure and temperature do not affect the joint.	• Joints are affected by high temperature and pressure.
• Equipment cost is more.	• Equipment cost is very low.

What is an Electric Arc?

An electric arc is a discharge of electric current across a gap in a circuit

- It is sustained by an ionized column of gas (*plasma*) through which the current flows
- To initiate the arc in AW, electrode is brought into contact with work and then quickly separated from it by a short distance

KSA 301 – WELDING

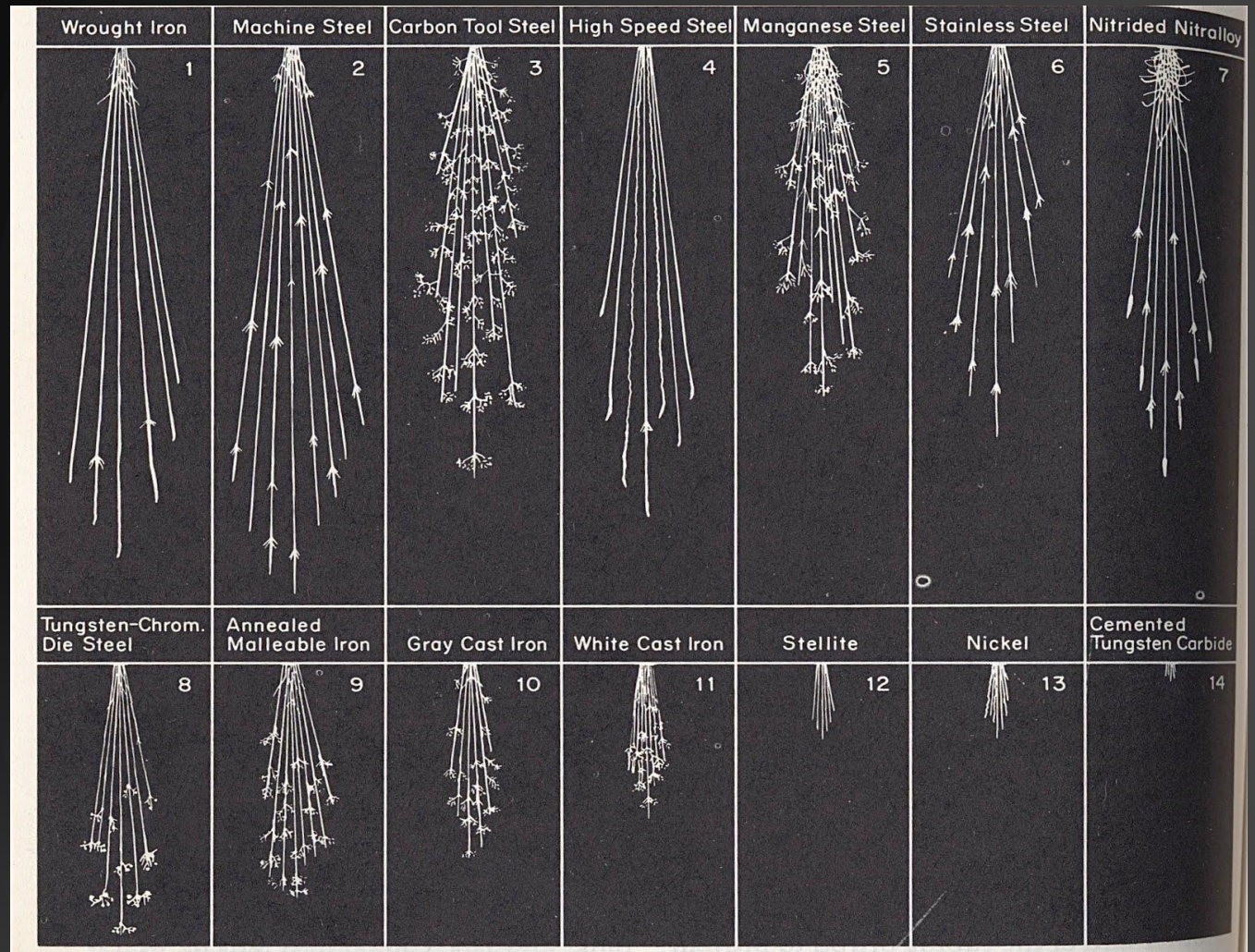


Fig. 10–8 Spark patterns produced by various metals and alloys when held against a carborundum grinding wheel.

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 302 – REPAIR & TROUBLESHOOT ENGINES

- To be an effective troubleshooter of any type of machinery or engines you must be able to see, smell, feel and hear. These sense assist in determining what system is having a problem and what needs to be done to return the equipment to normal operation.
  - Remember communications are vital with Plant Operators.

- Engine Horsepower is based on the well-known fact that one mechanical horsepower is equivalent to 33,000 foot-pounds of work in one minute or 500 foot-pounds of work in one second.

- The most common failure of gear fuel pumps are seals leaking from worn shafts and or bushings.

KSA 302 – 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 302 – ENGINE MAINTENANCE

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

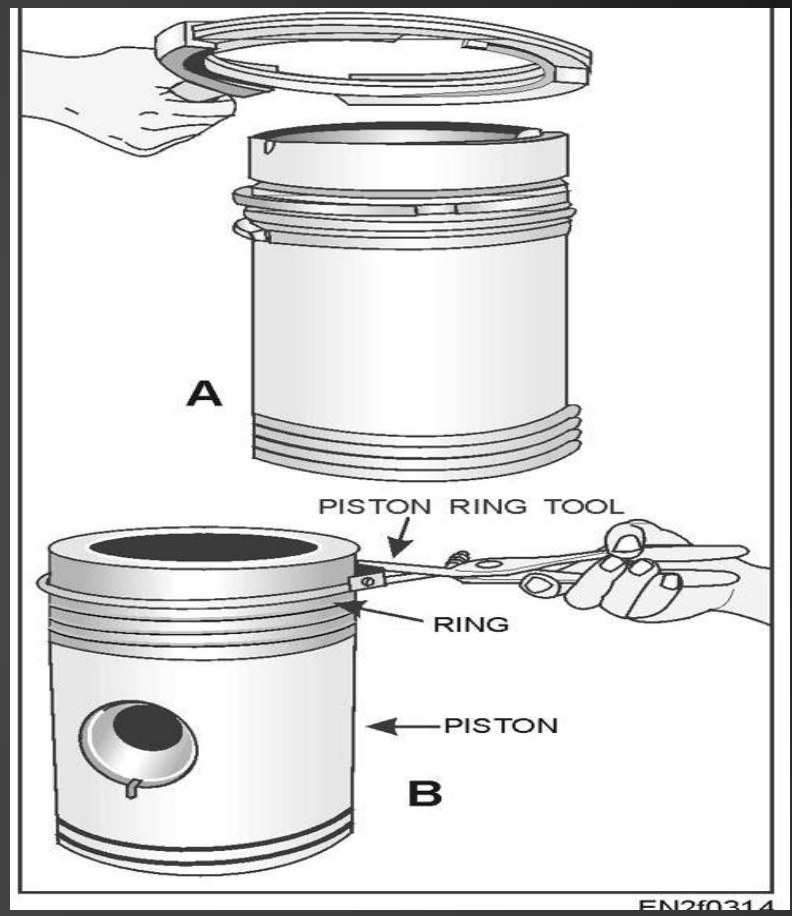
KSA 302 – REPAIR & TROUBLESHOOTING ENGINES

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 302 – REPAIR & TROUBLESHOOTING 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 302 – REPAIR & TROUBLESHOOTING 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 303 – MAINTENANCE MANAGEMENT

- The installation of a Maintenance Management system of either a manual or computerized system. Whatever mode(s) your facility chooses, the overall outcome is to have a Preventative, Predictive and Corrective Maintenance Program that will assist in making valued decisions.

- Preventative Maintenance is time based. Certain tasks such as lubrication, inspection or adjustments are made at a required time or frequency on a piece of machinery.

- Predictive Maintenance makes use of physical measurements on a machine, such as vibration levels, bearing conditions, noise emission reading, oil sample results or temperature and compares these readings to the norm. It also trends readings to determine impending failure in a machine or components.

KSA 303 – MAINTENANCE MANAGEMENT

Logical steps on establishing a successful Maintenance Management Program:

- Get a process drawing, building equipment location drawing or other "map" of the plant or process that list all the equipment and shows the location.

- Make a list of equipment that will need to be implemented into the program. It is beneficial to group the equipment by name, number, location and type.

- If equipment has never been numbered, it might be a smart idea to "adopt" an intelligent numbering system that helps in sorting or locating the equipment.
  - PU-2004. A Pump located on the second and the fourth one in the process train.
  - 100-EX-405. A heat Exchanger in building 100 on the fourth floor and the fifth item in the process train.
  - 100-AC-405. An AC motor used to drive the gear pump on the heat exchanger shown in the previous entry

KSA 303 – MAINTENANCE MANAGEMENT

- Locate all maintenance manuals for the equipment: Make sure to ask for "cut sheets" or "exploded diagrams" to make spare-part identification easier when working on the equipment.
- Schedule a meeting with the O&M personnel: Review the manufacturers' information with others and see if the recommended PM strategies makes sense. Some manufacturers will use an overkill approach and suggest much more PM than is necessary.
- Begin setting up the maintenance activities: Pay attention to common types of equipment (gear boxes, motors) and common activities (greasing, oil changes, chain inspections).
- Setup work orders with routes: Scheduling things to be accomplished so that staff use their time properly. Incorporate the entire Maintenance Management system into the daily planning and scheduling of personnel.
- Conduct audits every three to six months to determine the efficiency of the program and modify the program to change tasks, change frequencies, add or remove equipment, change routes or change personnel based on results of the audits.

KSA 304 – MANAGE MAINTENANCE RECORDS.

- The goal of managing maintenance is to minimize investments in labor, materials, money and equipment. In other words, we want to manage our human and material resources as effective as possible, while delivering a high level of service to our customers.

The benefits of an effective operation and maintenance program are as follows:

- Ensuring the availability of facilities and equipment as intended.
- Maintaining the reliability of the equipment and facilities as designed.
- Obtaining full use of the system throughout its design life.
- Collecting accurate information and data on which to base the operation and maintenance of the system and justify requests for the financial resources necessary to support it.

KSA 305 – TRAIN AND MENTOR STAFF

- Training has become an ongoing process in the workplace. The manager "must" provide new employee training as well as ongoing training for all employees. Safety training is particularly important for all staff members.

- Certification of mechanics assures the municipality, utility, JPA, etc. that the facility is going to be maintained by qualified mechanics who posses a certain level of competence.

- One area of training that is frequently overlooked is training for supervisors. Managing people requires a different set of skills than performing the day to day work maintaining a wastewater treatment facility.

- Supervisors need to know how to communicate effectively and how to motivate others, as well as how to delegate responsibility and hold people accountable for their performance.

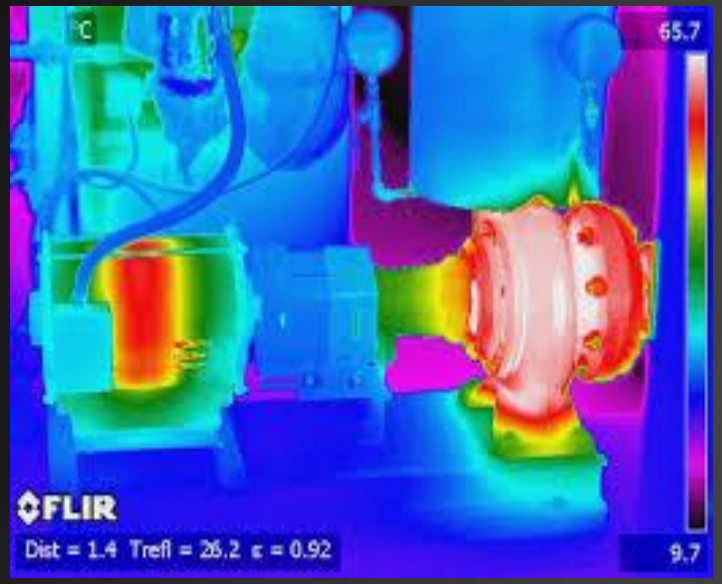
KSA 305 – TRAIN AND MENTOR STAFF

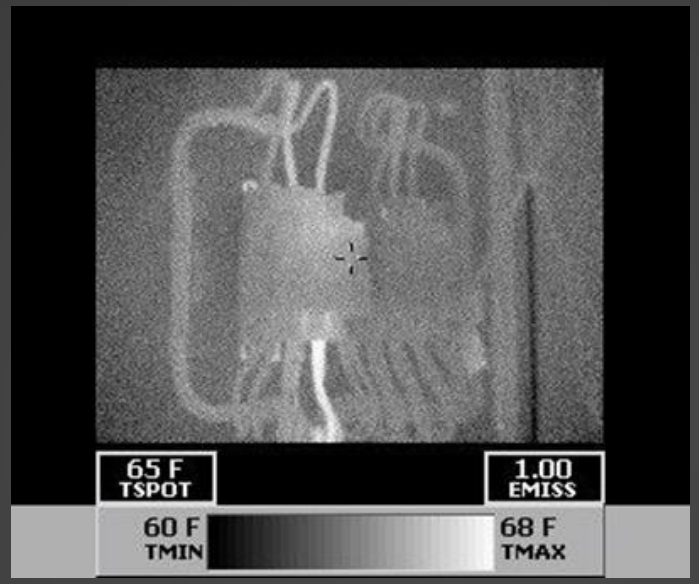
- For a successful safety program, the following must take place:
  - Safety education of all employees
  - Reinforced education in safety
  - Safety education in the use of tools and equipment

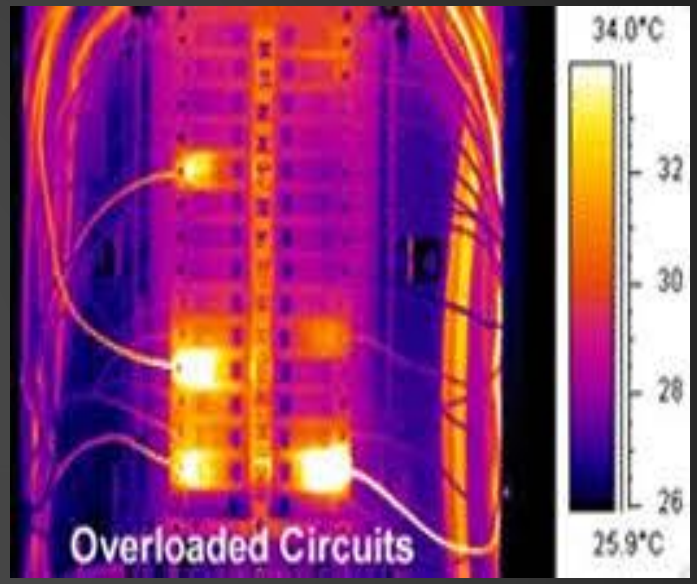
- The three most important controlling factors in safety are education, education, and more education.

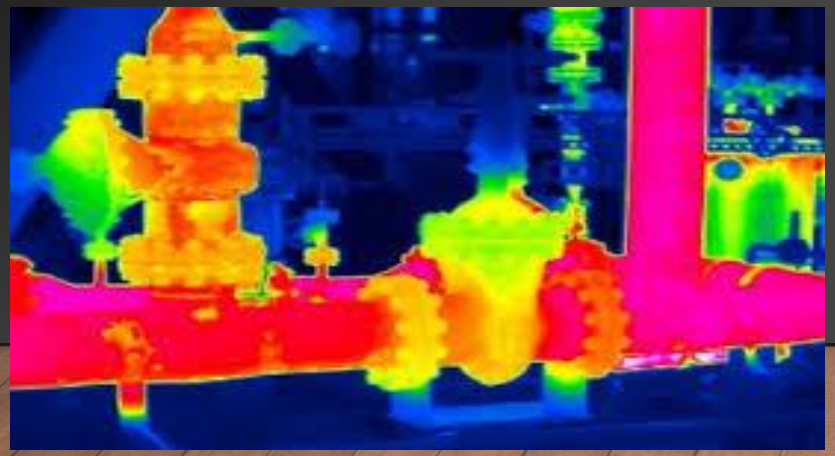
- Supervisors bear the greatest responsibility for safety and are held (generally) accountable for planning, implementing, and controlling the safety program.

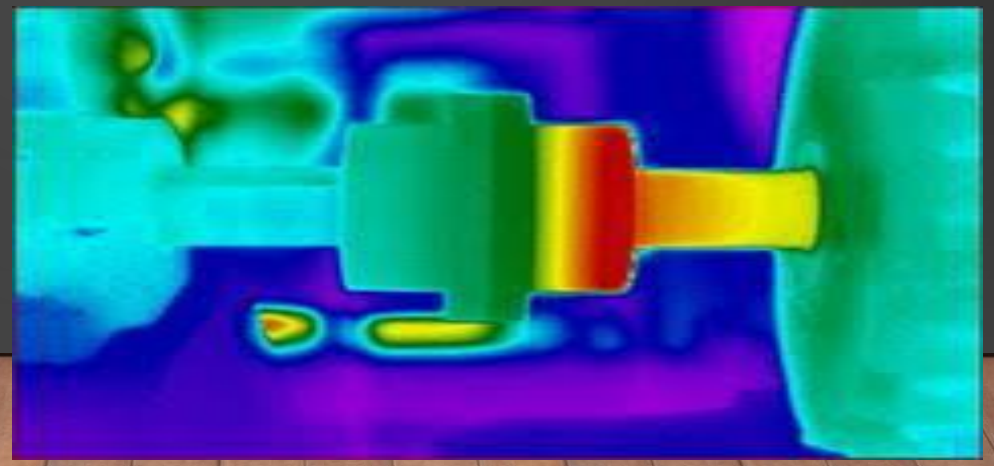
KSA 306 – PUMP REPAIR AND MAINTENANCE







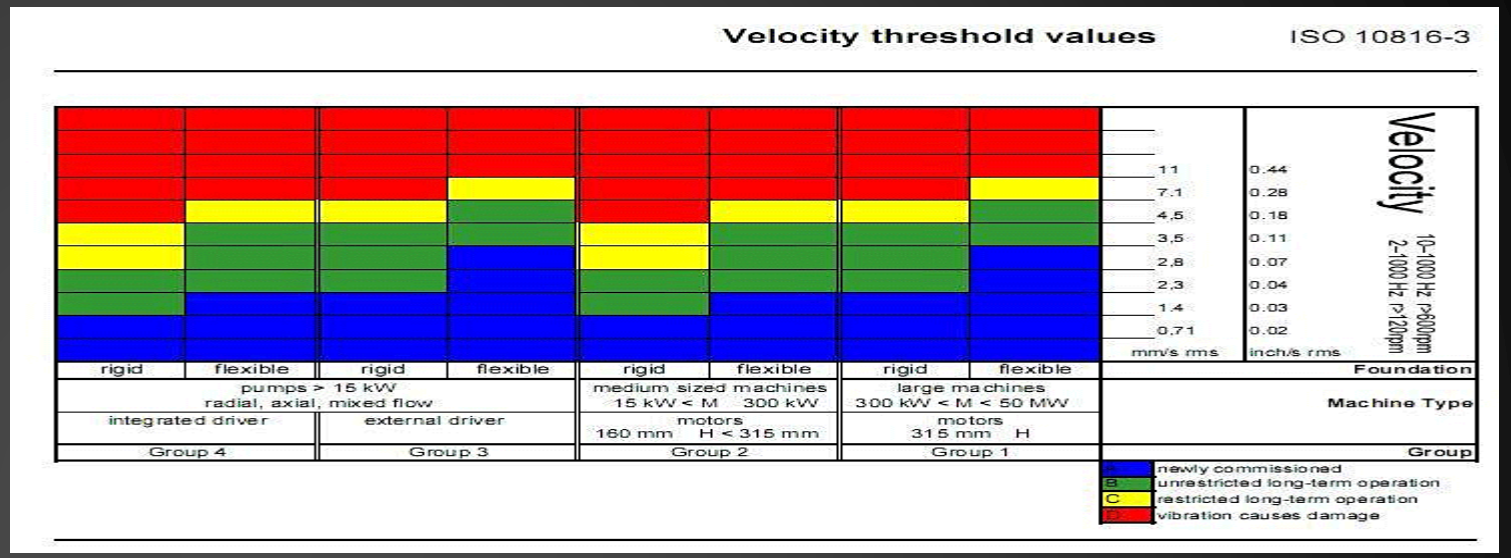




KSA 306 – PUMP REPAIR AND MAINTENANCE

- Vibration Measurement is a simple but effective method of looking at the condition or "health" of rotating machinery.

- Vibration meters help mechanics spot deteriorating machine conditions before they become critical. By identifying and quantifying a vibration problem, you can take corrective actions before the problem becomes significant.



- A simple vibration meter usually measures vibrations velocity in units of inch (often shown as in./sec or ips.) and can measure the bearing condition to determine flaws inside an anti-friction bearing.

- Checking the vibration velocity at key points on a machine is a very good indicator of machinery severity.

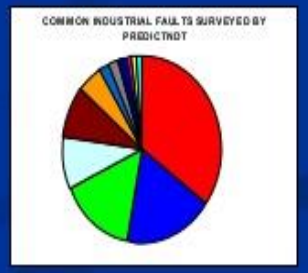
KSA 306 – PUMP REPAIR AND MAINTENANCE

INTEGRATED RELIABILITY TECHNOLOGY

VIBRATION - Faults

LEGEND	
Dynamic Unbalanced	35 %
Misalignment	18 %
Mechanical Looseness	15 %
Resonance	9 %
Bearings	9 %
Gear mesh Faults	5 %
Motor Vibration	2 %
Mech. Looseness	2 %
Rubbing	2 %
Soft Foot	1 %
Isolator Degradation	1 %
Others	1 %

Dynamic Unbalanced
- Dirt Accumulation
- Corrossion
- Rotor Bar Crack
- Thermal Deformation
- Coupling Compatibility
- Pulley Compatibility



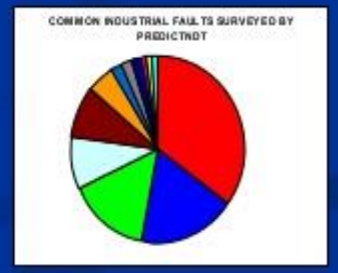
INTEGRATED RELIABILITY TECHNOLOGY

VIBRATION - Faults

LEGEND	
Dynamic Unbalanced	35 %
Misalignment	18 %
Mechanical Looseness	15 %
Resonance	9 %
Bearings	9 %
Gear mesh Faults	5 %
Motor Vibration	2 %
Piping Stress	2 %
Rubbing	2 %
Soft Foot	1 %
Isolator Degradation	1 %
Others	1 %

Bearing Faults

As a result of:
Dynamic Unbalance
Misalignment
Poor Assembly
Resonance
Over Greasing !!



KSA 306 – PUMP REPAIR AND MAINTENANCE

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)
- Defective well (Repair or 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 306 – PUMP REPAIR AND MAINTENANCE

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 306 – PUMP REPAIR AND MAINTENANCE

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 306 – PUMP REPAIR AND MAINTENANCE

Bearings:

Ball bearing are categorized into three area:

1. radial ball bearing
2. Angular contact ball bearing
3. Thrust ball bearing.

- Radial ball bearing primarily designed to support radial loads. This type of construction permits the bearing also to support relatively high thrust load in either direction. In the fact, the thrust load capacity is about 70% of radial load capacity.

- Angular-contact ball bearing is the one directional thrust type, which has a single row of balls and is so designed that the centerline of contact between the balls and raceway is at an angle to a plane perpendicular to the axis of rotation. This angle called contact angle.

- Thrust ball bearing are designed to carry pure thrust load and if any radial load is present, separate radial bearing must be used.

KSA 306 – PUMP REPAIR AND MAINTENANCE

Bearings (Cont.)

- Roller bearing serve the same purpose as ball bearing, but they can support much higher loads than comparably sized ball bearing because they have line contact instead of point contact.

- Most type of radial roller bearing cannot resist thrust load of any significant magnitude and with exception of the cylinder type.

- Cylinder roller bearing comes in a variety of forms. They are available in a wide range of bore sizes and function with rollers having length to diameter ratios from 1:1 to 3:1. The outside diameter of the roller is often crowned to increase the load carrying capacity by eliminating any edge loading.

- The variety of types available permit the consideration of a wide range of shaft and housing design.

KSA 306 – PUMP REPAIR AND MAINTENANCE

Bearings (Cont.)

- Needle roller bearing are like cylinder roller bearing in that they can withstand high radial loads but are different in that their roller (called needles) have a much greater length to diameter ratio.

- Tapered roller bearing is design specifically to withstand high radial load, high thrust load and combined high radial and thrust loads at moderate to high speeds. Tapered roller bearing are ideally suited to withstand repeated shock load that can be expected from service application.

- Spherical roller bearing is available in single row, double row or single row thrust types.
  - The important characteristic common to all spherical roller bearing is their self aligning property.

KSA 306 – PUMP REPAIR AND MAINTENANCE

What is brinelling to the races of a bearing?

- It is caused by wearing away of material due to **external** **vibratory** **motion** during storage or transport and corrosion due to lack of preservative compounds on bearing surfaces

- Squeaking noise = Inadequate lubrication or insufficient load
- Smooth, clear tone = Marks in stationary raceway cause by brinelling
- Intermittent noise = Usually unique to ball bearings and indicates a damaged ball
- Crunching noise = Presence of dirt
- Displaced grease may be dark in color which could indicate = The onset of oxidation or presence of dirt

Installing Bearings:

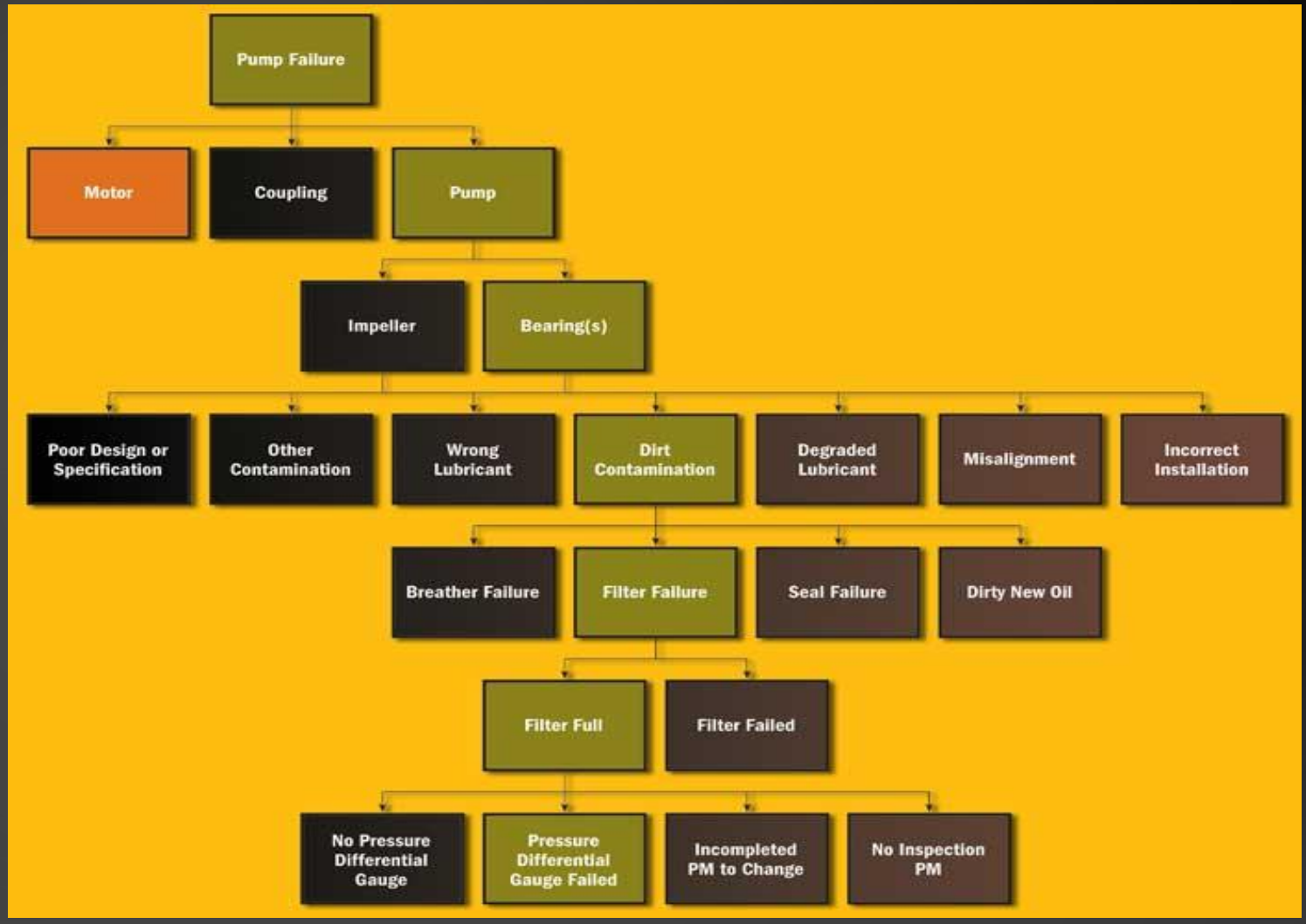
The first and most important rule when mounting and dismounting bearings is that: The mounting pressure will never be applied in such a way that's it is transmitted through the rolling elements of the bearing

KSA 306 – PUMP REPAIR AND MAINTENANCE

Root Cause Analysis (RCA):

- Is a systematic process for identifying "root causes" of problems or events and an approach for responding to them.

- RCA is based on the basic idea that effective management requires more than merely "putting out fires" for problems that develop but finding a way to prevent them.



KSA 306 – PUMP REPAIR AND MAINTENANCE

The most common causes of hydraulic system failures are:

- Clogged and dirty oil filters
- An inadequate supply of oil in the reservoir
- Leaking seals
- Loose inlet lines, which cause pump cavitation and eventual pump damage
- Incorrect type of oil
- Excessive oil temperature
- Excessive oil pressure

Most of these problems can be overcome through a planned preventive maintenance regime.

KSA 306 – PUMP REPAIR AND MAINTENANCE

The three maintenance procedures that have the greatest effect on system life, performance and efficiency are:

- Maintaining an adequate quantity of clean and proper hydraulic fluid with the correct viscosity
- Periodic cleaning and changing of all filters and strainers
- Keeping air out of the system by ensuring tight connections

A vast majority of the problems encountered in hydraulic systems have been traced to the hydraulic fluid, which makes frequent sampling and testing of the fluid, a vital necessity.

Oxidation and corrosion are phenomena which seriously hamper the functioning of the hydraulic fluid. Although rust and corrosion are two distinct phenomena, they both contribute a great deal to contamination and wear.

- Rust, which is a chemical reaction between iron and oxygen, occurs on account of the presence of moisture-carrying oxygen.
- Corrosion on the other hand is a chemical reaction between a metal and acid.
- Corrosion and rust tend to eat away the hydraulic component material, causing malfunctioning and excessive leakage

KSA 306 – PUMP REPAIR AND MAINTENANCE

Affinity Laws as it relates to impeller diameter change states that if speed should remain a constant:

1. The flow (GPM) varies proportionally with the change in impeller diameter. This means that 10 percent impeller reduction is 10 percent flow reduction.

2. The pump head (pressure) varies with the square of the change in the impeller diameter. If you reduce the impeller diameter by 20 percent (80 percent original diameter), the pump head is reduced to about 65 percent (.802 = .64) the original head generated.

3. The power requirement (BHp or Kw) varies by the cube of the diameter change. A 20 percent reduction in the impeller diameter (80 percent original diameter) would reduce the power consumption to about half (.803 = .512). This is significant.

Algebraically, we would write the equations as:
New Flow = Old Flow x (new imp. diam. / old imp. diam.)
New Head = Old Head x (new imp. diam. / old imp. diam.)
New Power = Old Power x (new imp. diam. / old imp. diam.)

KSA 307 – PIPELINE 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 307 – PIPELINE 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 307 – PIPELINE 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.

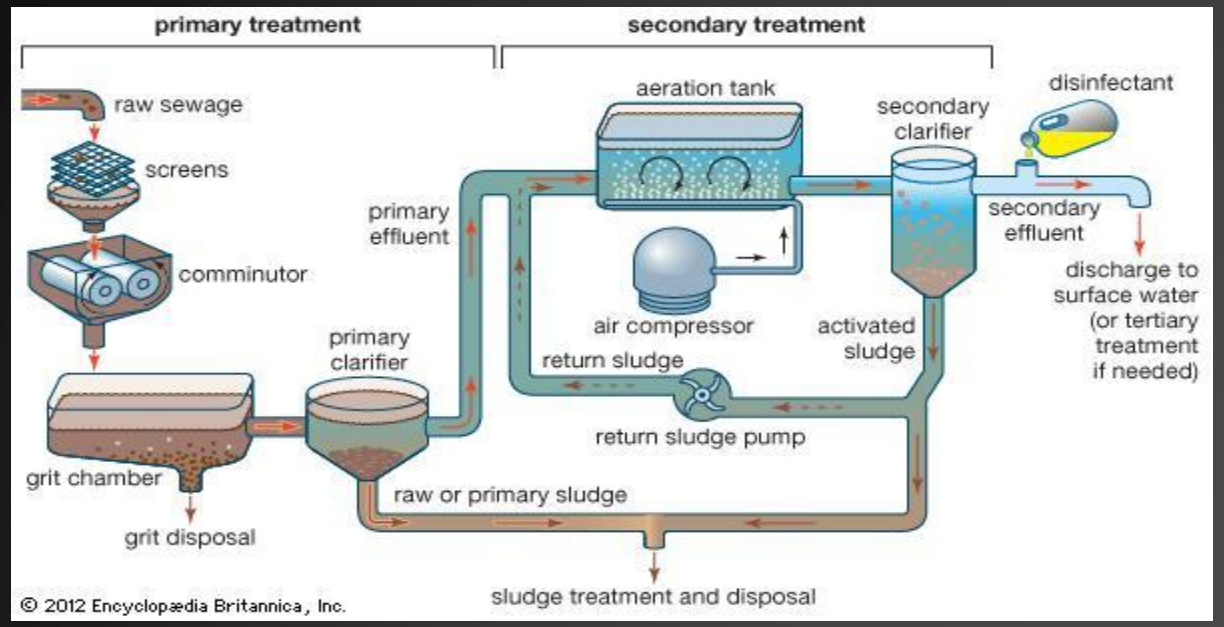
Shock Absorber:

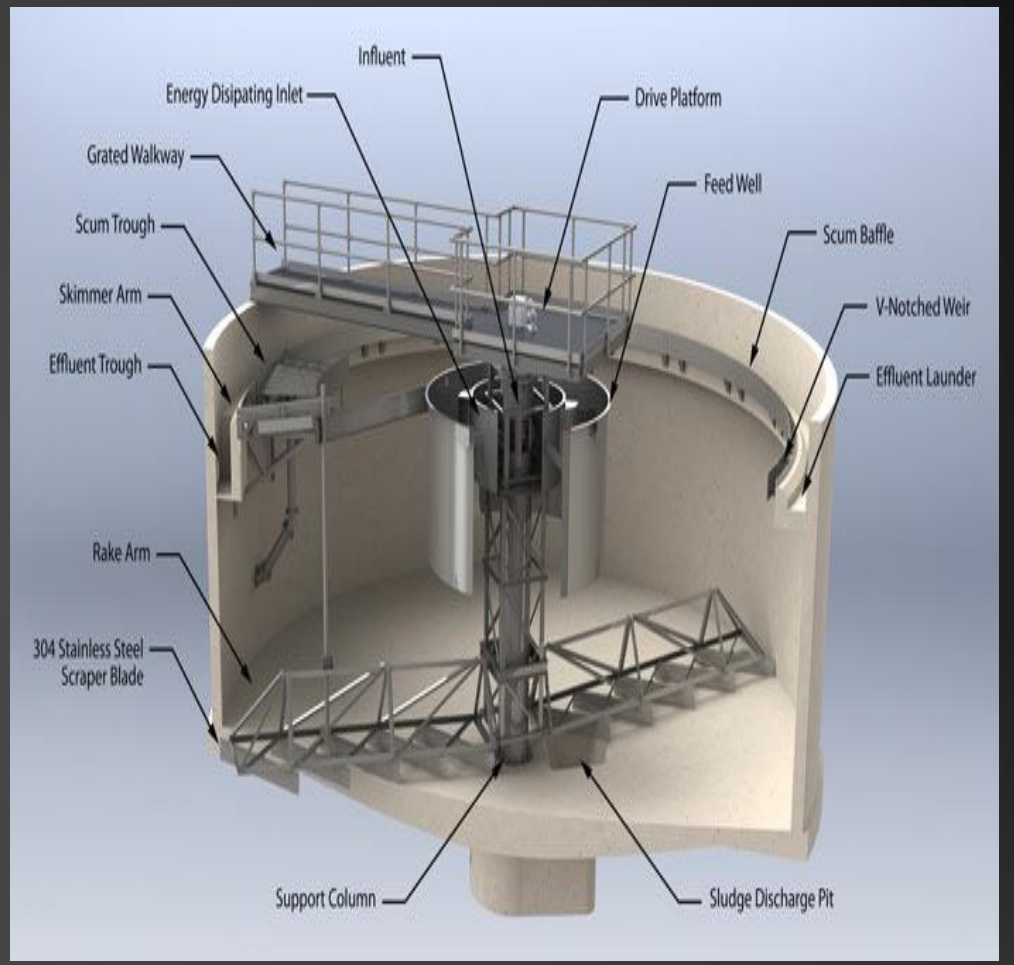
It is designed to absorb and transfer sudden increases in load from the pipe into the building structure and to deaden any opposing oscillation between the pipe and the structure. Types of restraints are: Hydraulic Snubber, Mechanical Snubber, shock absorber, insulated pipe support (also called pre-insulated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

KSA 308 – COMPRESSORS, TURBINES AND BLOWERS

- An air compressor should be selected to run 1/3 to 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, 1/3 to 1/2 of the time it will deliver enough air to satisfy the average air requirement of a system.

KSA 309 – PROCESS EQUIPMENT





KSA 309 – 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.

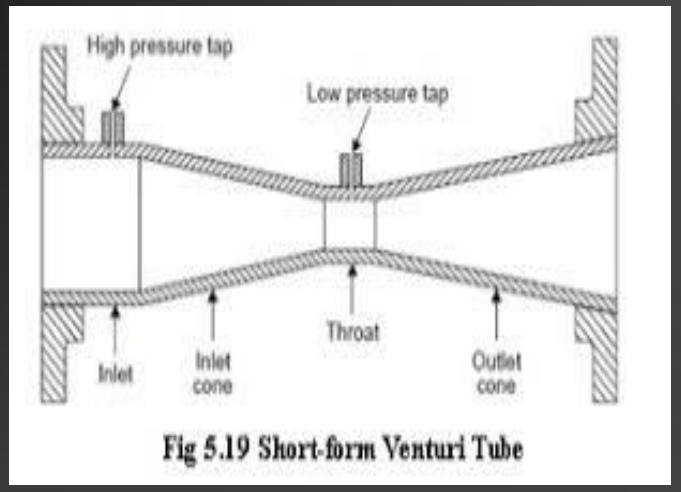
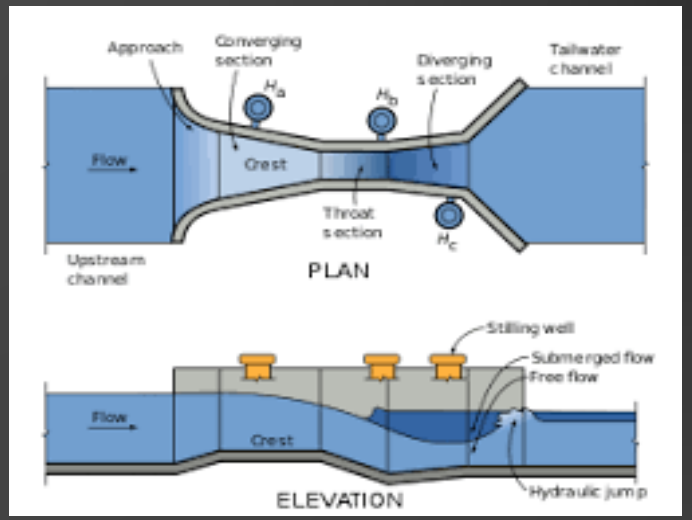


Fig 5.19 Short-form Venturi Tube

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 310 – SHOP MATHEMATICS

You change the impeller in pump that was pumping 500 gpm from a 5 inches to 6 inches. With no other changes to the volute or rotational speed, what would you expect the pump output to approach.

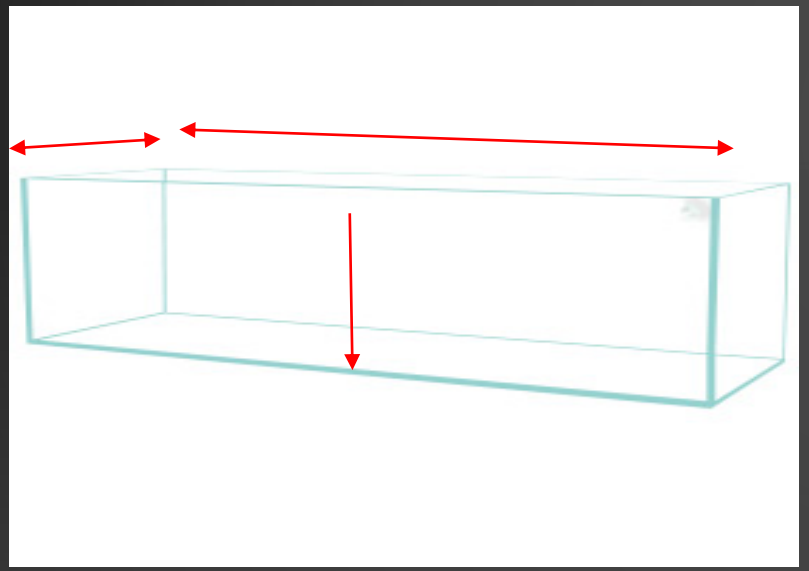
Affinity Laws

Algebraically, we would write the equations as:
New Flow = Old Flow x (new imp. diam. / old imp. diam.)

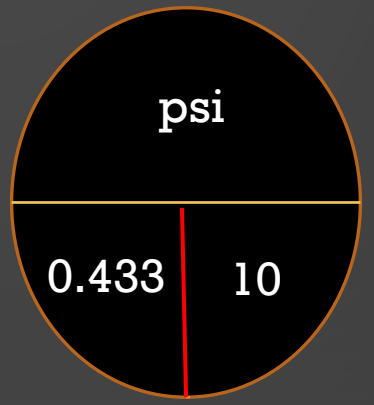
New Flow = 500 gpm x (6inches / 5 inches)
New Flow = 500 gpm x (1.2)
New Flow = 600 gpm

KSA 310 – SHOP MATHEMATICS

What is the pressure at the bottom of a rectangular tank 100 feet x 20 feet x 10 feet deep, in psi



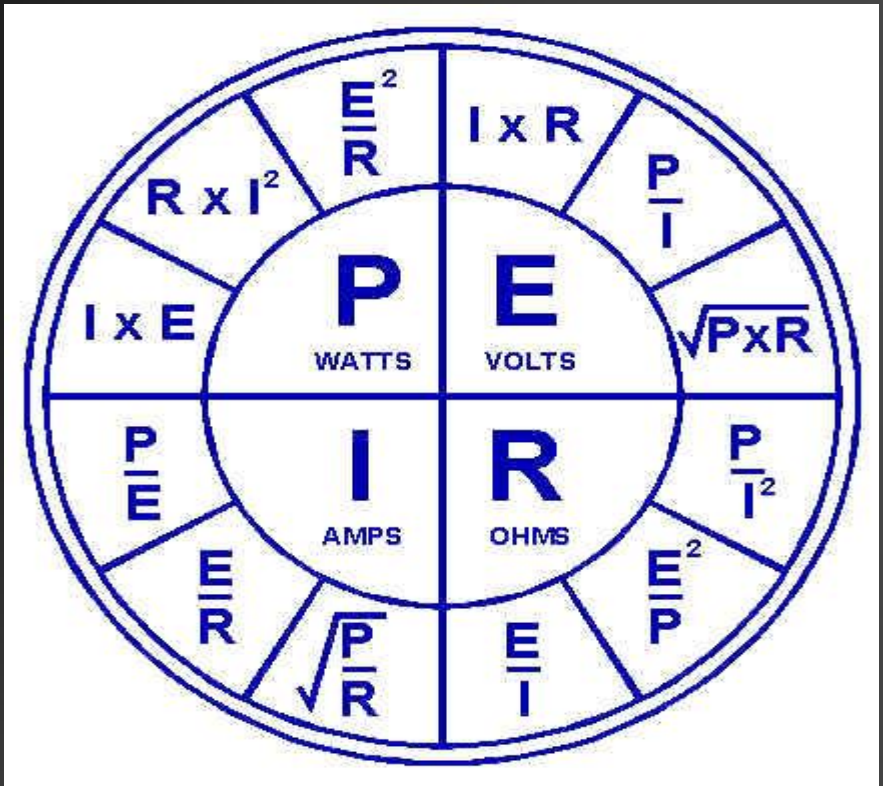
Formula – 1 psi at 2.31 feet
Psi at 1 foot = 1 / 2.31
Psi at 1 foot = 0.4329



psi = 0.433 x 10
psi = 4.33

KSA 310 – SHOP MATHEMATICS

A 480-volt system has a resistance of 20 ohms. What is the power consumed, in watts?

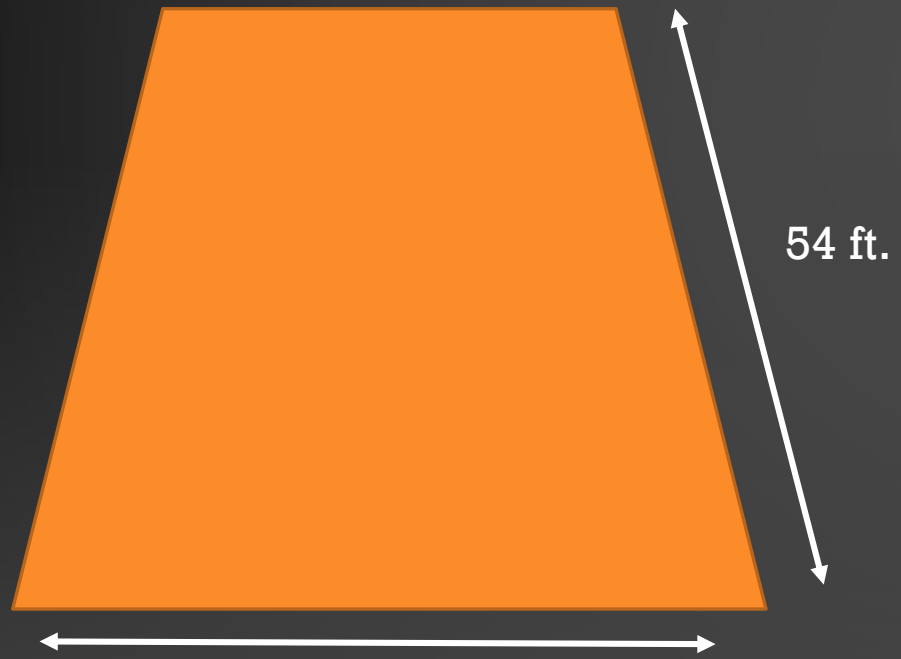


Formula: $P = E^2 / R$

$P = 480 \times 480 / 20$
$P = 230{,}400 / 20$
$P = 11{,}520$ watts

KSA 310 – 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?



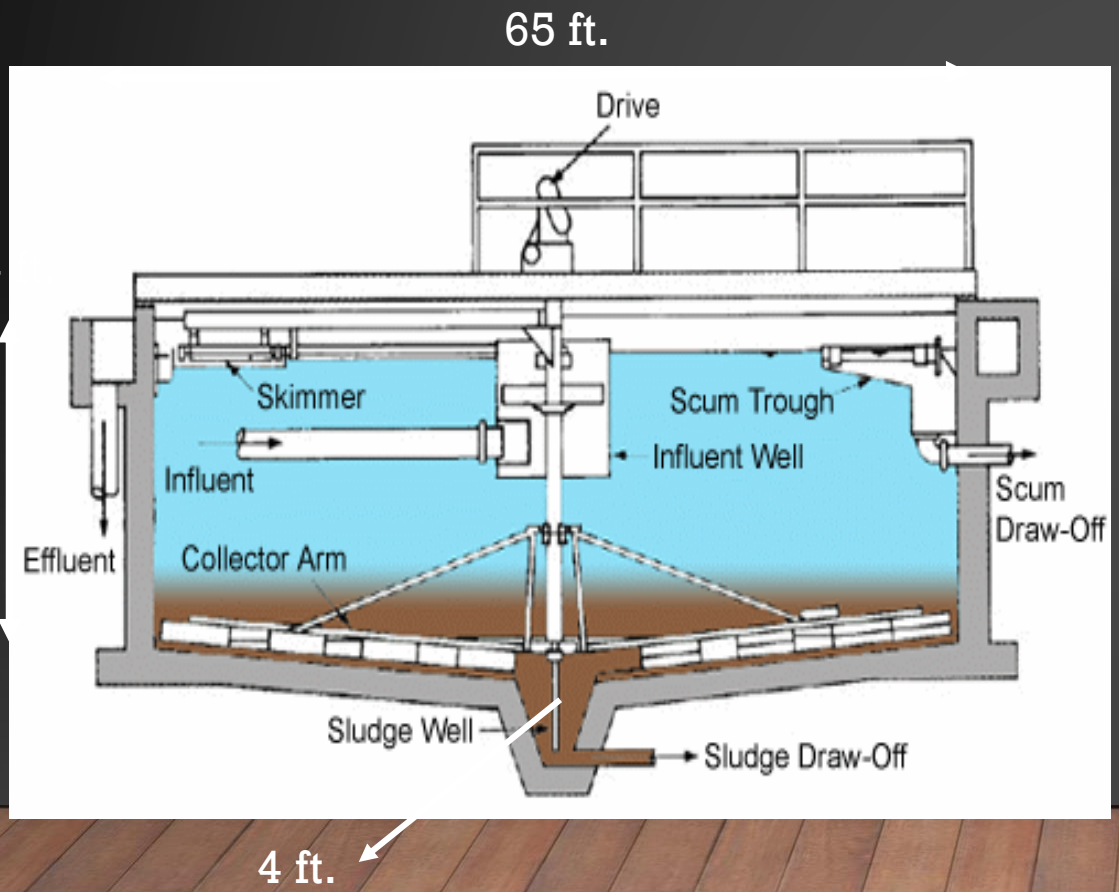
Formula:
Area rectangle = (length x width)
AR = (30 X 54)
AR = 1620 sq. ft.

Square yards = 3 ft. x 3 ft.
Square Yards = 9

AR (Sq. Yards) = 1620 / 9
AR (Sq. Yards) = 180

KSA 310 – SHOP MATHEMATICS

How many gallons in the clarifier that measures 65 diameter, 14 feet deep, with a 4 foot cone.



Formula:
Volume Cylinder = (.785)(diameter^2)(Height)
VC = .785 x (65 x 65) x (14)
VC = .785 X (4225) X (14)
VC = 3,317 x 14
VC = 46,433 ft^3

Volume of Cone = (1/3)(.785)(D^2)(H)
VOC = (1/3)(.785)(65 x 65)(4)
VOC = (1/3)(.785)(4225)(4)
VOC = (1/3)(3,317)(4)
VOC = (1/3)(13268)
VOC = 4,378 ft^3
46,433 + 4378 = 50811 ft^3
1 cubic foot = 7.48 gallons
Gallons = 50811 x 7.48
Gallons = 380,066

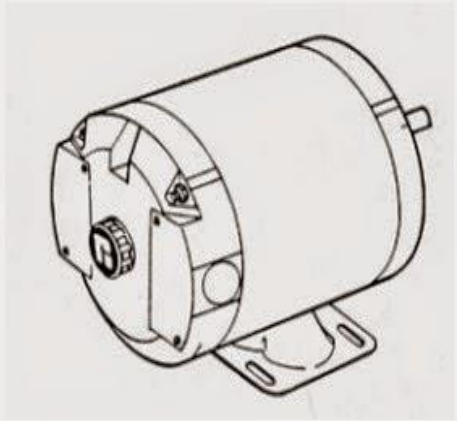
KSA 311 – ELECTRICAL PRINCIPLES (SAFETY/REPAIR)

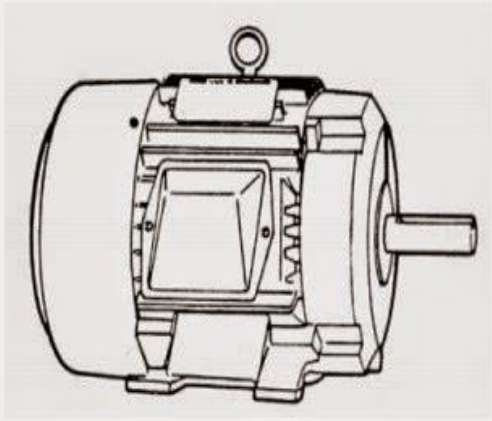
- Because of the ever-present dangers of electrical energy, a basic requirement when working with electricity is that there is no guesswork or risk taking.
- All mechanics, whether they do the actual electrical work or not, should have such an understanding if they must do troubleshooting. The potential danger , ever present with electrical energy, cannot be overemphasized.
- Three-phase current has three separate surges of current flowing together. In any given instant, however, their values differ, as the peaks and valleys of the pulsations are spaced equally apart. If each cycle were considered to be a full 360* rotation, each of the phases would be 120* apart.
- Overload Protection can be classified by the following protective devices, fuse, a circuit breaker, or any other overload protection device (thermal trips, moisture protection, etc.).
- The size of electrical wiring is specified by gauge number according to the American Wire Gauge (AWG) system.
- Cord-carrying capacity for No. 18 wire is 7A(840W), No. 16 wire is 10A(1200 W), No.14 wire is 15A(1800W) and No. 12 wire is 20A(2400W).

- Note: Use only extension cords that are listed by Underwriters' Laboratories.

KSA 311 – ELECTRICAL PRINCIPLES (SAFETY/REPAIR)

Synchronous vs Induction Motors

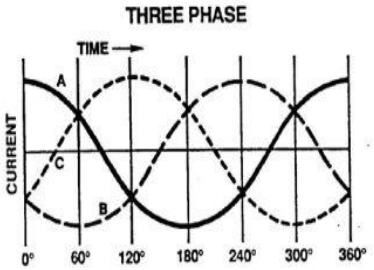


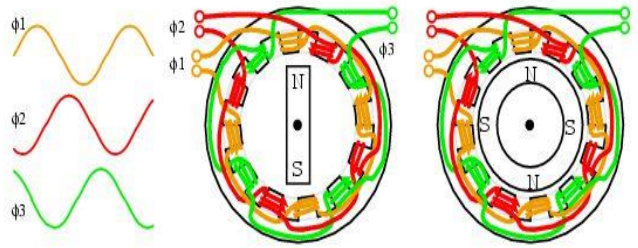


- Synchronous Motors
  - Turn at exactly the same speed as the rotating magnetic field.
  - 3600 rpm, 1800 rpm, etc.
- Induction Motors
  - Turn at less than synchronous speed under load.
  - 3450 rpm, 1740 rpm, etc.

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 x Frequency / Number of poles
  - 120 is constant
  - 120 x 60 = 7200
  - 7200/ 4 = 1800RPM





Two & Four Pole Three Phase Motors

KSA 312 – FIELD SAFETY

What an IIPP Is and How It Works

- The Injury and Illness Prevention Program (IIPP) is a basic written workplace safety program. Title 8 of the California Code of Regulations (T8CCR) section 3203, requires every employer to develop and implement an effective IIPP.
- An effective IIPP improves the safety and health in your workplace and reduces costs by good management and employee involvement.
- The 8 required Injury and Illness Prevention Program elements are:
  - Responsibility
  - Compliance
  - Communication
  - Hazard Assessment
  - Accident/Exposure Investigation
  - Hazard Correction
  - Training and Instruction
  - Recordkeeping

To be effective your IIPP must:

- Fully involve all employees, supervisors, and management
- Identify the specific workplace hazards employees are exposed to
- Correct identified hazards in an appropriate and timely manner
- Provide effective training

KSA 313 – CRANE/FORKLIFT OPERATIONS

Terms & Definitions

- **Competent person**:
  - A person who has acquired, through a combination of qualifications, training or experience, the knowledge and skill to perform the task required.
- **Grommet**:
  - Endless wire rope sling.
- **MBL**:
  - Minimum breaking load of the lifting tackle.
- **SWL**:
  - Safe working load.

Definitions

- **Tag line**:
  - A rope of suitable strength, construction and length attached with an appropriate recognised bend or hitch to the load, used to control the load during lifting or positioning.
- **Test certificate**:
  - A certificate issued by an authorized person

KSA 313 – CRANE/FORKLIFT OPERATIONS

Planning the lift

- The following points must be considered during planning:
  - *Where the load is to be picked up from*
  - *Where the load is to be placed*
  - *What areas to be passed over*
  - *Any obstructions in the way*
  - *How the load is to be slung*
  - *How the slings are to be removed and access to them*

The lift

After slinging but before lifting, the following must be considered

- Are the slings undamaged and properly attached to the load?
- Is the crane hoist rope vertical?
- Is the load free i.e not attached to any thing else?
- Are the legs of multi legged sling equally loaded?
- Are all spare all spare legs of the sling are hooked up to the master link on the lifting hook?

The lift

After slinging but before lifting, the following must be considered

- Are all personnel clear of the load?
- Is the landing site prepared to take the load?
- If required, is hand/tag lines attached to the load?

KSA 313 – CRANE/FORKLIFT OPERATIONS

Check Before Lifting

- Now lift the load a short distance above the ground and check that:
  - The load is balanced and stable.
  - The legs of the slings are at correct angles.
  - Any packing pieces used, are in place and sound.
  - The load itself is not stressed, especially when lifting packing cases, timber etc, which can fail under the loads applied due to lifting.

Landing the load

- Before landing the load check that:
  - The landing area will take the weight of the load.
  - There is sufficient space for the load.
  - There are strips of timber or similar on which to land the load such that the slings can be easily removed by hand.
  - The load should be landed gently to ensure that it is not damaged and that the crane does not receive any shock loading.

Do's & Don'ts

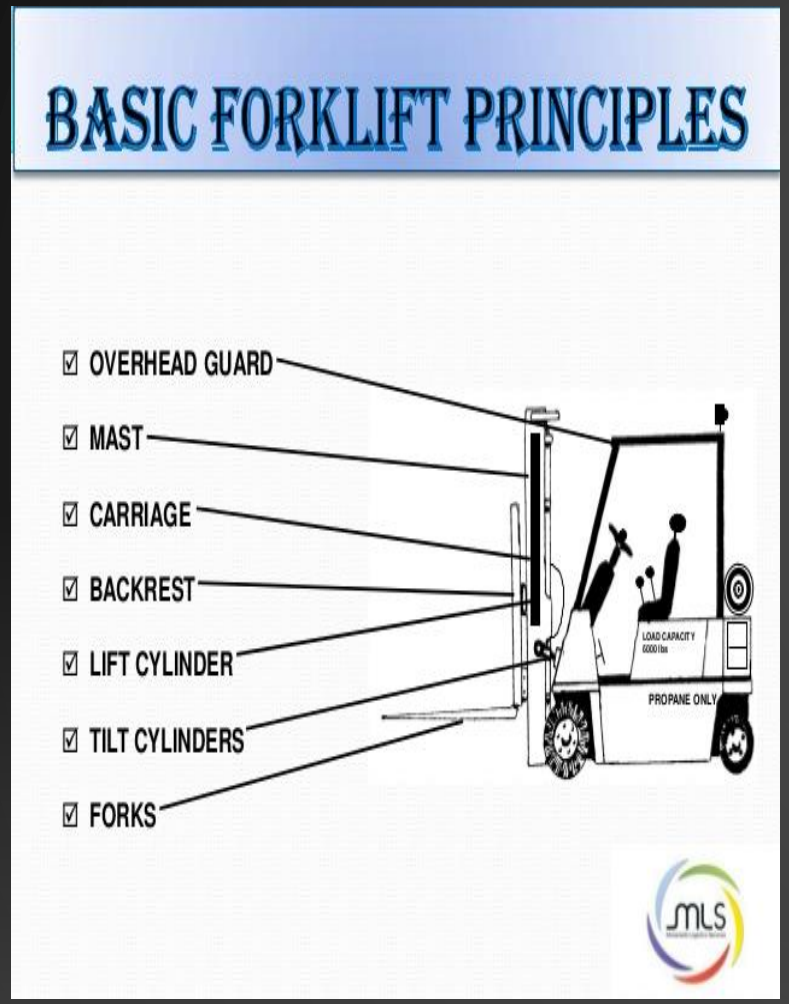
Always

- Ensure that only authorized slingers/signalers attach or detach loads, or signal the crane operator.
- Discuss operations with the crane operator (special operations).
- Ensure that the capacity of the crane is sufficient.
- Seek expert advice when using eye bolts, plate clamp etc.
- Use tag line always

Never

- Wrap tag line around hand or body.
- Leave a suspended load unattended.
- Pass loads over people.
- Ride or climb on suspended loads.
- Stand or walk beneath the loads.
- Use pipes to support for landing the load

KSA 313 – CRANE/FORKLIFT OPERATIONS



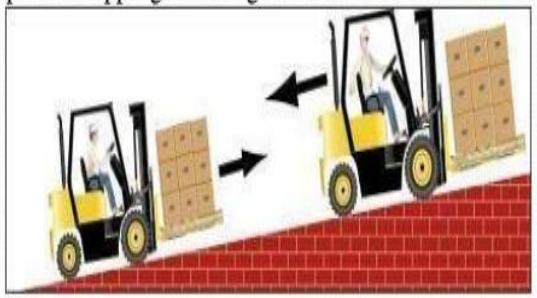
Safety Practices for the Operator

- 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.

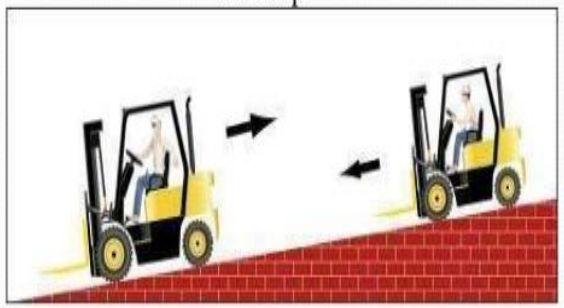
KSA 313 – CRANE/FORKLIFT OPERATIONS

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 313 – CRANE/FORKLIFT OPERATIONS

FORKLIFTS AND PEDESTRIANS

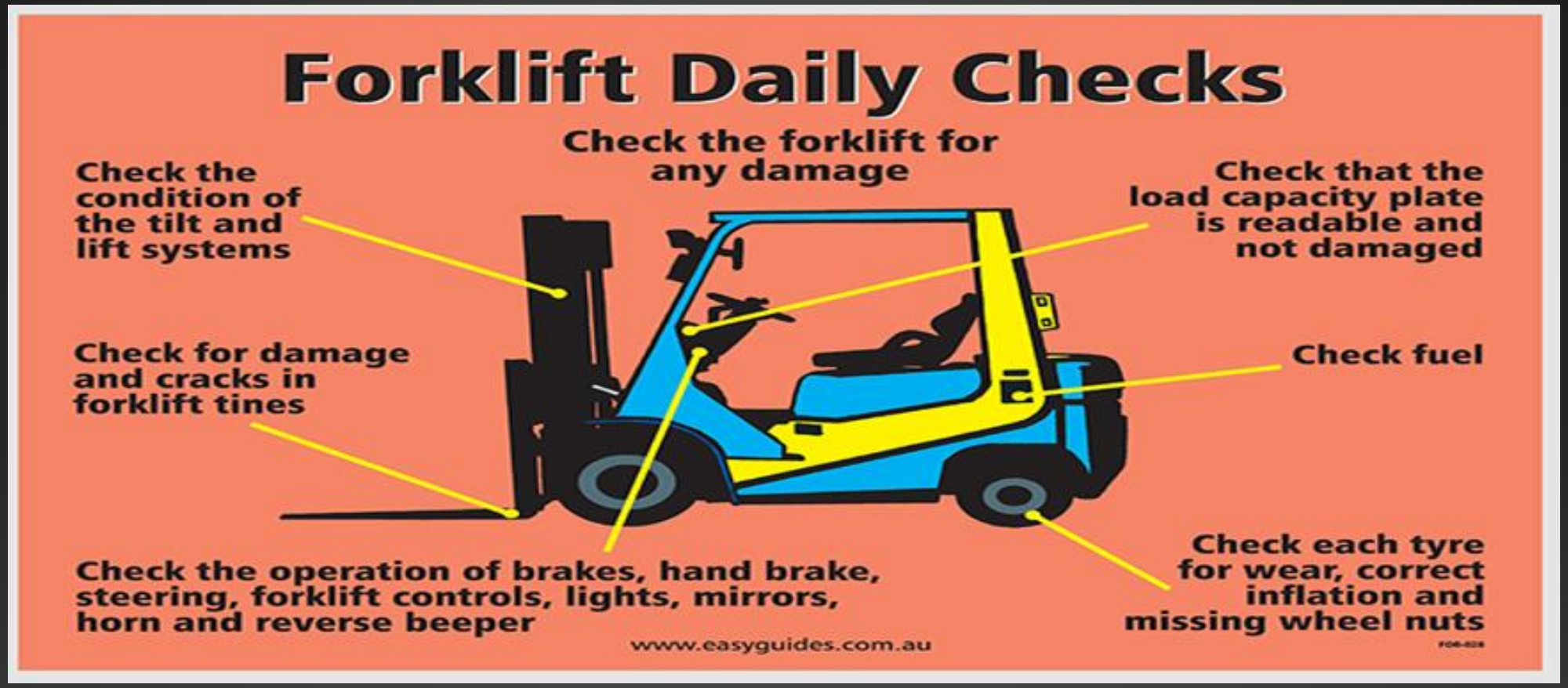
- Slow down and sound horn at intersections, corners, and wherever your vision is obstructed.
- When provided, use flashing warning light or backup alarms when traveling in reverse.
- Always look in the direction of travel.
- Signal to pedestrians to stand clear.
- Do not allow anyone to stand or walk 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.

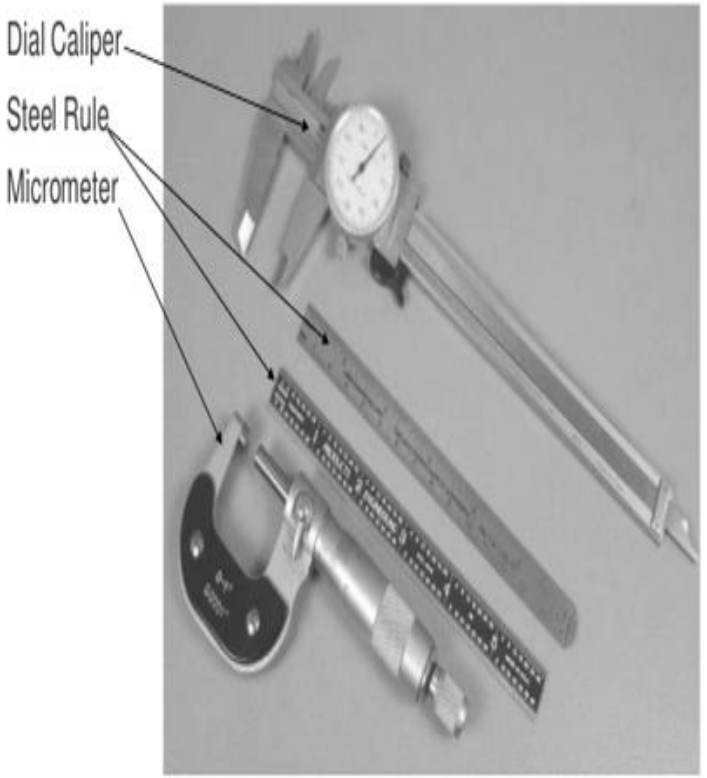
Watch overhead clearances – especially entering or exiting buildings or when you are raising a load on the forks.

KSA 313 – CRANE/FORKLIFT OPERATIONS



KSA 314 – TOOL USAGE (TRAIN AND APPLY)

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:

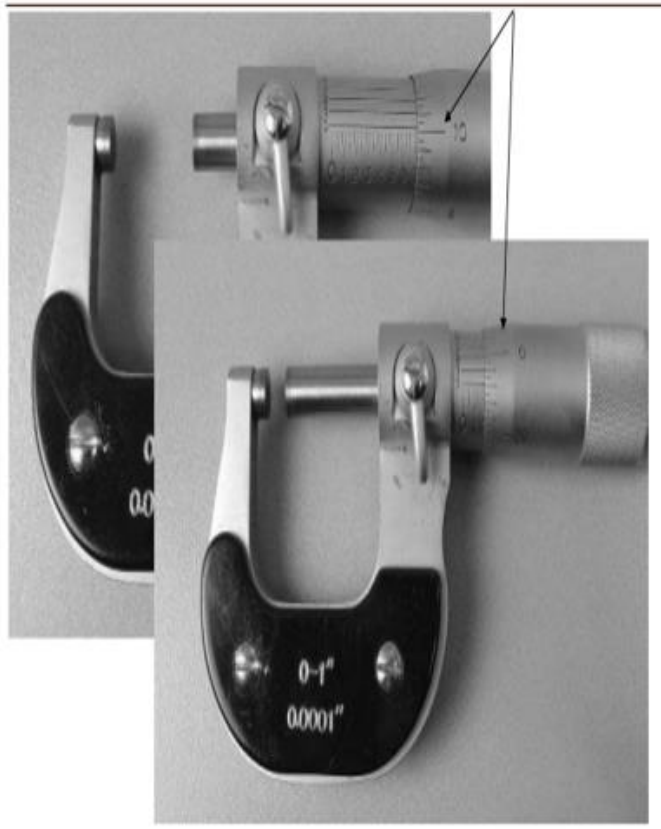
- Outside caliper
- Inside caliper
- Depth gauge

Micrometer

KSA 314 – TOOL USAGE (TRAIN AND APPLY)

Micrometer - thimble

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

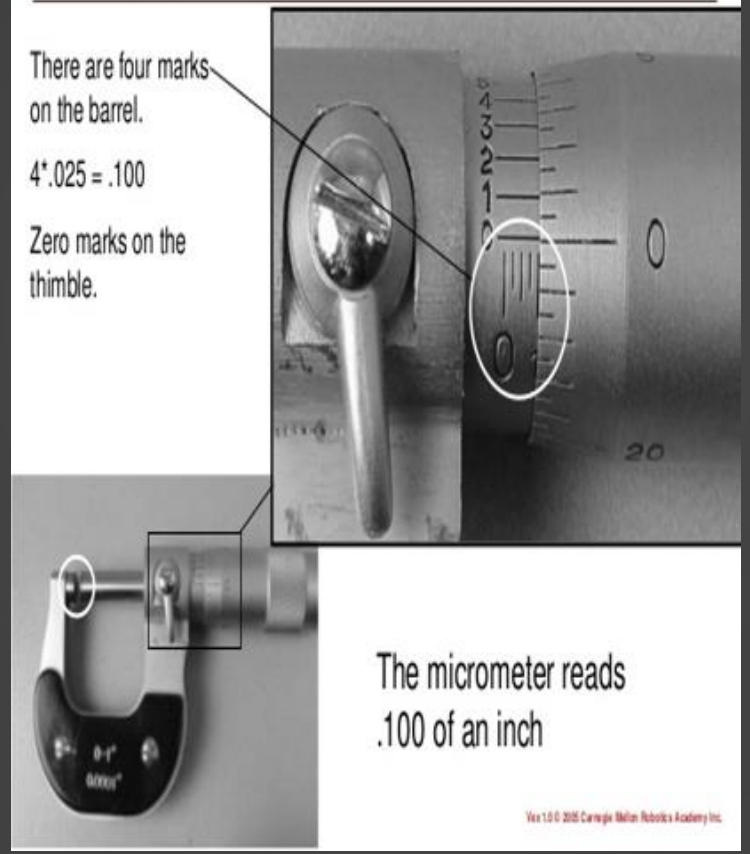


Reading the Micrometer

There are four marks on the barrel.

4*.025 = .100

Zero marks on the thimble.



The micrometer reads .100 of an inch

Reading the Micrometer

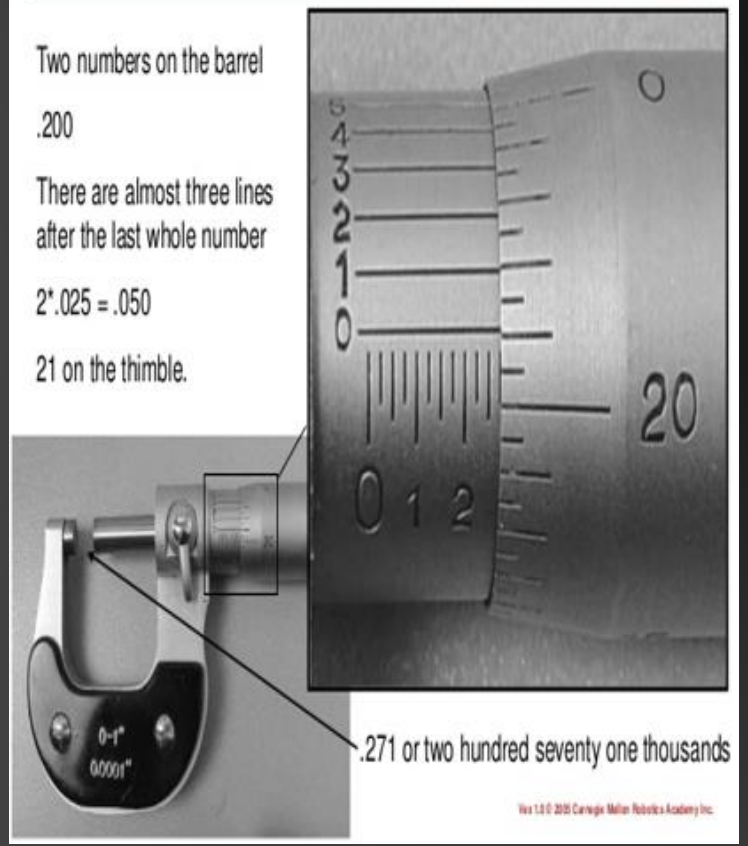
Two numbers on the barrel

.200

There are almost three lines after the last whole number

2*.025 = .050

21 on the thimble.



.271 or two hundred seventy one thousands

KSA 315 – FACILITY MAINTENANCE

Refer to Grades 1 and 2 Study Guides and Reference Material

KSA 316 – PRINTS, DIAGRAMS, SPECIFICATIONS

Drawings made up of lines to describe shape and contour must also have dimensions and notes to supply sizes and locations.

Three systems of writing dimension values are in general use.

- The first is the "common fraction" system, with all dimension values written as units and common fractions.
- The second system uses decimals to express fractions when distances require precision greater than plus or minus 1/64 of an inch.
- The third system , the complete decimal system, uses decimal fractions for all dimensional values.

- The foot (') and inch (") marks may be used to identify the units.
- Feet and inch dimensions should only be used for distances exceeding 72 inches.

KSA 317/318 – WORKING RELATIONSHIPS & COMMUNICATION

"A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable.“

Three important competencies for the effective team builder and leader:

- Promoting understanding of why a group of people need to be a team. The team needs to understand its shared goals and what each team member brings to the team that is relevant and crucial to its overall successes.
- Ensuring the team has adequate knowledge to accomplish its task. This includes information relevant to the team's goals and individual job competencies.
- Facilitating effective interaction in such as way as to ensure good problem solving, decision making and coordination of effort.

KSA 317/318 – WORKING RELATIONSHIPS & COMMUNICATION

Characteristics of Highly Effective Teams

- An effective team understands the big picture.
  - In an effective team, each team member understands the context of the team's work to the greatest degree possible. That includes understanding the relevance of his or her job and how it impacts the effectiveness of others and the overall team effort. Too often, people are asked to work on part of a task without being told how their role contributes to the desired end result, much less how their efforts are impacting the ability of others to do their work. Understanding the big picture promotes collaboration, increases commitment and improves quality.

- An effective team has common goals.
  - Effective teams have agreed-upon goals that are simple, measurable and clearly relevant to the team's task. Each goal includes key measurable metrics (that are available to everyone on the team), which can be used to determine the team effectiveness and improvement. Understanding and working toward these common goals as a unit is crucial to the team's effectiveness.

KSA 317/318 – WORKING RELATIONSHIPS & COMMUNICATION

- An effective team works collaboratively, as a unit.
  - In an effective team you'll notice a desire for collaboration and a keen awareness of interdependency. Collaboration and a solid sense of interdependency in a team will defuse blaming behavior and stimulate opportunities for learning and improvement. Without this sense of interdependency in responsibility and reward, blaming behaviors can occur which will quickly erode team effectiveness.

The Roles of the Effective Team Leader

- In order to encourage this level of collaboration and interdependency, the team leader must provide the necessary support and structure for the team, starting with putting together the right people. Team members should be selected, and their tasks assigned with their natural skills in mind.

- The team must also have the resources and training required to develop the skills needed to do their jobs. This includes cross-training. Cross-training gives team members a greater awareness of how their jobs are interdependent, increasing the team's flexibility and improving response time.

KSA 317/318 – WORKING RELATIONSHIPS & COMMUNICATION

- The quality of the team's response is highly dependent on the timeliness of the feedback received from the team's leader, other team members and customers. Receiving timely feedback is crucial to the effectiveness of the team.

- The effective team leader ensures that feedback reaches the entire team on its goals and metrics, as well as feedback to each individual team member. This feedback must be received in time to make adjustments and corrections. Often, feedback is received too late to have any practical value in the moment, and consequently, it feels like criticism.

- Criticism, while it might be useful for future planning, it does not promote immediate corrections in performance. Feedback is a form of constructive communication, another necessary tool in the effective team leader's tool chest. No matter how traditional or innovative the workplace, consistent and constructive communication throughout the team is essential.

- The act of constructive communication can do more than anything else to improve quality and productivity. Timely and appropriately delivered feedback can make the difference between a team that hides mistakes and a team that sees mistakes as opportunities.

KSA 317/318 – WORKING RELATIONSHIPS & COMMUNICATION

- When a team views mistakes as opportunities for improving the team's process and results, it's a sign that the team leader has successfully created an environment that promotes problem-solving. People are problem solvers by nature. When they are allowed to create their own solutions (rather than having expert solutions imposed upon them) team members are more proactive and engaged.

- Teams also have greater ownership of solutions they discover for themselves. Creating an environment that promotes problem-solving is part of creating an effective team structure. Poor team structure can actually create negative, ineffective behaviors in individuals and impede communication.

- The responsibility for poor performance is usually a function of the team structure rather than individual incompetence; yet, it is individuals who are sent to human resources or training programs for fixing. If team members feel like they are pitted against one another to compete for rewards and recognition, they will withhold information that might be useful to the greater team. When a team has problems, the effective team leader will focus on the team's structure before focusing on individuals.

KSA 317/318 – WORKING RELATIONSHIPS & COMMUNICATION

Remember:

- A "willingness" to participate collaboratively as a team member does not guarantee the desired outcome. People thrown into a collaborative situation, especially those without experience operating in this mode, need assistance to guarantee success. Managers who are skeptical of team participation to begin with often throw their people into an unplanned, unstructured decision-making process, responding with "I told you so" as they watch their team flounder.

- By contrast, managers who focus on promoting good understanding, ensuring adequate knowledge and facilitating effective interaction, will watch the transformation of their job from one that required constant supervision, fire-fighting, and oversight, to one that allows the leader to focus on serving the needs of the team and each individual team member.

KSA 319 – POWER TRANSMISSION

Rigid Coupling

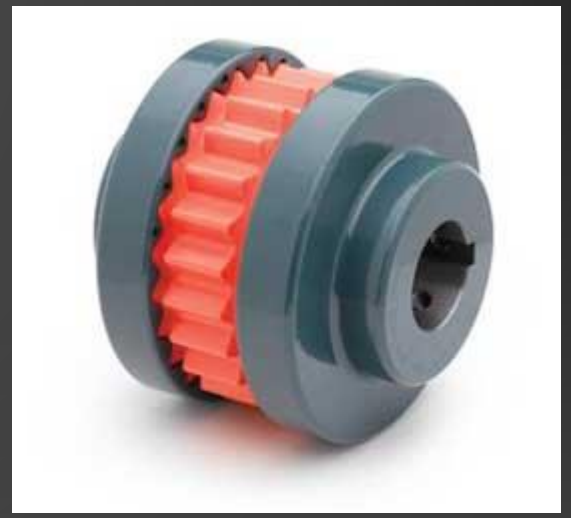
Flexible (Disc) Coupling

Roller-Chain Coupling

Spider coupling

Grid Coupling

Gear Coupling



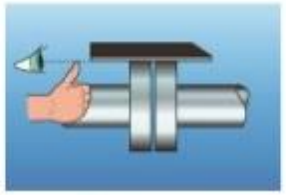
Grid-align Coupling

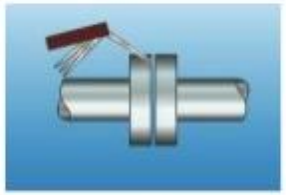
KSA 319 – POWER TRANSMISSION

Common alignment methods

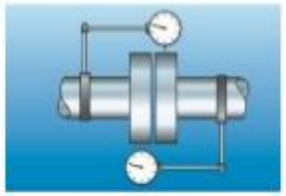
FLUKE

Straightedge/Feeler gauge
Resolution 1/10 mm

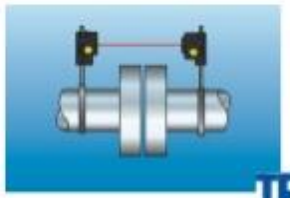




Dial indicator
Resolution 1/100 mm

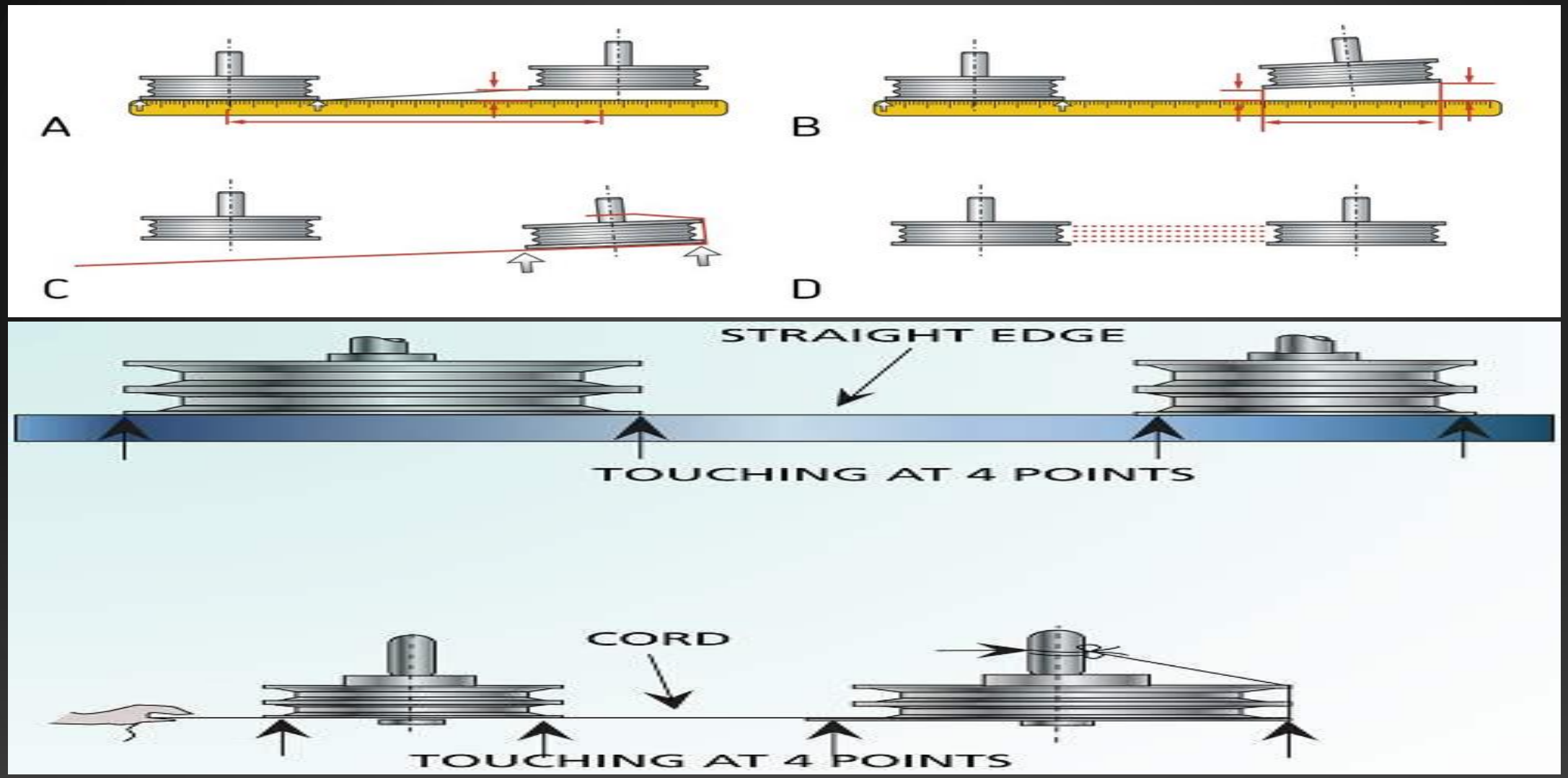


Laser-optical alignment
Resolution 1/1000 mm



TRANSCAT
Better by every measure

KSA 319 – POWER TRANSMISSION



KSA 319 – POWER TRANSMISSION

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.

KSA 320 – CONTINGENCIES AND EMERGENCY PLANS

Emergency Planning Process:

- The chief motivation behind emergency planning is to reduce the likelihood of lives being lost. A second motivation is to reduce damage to the infrastructures.

- An emergency plan in its broad sense is to inform, instruct and direct participants in the measures needed to manage the direct and flow-on effects of emergency events that may lead to disasters. A plan is also a means of coordinating and advoiding the duplications of effort and resources. By its very nature, an emergency plan must be devised, implemented and tested.
- Planning needs to be undertaken for each of the four emergency management cycles:
  - Reduction
  - Readiness
  - Response
  - Recovery

- Inefficiencies' in planning lead to loss or damage that could have been adverted. Thus, it is a moral responsibility for those involved with public or employee safety to ensure that emergency planning is carried, effectively and appropriately.

KSA 320 – CONTINGENCIES AND EMERGENCY PLANS

- Under 40 CFR Part 122.26, stormwater from certain industrial activities is required to be under a National Pollution Discharge Elimination System (NPDES) permit.

- All NPDES permits that include stormwater are required to have a stormwater pollution prevention plan (SWPPP).

- The key elements of an SWPPP are:
  - A detailed site map showing drainage areas and hazardous material storage areas
  - A materials inventory
  - Identification of past spills and leaks
  - The location of non-storm discharges
  - Details of existing monitoring data
  - An evaluation of the site for potential spills and leaks
  - Best management practice procedures
  - Conducting an annual site compliance evaluation
  - Inspection procedures
  - Recordkeeping and internal reporting, and
  - Employee training

KSA 320 – CONTINGENCIES AND EMERGENCY PLANS

Risk Management Plan (RMP): 40 CFR Parts 68.150 to 68.195 under the chemical accident prevention program, require the development of a risk management plan (RMP).

- The regulations require that the RMP be submitted to the U.S. EPA, certified by the owner/operator and updated at a minimum of every 5 years.

- Water and Wastewater facilities that handle or store above a threshold quantity from a specific list of chemicals may be subject to RMP requirements.

The key elements of an RMP are:

- An executive summary
- A registration form
- An offsite consequence analysis
- 5-year accident history
- Prevention program depending on the type of process being used
- An emergency response program, and
- A certification statement from the owner or operator.

KSA 320 – CONTINGENCIES AND EMERGENCY PLANS

- The most important principle of good disaster preparedness planning is that it must include training as a key component.
- The goal of training in emergency management is to bring order to chaos during a disaster.
- Training must focus on a specific system the organization is using to manage a disaster
- For most organizations, the incident command system (ICS) is used to manage disasters.

QUESTIONS?

Thank You, Best wishes on your upcoming Test!

Robert Delgado
rdelgado@ieua.org