



*Success*

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# GENERAL SAFETY

## Fitness for Duty

All employees are expected to be fit for duty when they report for work. This means that they are capable of performing all of the essential aspects of the job for which they were hired. HORSE-PLAY OR FIGHTING IS NOT ALLOWED.

## Daily Work Permits

All work performed will require a “Safe Work Permit” before the job can begin. These jobs include general work plus activities involving “Hot-Work” and work in confined areas. In addition to the Safe Work Permit, permits are also required for work on equipment connected to sources of energy and ground breaking with machinery for excavation.

## General Work

The procedure for obtaining a Safe Work Permit for general work is as follows:

1. The contractor foreman will obtain a blank Safe Work Permit form from the job supervisor, Safety Department or control room.
2. The contractor foreman will fill in the proper information on the Safe Work Permit.
3. The third copy (hard copy) will be posted at the job site by the contractor.
4. The contractor foreman must sign in as required by your site.
5. Upon completion of work the contractor must sign out on the “Unit Entry Sheet” and post “OUT” time on all copies of the Safe Work Permit.
6. Contractors will forward their copies with their time sheets to their client supervisor.

## General

Conditions may arise which change the work conditions under which the permit is issued such as oil or gas leaks in the adjacent area, change in wind conditions, general plant emergency, etc. Any such change shall be cause for the Safe Work permit to become invalid and hazardous work shall immediately cease until permission is granted to resume work. Contractors with a valid permit and who detect unusual odors or see indications of hazardous conditions arising should stop all hot-work immediately and contact the **Appropriate Supervisor**.

## **Personal Protective Equipment (PPE)**

1. All personnel including Welders and Equipment Operators shall wear hard hats at all times while inside the jobsite. Plant entry will be denied to those without hats. The hats must be non-metallic and meet ANSI Z-89.1. “Bump caps” do not meet those standards and shall not be used.
2. All personnel shall wear safety glasses with permanently attached side shields meeting ANSI Standard Z-87.1. Tinted glasses may only be worn in bright sunlight outside. Safety glasses shall be worn at all times while in the confines of the jobsite. Welders shall wear safety glasses under welding and burning shields. Check to see if contact lenses are allowed at your work site. Additional eye protection (goggles, shields, etc.) must be worn whenever a hazard exists for eye damage. Such conditions include concrete chipping, sandblasting, welding, working near leading pressurized equipment, etc.
3. Hearing protection must be worn while working in posted areas or if deemed necessary by the job supervisor.
4. Respiratory protection must be used for certain jobs such as sandblasting, working around blowing catalyst, working around toxic gases, etc.
5. Other special safety gear is required in certain areas of the jobsite and for certain tasks. Face shields and gloves are required for jobs dealing with caustics, acids and other chemicals. Life jackets are required for over water work.
6. All contractors shall wear long pants covering the legs and shirts with long sleeves. Shirts shall be buttoned and tucked in. Identification badges shall be affixed to shirt. Sleeves are required to be buttoned. Loose fitting pants should be supported by use of belts or suspenders. Long flowing garments which may get caught in machinery are prohibited. Short pants, kilts, skirts, dresses, and sleeveless shirts are prohibited. Contractors shall not be permitted to be shirtless inside the jobsite. If you are required to wear either flame resistant clothing (i.e. Nomex) or Fire Retardant Clothing (FRC) it must be worn at all times.
7. Contractors must wear socks and closed hard-soled oil resistant steel-toed shoes with a minimum of a 45° heel unless other type shoes are specifically required for a job and approved by the Safety Department. Sandals, canvas, tennis, deck, jogging, ventilated or open-mesh shoes shall not be worn.

## **Scaffolding**

Scaffold users shall inspect the scaffold before each use. The following “Inspection Checklist” is provided for user safety. In the

event the user finds any item on the “Inspection Checklist” not true, the user shall notify a supervisor to correct the problem. For those items that deal with construction of the scaffold, the **Competent Person** shall be contacted. (A Competent Person is a worker authorized by the company to, erect and disassemble scaffolding and inspect scaffolding.)

1. Any scaffold should have a color coded tag: green (ready for use), yellow (usable with restrictions) or red (do not use) that includes builder’s name, date and maximum load bearing capacity of scaffold. **DO NOT USE AN UNTAGGED SCAFFOLD** – contact the Competent Person.
2. Do not alter or modify a scaffold. Contact the Competent Person in the construction of scaffolds and/or for modifications to the scaffold.
3. The maximum intended load that will be placed on the scaffold is known and is less than the maximum load-carrying capability of the scaffold.
4. The scaffold bays appear to be plumb and level and scaffold base plates are on firm footings.
5. Scaffold bracing is in place.
6. Scaffold platforms are fully planked and extended at least 6 inches over the end support.
7. Guardrails are in place.
8. Overhead obstructions are noted on the yellow tag.
9. No unprotected electrical hazards are within 10 feet of the scaffold.
10. Safe access is provided (ladder must be tied off, and extend 3 feet above landing where feasible).
11. If using a rolling scaffold, the wheels are locked and diagonal braces must be present to keep uprights squared properly.
12. If the scaffold extends into a roadway, roadway is marked and scaffold and scaffold access ladder(s) are protected from vehicular traffic.

## **Elevated Work and Fall Protection**

Thousands of workers are killed each year from falls. Workers exposed to fall hazards must be trained to recognize hazards and how to use and operate various fall protection systems:

- Personal fall arrest systems
- Safety net systems
- Warning line systems
- Safety monitoring systems
- Controlled access zones

- 1) No person will be allowed to work above the ground without fall protection.
- 2) In some cases this may mean 12" above the next level. Examples include, working over:
  - a) Dangerous machinery
  - b) An impalement hazard such as rebar stakes
  - c) An engulfment or drowning hazard.
- 3) Ladders must be:
  - a) Nonconductive, secured against movement and extend at least 36" above their point of landing.
  - b) Set at a 4 to 1 ratio angle with the vertical. (1 foot out for each 4 feet up)
  - c) Rated for four times the maximum intended load.
  - d) Used to access elevated scaffold decking, walkways and work areas unless gangways or stairs are provided. Climbing the scaffold bucks is not permitted.
- 4) Prefabricated concrete form panels are not to be used in place of step ladders or as catwalks or ramps.
- 5) Scaffolds will be adequately decked. As a minimum, each work level will have no less than two (2) fully enclosed 2" x 12" scaffold grade planks cleated or wired to the scaffold.
- 6) The perimeter of elevated scaffold decking, walkways and work areas with any unprotected sides or edge which is 6 feet (1.8 m) or more above a lower level shall be protected from falling by the use of guardrail systems, safety net systems, or personal Fall Arrest Systems (FAS).
- 7) Any worker working above the ground, on formwork, or from a ladder will be tied off, unless working inside an area protected by appropriate handrails, midrails and toeplate.
- 8) Covering for floor openings will be:
  - a) A minimum of 2"x6" braced 3/4" plywood
  - b) Overlapping all edges at least six (6) inches
  - c) Chocked against movement
  - d) Labeled "HOLE" or barricaded
  - e) Constructed differently according to hole size
- 9) Walking on or standing on the tops of walls over 4' high is not permitted.
- 10) All lifelines and anchor points must be approved and able to withstand at least 5,000 pounds of force per person.
- 11) When climbing a ladder:
  - a) Always have three points of contact - Two hands and one foot or two feet and one hand.
  - b) Never attempt to carry tools or materials while climbing a ladder. Use an alternative method such as a rope hoist.
  - c) Never lift electrical tools by their cords.

- 12) Scaffolding and ladders shall be inspected by the designated Competent Person:
  - a) Prior to the start of each shift
  - b) After any incident which could have resulted in damage to the scaffolding system.
- 13) Scaffolding and ladders found to be in compliance and ready for use should be tagged as such.
- 14) For those items that deal with construction of the scaffold, the Competent Person shall be contacted. (A competent person is a worker authorized by the company to, erect and disassemble scaffolding and inspect scaffolding.)
- 15) When a scaffold is found to be out of compliance all workers are required to exit the scaffold confines.
- 16) Fall Protection system components shall be selected and constructed in accordance with the applicable ANSI and ASTM requirements annotated (See OSHA Website)
  - a) Example - Guardrail systems shall be capable of withstanding, without failure, a force of at least 200 pounds applied within 2 inches of the top edge, in any outward or downward direction, at any point along the top edge.
  - b) When the specified 200 pound test load is applied in a downward direction, the top edge of the guardrail shall not deflect to a height less than 39 inches above the walking/working level.
  - c) Midrails, screens, mesh, intermediate vertical members, solid panels, and equivalent structural members shall be capable of withstanding, without failure, a force of at least 150 pounds applied in any downward or outward direction at any point along the midrail or other member.
- 17) Use a Safety Monitoring System (SMS) when working in elevated work areas that can not be made safe using engineering, guarding or PPE. The person responsible for supervising the SMS is referred to as a Safety Monitor. The Safety Monitor shall:
  - a) Be competent to recognize fall hazards.
  - b) Set up an Exclusion Zone warning system of danger tape or other no closer than 7 feet from the unprotected edges.
  - c) Warn workers who trespass into the Exclusion Zone.
  - d) Be on the same walking/working surface and within visual sighting distance of the worker being monitored.
  - e) Be close enough to communicate orally with the worker; and
  - f) Not have other responsibilities which could take the monitor's attention from the monitoring function.

- g) Related Concerns
  - i) Mechanical equipment shall not be used or stored in areas where Safety Monitoring Systems are being used to monitor workers.
  - ii) No workers are allowed in controlled access zones being protected by a Safety Monitoring System.
  - iii) When in a controlled access zone, a safety monitor will direct you to comply promptly with fall hazard warnings.
- 18) Pay attention to your footing; watch the ground; stay a safe distance away from excavations; Remember: Walk . . Don't Run; . . Climb Down . . Don't Jump.

### **Pole Climbing**

Climbing a wooden pole with boot spikes takes practice. This includes not only climbing technique and but also how to properly put on the boot spikes. Poles should be climbed in-line to reduce pole disturbance and on the side away from any cutouts. Poles must be thoroughly inspected for soundness:

- 1) Pole must be set at adequate depth to prevent slipping out of ground.
- 2) Ground condition to prevent tilting or settlement
- 3) General condition such as decay, especially at the ground line
- 4) Framing and attachments such as cross-arms, transformers, switches, guys and conductors
- 5) The pole's position in the line.
- 6) Poles shall not be climbed if:
  - a) There is any doubt as to soundness or
  - b) The pole is marked for stubbing or replacement.

### **Personal Fall Arrest Systems**

- 1) Sometimes there is simply no way to use traditional fall protection systems. In this situation a personal fall arrest system which connects the worker's body to an approved anchorage, is needed. A Personal Fall Arrest System includes as needed:
  - a) Full body harness
  - b) Lanyard
  - c) Double locking snap hooks
  - d) Rope climbing/descent control device
  - e) Carabiners
  - f) Vertical and horizontal lifelines
  - g) Anchor system

### **Inspection and Set Up**

- 1) Inspect fall protection equipment before each use. Cut up defective equipment to make it unusable and discarded. Do not repair.



- 2) Anchorage must support the suspended load. Lanyards tied off so the maximum fall distance is 6 feet or less.
- 3) Set up fall protection equipment so as to:
  - a) Direct any falls away from energized equipment
  - b) Not to strike a lower level
  - c) Have a maximum fall distance of six feet
  - d) Not pendulum into solid structures.
  - e) Be capable of supporting 5,000 pounds without failure.

### **Harnesses**

- 1) Harnesses have many attachments. It is important to understand which "D" ring is used for which purpose:
  - a) Attach lanyard D-ring at the back between the shoulder blades for fall protection
  - b) Front D-ring may be used for climbing; for example, when there is a ladder rail system
  - c) Shoulder D-rings on some harnesses may be used for confined space work or other rescue type situations
- 2) Falls occur when the worker is unhooked and moving. Never put yourself in a position where you are unprotected.

### **Training**

Specific hands-on training is required for the type of fall protection being used. You must:

- 1) Be familiar with and follow all manufacturer's instructions.
- 2) Use caution around rotating equipment as lanyards could become entangled and pull you in.
- 3) Eliminate trips and slips by removing fall protection equipment when elevated work is finished.

### **Material Safety Data Sheets (MSDS)**

MSDS sheets are located in the unit control rooms and may be obtained from your supervisor. They must be made available for you to review upon request.

### **Hearing**

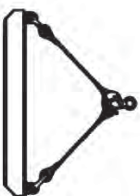
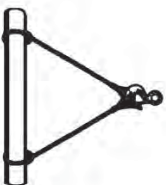
Ear protection must be worn within 30 feet of operating any pneumatic tools, portable grinders, jackhammers, air-compressors, diesel or gasoline driven welding machines, hydraulic cranes, vacuum trucks, and in designated areas.

### **Safe Rigging**

See Charts on the following pages.

## Use of Slings

1. Protection shall be provided between the sling and all sharp surfaces of load
2. Properly store all slings while not in use
3. Do not choke slings in the splice
4. Do not permit kinks or knots in slings
5. Secure the unused legs of a multi-leg bridle
6. The loading on the sling is increased at any angle other than vertical
7. Cut the eyes or remove fittings of any defective sling, discard the sling body
8. Do not place eye of sling over a hook or pin that is larger than natural width of eye
9. Visually inspect sling before each use
10. Wire rope slings should not be field fabricated
11. No single leg sling shall be used with a load that cannot be controlled
12. Slings shall not be made using wire rope clips
13. Rated loads of a sling are different for each of the basic methods of rigging: vertical, choker, basket, etc.



Single Leg or Vertical

Basket

Choker

Double Wrap Choker

Double Choker

Bridle

## APPLYING WIRE ROPE CLIPS

The only correct method of attaching U-bolt wire rope clips to rope ends is shown in the illustration. The base of the clip bears against the live end of the rope, while the "U" of the bolt presses against the dead end. The clips are usually spaced about six rope diameters apart to give adequate holding power.

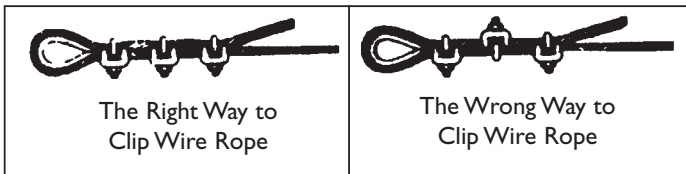
Before ropes are placed under tension, the nuts on the clips should be tightened. It is advisable to tighten them again after the load is on the rope to take care of any reduction in the rope's diameter caused by the weight or tension of the load.

A wire rope thimble should be used in the loop eye to prevent kinking when wire rope clips are used.

The correct number of clips for safe application, and spacing distances, are shown in the table below.

Number of Clips and Spacing for Safe Application







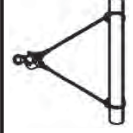
Rope Diam.	Minimum No. Clips for Each Rope End	Spacing of Clips in.
3/16	2	1 1/8
1/4	2	1 1/2
5/16	2	1 7/8
3/8	2	2 1/4
7/16	2	2 5/8
1/2	3	3
5/8	3	3 3/4
3/4	4	4 1/2
7/8	4	5 1/4
1	4	6
1 1/8	5	6 3/4
1 1/4	5	7 1/2
1 3/8	6	8 1/4
1 1/2	6	9
1 5/8	6	9 3/4



# Wire Rope Sling Capacities (LBS.) - Flemish Eye - ANSI B30.9

## 6 X 19 and 6 X 37

### Improved Plow Steel - IWRC 5/I Design Factor

Wire Rope Size Inches							
	Minimum Crosby Shackle Size	Minimum Crosby Shackle Size	Single Choker	Two Leg Sling Vertical	Two Leg Sling 60° Horizontal Sling Angle	Two Leg Sling 45° Horizontal Sling Angle	Two Leg Choker 60° Horizontal Sling Angle
3/8	7/16	2400	1840	4800	4200	3400	3200
7/16	1/2	3400	2400	6800	5800	4800	4200
1/2	5/8	4400	3200	8800	7600	6200	5500
9/16	5/8	5600	4000	11200	9600	7900	6900
5/8	3/4	6800	5000	13600	11800	9600	8700
3/4	7/8	9800	7200	19600	16900	13800	12500
7/8	1	13200	9600	26400	22800	18600	16600
1	1-1/8	17000	12600	34000	30000	24000	21800
1-1/8	1-1/4	20000	15800	40000	34600	28300	27400
1-1/4	1-3/8	26000	19400	52000	45000	36700	33600
1-3/8	1-1/2	30000	24000	60000	52000	42400	41600
Horizontal Sling Angles of Less Than 30 Degrees are Not Recommended							

## CARBON STEEL SHACKLES

Stock Diameter (Inches)	Inside Width at Pin (Inches)	Pin Diameter (Inches)	Max. Safe Working Load Single Vertical Pull (Pounds)
1/2	13/16	5/8	4,000
5/8	1 1/6	3/4	6,500
3/4	1 1/4	7/8	9,500
7/8	1 7/16	1	13,000
1	1 11/16	1 1/8	17,000
1 1/8	13/16	1 1/4	19,000
1 1/4	2 1/32	1 3/8	24,000
1 3/8	2 1/4	1 1/2	27,000
1 1/2	2 3/8	1 5/8	34,000
1 3/4	2 7/8	2	50,000
2	3 1/4	2 1/4	70,000

### POUND TO TON

2,000 LBS. = 1 TON

10,000 LBS. = 5 TONS

5,000 LBS. = 2-1/2 TONS

15,000 LBS.= 7-1/2 TONS

## SYNTHETIC WEB SLINGS

1,000 Pounds per Inch of Width – Single Ply Triangle

Sling Body Width (Inches)	Vertical	Choker	Vertical Basket	60 Deg. Basket	45 Deg. Basket	30 Deg. Basket
1	1,000	750	2,000	1,700	1,400	1,000
2	2,000	1,500	4,000	3,500	2,800	2,000
3	3,000	2,200	6,000	5,200	4,200	3,000
4	4,000	3,000	8,000	6,900	5,700	4,000
5	5,000	3,700	10,000	8,700	7,100	5,000
6	6,000	4,500	12,000	10,400	8,500	6,000

- Notes: (1.) All angles shown are measured from the horizontal.  
 (2.) Capacities for intermediate widths not shown may be obtained by interpolation.

## PIPE WT. LBS. PER FT.

SIZE	SCH. 40	SCH. 80
4"	10.19 lb	14.99 lb
5"	14.62 lb	20.78 lb
6"	18.98 lb	28.58 lb
8"	28.56 lb	43.40 lb
10"	40.50 lb	54.70 lb
12"	49.60 lb	65.40 lb
14"	54.60 lb	72.70 lb
16"	62.60 lb	82.80 lb
18"	70.60 lb	93.50 lb
20"	78.60 lb	104.10 lb
24"	94.60 lb	125.50 lb
30"	118.70 lb	157.60 lb

## Hazards on the Jobsite

1. **Physical hazards** – holes or ditches, sharp objects such as nails, broken glass, slippery surfaces, steep grades, uneven or unstable surfaces, scaffolds under construction, ladders, low overhead piping, non insulated hot piping, hot steam.
2. **Heat stress** can be a serious hazard, especially when wearing protective clothing. During hot humid days, heat stress can occur in as little as 15 minutes. Drink plenty of fluids.
3. **Electrical hazards** such as overhead power lines, downed electrical lines and buried cables.
4. **Explosion and fire hazards** – Ignition of explosive or flammable chemicals, including liquid or gaseous hydrocarbons, by the introduction of a spark, flame, or heat source. Chemical reactions that produce heat, fire or explosion. Agitation of shock-sensitive compounds.
5. **Health Hazards** – Be alert for any unusual odors, abnormal vapor or liquid leakage, vapor clouds or unusual sounds. Should you encounter any of these, immediately notify your supervisor and/or the client.
6. **Oxygen deficiency** might be a problem especially in confined spaces. Always monitor using properly calibrated analyzer equipment to see if sufficient oxygen is in the space before entering.

## Other Common Hazards

1. **Benzene** is an aromatic hydrocarbon found in many organic compounds. It is a colorless to light yellow liquid with an aromatic odor (sweet aroma). Symptoms of over exposure are irritation to the eyes, nose and respiratory system. It can cause headache, nausea, staggered gait or fatigue. In high concentrations it can cause unconsciousness and death. It also is a carcinogen. **Emergency First Aid:** remove victim to fresh air, wash skin, flush eyes with water and do not force to vomit. Get medical help immediately.
2. **Hydrogen Sulfide Gas (H<sub>2</sub>S)** is a powerful asphyxiant that is commonly found in the petroleum refining industry. It is a colorless gas with a strong sulfur odor. It is heavier than air and a flammable gas. It is classified as a Poison B Flammable. It can be identified by its rotten egg odor, which can deaden your sense of smell. Symptoms of over exposure are nasal and respiratory irritation, weakness, headache, or unconsciousness.

**Emergency First Aid:** thoroughly wash exposed areas and flush eyes with water, remove to fresh air. If breathing and circulation has stopped give CPR (if qualified to do so). Get medical attention immediately.

3. **Asbestos** is a mineral fiber generally found in insulations. It becomes hazardous when it is disturbed causing the fibers to become airborne. All new insulation is marked Non Asbestos. Work required in any area where insulation not marked Non Asbestos, should not be disturbed and should be reported to your supervisor.
4. **Radiography or x-ray** is often used in the refinery as a means of checking weld quality. This Gamma radiation in sufficient doses can cause serious physical harm so it is imperative that all personnel be alert for barricaded areas and radiography markers and that these areas are not entered for any reason.
5. **Nitrogen purges** may be used in environments where there is an ignition hazard. Please refer to your permits.

## **Electrical Safety for Non-qualified Workers**

A non-qualified worker is someone who has not been formally trained or certified as an electrician. Only qualified persons may work on electric circuit parts or equipment that have not been deenergized. Such persons must be made familiar with the use of special precautionary techniques, PPE, insulating & shielding materials and insulated tools.

This section applies to the safe work practices used to prevent electric shock or other injuries resulting from contact with electricity when work is performed on or near:

1. Equipment or circuits which are or may be energized and
2. Exposed deenergized parts or near enough to them to expose the worker to any electrical hazard they present.

### **Workers Who Face A Risk Of Electric Shock Must Be:**

1. Familiar with electrically related safety practices
2. Trained in safety related work practices related to their job assignments
3. Know clearance distances from energized equipment necessary to prevent electrical shock

### **Protection from Overhead Powerlines**

The lines must be deenergized and grounded or other protective measures must be provided before work is started.



## **Clearance distances for Personnel, vehicles and mechanical equipment**

1. Overhead powerlines of 50 kV or less may be approached no closer than ten (10) feet by any person, vehicle or mechanical device such as a crane or aerial platform.
2. Increase this by an additional 10 feet for each additional 50 kV.
3. Include barricading, marking off the ground under the power lines and providing a Safety Monitor.

## **Illumination**

Workers may not enter spaces containing exposed energized parts unless illumination is provided that enables them to work safely.

## **Confined Space and Enclosed Work.**

1. Protective measures such as dielectric rubber insulating clothing, and rescue devices are to be used when working in confined or enclosed work spaces where electrical hazards may exist. Buckles and D-rings must be made of nonconductive material.
2. Use protective shields, barriers or other insulating materials as needed.
3. When handling long dimensional conductive objects such as ducts, pipes, or rebar etc.:
  - a. Sources of electricity must be covered with a dielectric blanket or
  - b. Ends must be covered with a nonconductive material.

## **Portable Ladders**

All portable ladders must have nonconductive side rails such as fiberglass. Wooden ladders will conduct electricity and conductivity will increase if wet or oily.

## **Personal Items**

Conductive items of jewelry or clothing must not be worn unless they are rendered non-conductive by covering, wrapping or other insulating means.

## **Process Safety Management**

Process Safety Management (PSM) procedures are intended to prevent or reduce the effects of a large release of toxic, reactive,

flammable or explosive Highly Hazardous Chemicals (HHC) from a process.

**A Process** – One or more activities including any use, storage, manufacturing, handling or the on-site movement of HHC's. May include any group of vessels which are interconnected and separate vessels which are located near a HHC could be involved in a potential release.

**Application** – The standard applies to a process which contains a threshold quantity or greater amount of a toxic or reactive HHC. Also, it applies to 10,000 pounds or greater amounts of flammable liquids and gases and to the process activity of manufacturing explosives and pyrotechnics.

**Exceptions** – The standard does not apply to retail facilities, normally unoccupied remote facilities and oil or gas well drilling or servicing activities. Hydrocarbon fuels used solely for work place consumption as a fuel are not covered, if such fuels are not part of a process containing another HHC covered by the standard. Atmospheric tank storage and associated transfer of flammable liquids which are kept below their normal boiling point without benefit of chilling or refrigeration are not covered by the PSM standard unless the atmospheric tank is connected to a process or is sited in close proximity to a covered process such that an incident in a covered process could involve the atmospheric tank.

Injury and illness log experience must be maintained as it relates to work in covered areas.

**Workers Should Receive Documented Training In:**

1. Safe work practices necessary to the performance of their jobs
2. Known potential fire, explosion or toxic release hazards
3. Their company's Emergency Action Plans
4. Management of change
5. Job Hazard Analysis
6. Maintaining client confidentiality
7. Hot work permitting procedure
8. Incident investigation

## **Training Records Maintained Shall Include:**

1. Date of training
2. Identity of employees trained
3. Verification of employee understanding

**All employees are expected to perform their work in accordance with company and client safety rules and procedures as applicable to the work being performed.**

The client will advise the company of any unique hazards presented by client's work, or of any hazards found by the client and will provide a complete list of chemicals and other similar materials applicable to this section and provide access to the corresponding Material Safety Data Sheets.

## **Hand Tools and Hand Protection**

### **No One Glove Protects Against All Hazards**

Your hands are your livelihood. Protecting them is essential. Wear work gloves suited to the work and in good condition

- Leather and leather palm gloves provide protection against abrasion, cuts, etc.
- Chemical gloves provide protection against exposure when handling chemicals,
- Dielectric (rubber insulating) gloves provide protection by not allowing electricity to go through your body.

Specific hazards require specific gloves; know the hazard you will be working with or around when selecting the type of glove to be worn.

### **Be Sure Gloves Fit**

One size does not fit all with gloves. If too loose, gloves may slip off or strain the hand and wrist. If too tight, your grip will loosen faster and wrist tire more quickly due to the strain of forcing the glove closed.

### **When Not to Wear Gloves**

Rotating machinery such as drills, saws, shafts, and fans can grab gloves, jewelry and loose clothing and pull you into the mechanism. Do not wear gloves when working on rotating machinery. Use a push stick or tongs when working with a table saw or hot metal.

## **Causes of Hand Injuries**

Hand injuries are the most common type of injury. Hand injuries increase when a potential exists for:

1. Broken tools
2. Extreme heat, cold or wet
3. Distractions
4. Boredom or loss of focus
5. Pinch points and rotating or automated machinery

## **Tools**

Tools should be well-balanced, fit your hand comfortably, and not put the hand or wrist in an awkward position.

1. Brace yourself when using powered tools
2. Training and experience are required to operate power tools. Do not attempt to learn how to use power tools without your Supervisor's permission.
3. Start out by using the proper tools for the job.
4. Do not remove the guard from any tool
5. Inspect tools and equipment prior to use and report out of service if defective. Examples of defects:
  - a. Any tool which shocks you
  - b. Broken or missing guards
  - c. Cut or taped insulation on any power cord
  - d. Broken power tool cases
  - e. Cracked handles on shovels, picks or hammers
  - f. Mushroomed or distorted surfaces on any striking tool such as a hammer, wrench or chisel
6. Be prepared for the jamming of power tools such as drills. Have good footing and balance. Mount auxiliary handles if equipment is so supplied.
7. Be sure all cutting tools are sharp

## **Materials Handling**

Whether by manual lifting or by machine, perform materials handling so as to prevent injury or property damage.

1. Know your personal limitation before lifting
2. Ask for help with heavy or unstable loads
3. Make certain your footing is solid. Clear the path of travel.
4. Have a prearranged place to put the load down.
5. Get a firm grip on the object.
6. Lift with the leg muscles. Stand close to the object, set feet

comfortably wide apart and lower the body to the object using hips and knees. Grip the object firmly. Keep your center of gravity close to that of the object being lifted.

7. When two persons are lifting, one must give directions.
8. When two persons can not lift a load, use a mechanical lifting device, not a third person.

## **Trenches And Excavations**

DO NOT enter any trench unless provisions have been made to prevent its cave in. Some methods include:

1. Sloping the banks on both sides to the angle recommended by soil type and conditions. Vertical or shear cut trench walls may not be any deeper than 4 feet.
2. Shoring - Using engineered panels and braces to prevent cave in.
3. Working INSIDE a trench box.

## **Escorting Loads**

All loads should be escorted by a flag man to ensure safe movement on the jobsite at all times.

## **Fire Safety and Emergencies**

1. In the event of a jobsite emergency, all employees shall immediately stop work and evacuate to your designated assembly area. Travel upwind or crosswind in an orderly fashion. Know the alarm for your jobsite. It is a good idea to record alarms, emergency phone numbers, and radio numbers for your jobsite.
2. Fire equipment such as hoses, extinguishers, etc., shall not be removed from their locations except for fire use only. Whenever an extinguisher is used, the job supervisor must be informed. Fire hydrants and monitors shall be used for fire-fighting only; unless otherwise approved by the Safety Department.
3. The contractor shall submit to the job supervisor a list of personnel to be contacted during off hours in case of fires or emergencies for the purpose of moving their equipment, etc. This list should include names, and appropriate contact information.
4. Flammable liquids such as gasoline, kerosene, diesel, paints, solvents, etc., shall be transported and stored in properly labeled

metal containers designed specifically for handling these liquids. Such flammable liquids shall be stored away from sources of heat or ignition.

5. Internal combustion engines shall be shut down while refueling.

## **Barricades and Signs**

Excavations, trenches, and disruptions will require the use of barricades to protect employees from unsafe conditions. Sturdy physical barricades are required on roadways, walkways, and passage ways. Lighting of the barricade systems will be required during the hours of darkness when blocking roadways or walkways. Barricade tape can be used as a temporary means of restriction.

Yellow “caution” tape can only be used in those situations requiring caution.

Red “danger” barricade tape is to be used in those situations requiring no movement through the area. Only those workers involved with and knowledgeable of the immediate hazards can work or pass through the red “danger” barricade.

All barricades **MUST** be removed immediately after work is completed. Signs alerting other workers to the hazards shall be used (i.e. men working above, danger radiation source, danger asbestos removal, etc.) when necessary to alert others of possible hazards.

## **Housekeeping**

Housekeeping is a reflection of the employee’s feelings about safety and their quality of work. Good housekeeping is not attained by special cleanups. Good housekeeping is a daily effort.

1. Dumpsters are provided for waste disposal.
2. Cigarette butt cans must be utilized in all designated smoking areas.
3. Walking working surfaces (i.e. stairs, aisles, ladders, walkways, etc.) shall be kept free of materials, tools, debris, welding leads, cords, and hoses.
4. Lunch areas, shops, and offices should be cleaned on a regular basis.
5. Fire proof containers shall be used for oily rags, etc.

6. All nails will be immediately removed from lumber.
7. Lay down areas and material storage areas shall be properly stacked, sorted, and cleaned on a regular basis.
8. **Fire hydrants, monitors, and roadways shall not be blocked by materials, tools, vehicles, or debris.**
9. Prior to work being done in operating units, contact unit operators to notify where and how long material will be stored or left in the unit.

## **Sanitation, Wastes, & Spills Control**

1. Wastes such as lube oil, transmission oil, filters, etc. shall be disposed of in designated areas. (See Foreman.)
2. The release or spillage of oil or any other material which could contaminate the ground or water is strictly prohibited. In no case shall oils be drained on the ground.
3. Spill/drip pans (or other control devices) must be used and regularly emptied anywhere the possibility of spillage or leakage exists. Drip pans are required for leaking equipment even if it is being operated under emergency or temporary conditions. The leaking material must be collected and disposed of properly.
4. Drums, containers, carboys, tanks, etc., shall be properly marked and stored and used only in areas where any accidental or uncontrolled leak or spill would be contained and drained into the oily water sewer system.
5. The cause of any leakage or spill from any tank, vehicle, container, drum, etc., must be reported and corrected immediately by properly trained personnel.
6. All spills or leaks, regardless of size, are to be cleaned up promptly by authorized personnel using proper hazardous material handling procedures.

## **Vehicles & Traffic**

1. Obey all posted speed limit and traffic signs.
2. Personnel riding in the back of pickup trucks must be seated inside the bed of the truck. Feet and legs should not be hanging over the sides or back of trucks. Riding on bumpers, fenders, running boards, or sides of cranes, backhoes, bulldozers, forklifts, etc., is prohibited.
3. Vehicles shall not enter the process areas without operator notification.
4. When inside a jobsite, vehicles must not be left to block road access of fire fighting or operational equipment. Vehicles shall

not be parked or stopped in hazardous areas, such as over sewer boxes. Vehicles left unattended shall be turned off and left with keys in the ignition.

5. Piping, hoses, and electric cables crossing traffic lanes shall be suitably protected from damages via wooden planks, beveled-edge metal ramps, or pipe sleeves.
6. Materials, tools and equipment shall not be stored any closer than six feet from the edge of a road.

## **Hot Work**

A Safe Work Permit with hot work authorization is required for all cutting, burning, welding, grinding, use of non-explosion proof power tools, electrical equipment, or any ignition source. Permit requirements must be met before work is started. The immediate area shall be tested for oxygen and combustible or flammable concentrations. The oxygen level must be between 19.5%-23.5%. The Lower Explosive Limit (LEL) must be 5% or less, as per OSHA STD 1910 & 1926.

All sewers, manholes, valves, flanges, etc. in the immediate area will be tested and sealed or protected as necessary.

A qualified fire watch will be assigned, if needed. Additional fire watches may be required. The authorized person issuing the permit makes this determination and notes it on the permit. Fire suppression equipment as required by the permit will be made ready for immediate use on the job site.

The authorized person must conduct periodic testing of the hot work area as required by conditions.

If the object to be welded or cut cannot be moved and if all the fire hazards cannot be removed, then guards shall be used to confine the heat, sparks, and slag to protect the immovable fire hazards.

Before welding or cutting is performed above or near oily surfaces, the area should be flushed with water, steam cleaned, or covered with fire blankets, clean dirt or sand.

Grounding leads from the welding machine shall be attached as closely as possible to where the welding will take place. Welding



leads shall be carefully inspected for insulation abrasions, cuts, scuffs, or breaks. Whenever practicable, all arc welding and cutting operations shall be shielded by non-combustible or flame proof screens, which will protect employees and other persons working in the vicinity from the direct rays.

## **Lockout/Tagout (LOTO)**

Most companies have a Safety Standard Procedure (SSP) which addresses the control of hazardous energy during service and maintenance of machines and equipment known as lockout/tagout. The SSP establishes a program and describes the utilization of procedures for affixing appropriate lockout/tagout devices to machines and equipment. The purpose of these procedures is to disable the machines and equipment to prevent the unexpected energization, start-up, or release of stored energy that might otherwise cause serious injury to employees. All employees will be expected to conform to the procedures when lockout/tagout is needed to perform their work.

## **Confined Space**

The information found in this section should give a review of the confined space entry procedure. For more information about this procedure, contact your supervisor before work.

**Confined Space** – A space that:

1. Is large enough and so configured that an individual can bodily enter and perform assigned work;
2. Has limited or restricted means for entry or exit (for example; tanks, vessels, silos, storage bins, hoppers, vaults, pits or excavations deeper than 4 feet); and
3. Is not designed for continuous occupancy.

**Confined Space Entry (CSE)** – The action by which a person passes through an opening into a confined space. Entry includes ensuring work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

## **HOW TO IDENTIFY PERMIT SPACES AND HAZARDS**

**Permit required confined space** – A confined space that has one or more of the following characteristics:

1. Hazardous atmosphere;
2. Engulfment potential;
3. Entrapping design; or
4. Contains any other recognized serious safety or health hazard.

## **CONFINED SPACE ENTRY**

1. A safe work permit shall be issued under the provisions of your company's CSE procedures.
2. A qualified outside attendant is to be stationed at point of entry before entering into a confined space.
3. Personnel entering a confined space may be required to wear a full body harness.
4. All personnel entering a confined space shall be trained in the hazards and requirements of confined space entry.
5. Lockout/tagout of all equipment and processes shall comply.
6. Before anyone enters the confined space, the internal atmosphere shall be tested with a calibrated direct-reading instrument for oxygen content, flammable gases and vapors, and potential toxic air contaminants.
7. Other equipment that is necessary for safe entry into and rescue from confined spaces shall be designated on the safe work permit.
8. Compressed gas cylinders shall be kept on the outside of confined spaces.
9. Whenever changing working conditions have introduced a new hazard, the previous permit must be revoked, the space vacated, and a new entry permit must be issued prior to re-entry.
10. Keep all unauthorized personnel away from the confined space.
11. All personnel entering a confined space will log in and out with the attendant.

## **Contractor Evacuations**

### **Site Evacuation**

1. Always be aware of the wind direction which will determine the safe escape route. Bright orange wind socks are usually placed throughout plants for employees to identify the wind direction. Be aware that windsocks can be frozen in place. So the process steam exiting the unit stacks is a better indication of wind direction.

2. The Plant Alarm Signal may be used to indicate a general plant emergency. Be familiar with alarms at your site.
3. When an evacuation is signaled, personnel must recognize and avoid downwind locations. Egress from the plant should be along main roadways, when possible, and not through process areas. Do not return for personal belongings. Go to the nearest designated assembly area via the safest route, depending upon the wind direction. If there is a vapor release, exit the site upwind out of the vapor cloud. Never go downwind. If in a vehicle, park off the roadway, turn off the engine and leave the keys in the vehicle and then proceed on foot. Go to the nearest designated assembly area and wait for further instruction.

### **Assembly Points**

Assembly points will vary from site to site. Familiarize yourself with site assembly points.

### **Area Head Count As It Pertains To Evacuation**

It is the responsibility of each contractor to appoint a supervisor and an alternate who will be responsible for taking his/her work groups head count and reporting the count to his site representative and/or the Contractor Safety Coordinator in the event of an evacuation. Upon arriving at an assembly site, this person will again take a head count and report any missing persons to his site representative.

### **Respirator**

The daily Work Permit will advise if or what type of respirator is required.

Types:

1. HEPA
2. Nuisance Dust
3. AP - Air purifying
4. ASR - Air supplying respirator
5. SCBA - Self-contained breathing apparatus

# Crane Hand Signals

## Use Load Line

Tap fist on head, then use regular signals



## Use Whip Line

Tap elbow with one hand, then use regular signals



## Raise Load



## Lower Load



## Raise Load Slowly



## Lower Load Slowly

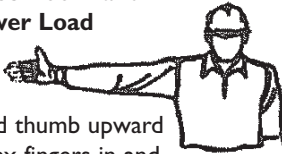
## Raise Boom



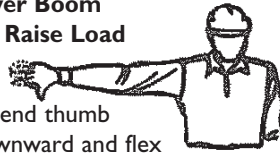
## Lower Boom



## Raise Boom and Lower Load



## Lower Boom and Raise Load

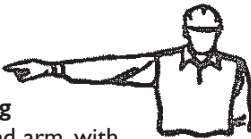


Extend thumb upward and flex fingers in and out as long as load movement is desired

Extend thumb downward and flex fingers in and out as long as load movement is desired

## Swing

Extend arm, with forefinger indicating direction of swing



## Stop

Extend forearm and hand in horizontal position and make slicing motion



## Emergency Stop

Both arms extended, palms down, move arms rapidly up and down

## **Reporting Procedure**

### **Environmental Guidelines**

#### **Incidents**

- Immediately notify the plant of any spills, odors, or releases to the air.
- The Shift Foremen will notify Safety and Environmental.

#### **Community Impact**

- Prevent odors, noise, dust, particulates, paint over-spray, etc.
- High noise operations should be conducted during daylight hours whenever possible.

#### **Sewer System**

- Avoid shocking the Waste Water Treatment Plant (WWTP) with caustic- and fluoride- containing materials.
- Do not wash solids or detergents into the sewer system.

#### **Spills**

- Take all reasonable measures to prevent spills. All portable tanks must have secondary containment
- Immediately report all spills.
- Immediately see qualified personnel to remediate all spills.
- Leaking mobile equipment (fork lifts, cranes, etc.) must be taken out of service until repaired.
- Petroleum Oil
  - a) minimize contamination to bare ground, surface waters that may drain offsite, or groundwater and rapidly deploy sorbent materials to capture spills.
  - b) spills on concrete within the units may be washed to the WWTP via the oily water sewer
    1. minimize solids to the sewer
    2. no detergents to the sewer

### **Superfund Amendments & Reauthorization Act (SARA)**

#### **Regulatory Requirements**

- Contractors must update the “Chemical Inventory” spreadsheet on the Intranet regarding all chemicals deployed on-site:
  - a) a list of chemicals and their quantities
  - b) each chemical's Reportable Quantity (RQ) value
  - c) storage location and container type (plastic drum, tote, etc.)

- d) number of days on site
- Contractors must provide copies of Material Safety Data Sheets to Safety and Environmental

### **Resource Conservation & Recovery Act Regulatory Requirements**

- Contractors must submit Hazardous Waste Operations & Hazardous Response (HAZWOPER) training documentation to the Environmental Department regarding personnel working with hazardous materials.

### **Accident Reports**

Any accident must be reported immediately to your supervisor. Within 24 hours, any OSHA Recordable or Lost Time Accident must be investigated and a report from the Contractor filed with the client. Each contractor is to use their own accident reporting form.

### **HAZWOPER**

Hazwoper Training must comply with OSHA requirements and that of each contractor.

# JOB SAFETY ANALYSIS CHECKLIST PREPARATION FOR JOB

## STEP 1: Use PPE/Safety Equipment checklist

Check off the PPE/Safety Equipment required and indicate the person responsible.

<input type="checkbox"/> Hard Hats <input type="checkbox"/> Safety Shoes <input type="checkbox"/> Safety Glasses <input type="checkbox"/> Face Shield <input type="checkbox"/> Goggles <input type="checkbox"/> Cotton Gloves <input type="checkbox"/> Leather Gloves <input type="checkbox"/> Rubber/Chemical Gloves <input type="checkbox"/> Chemical Apron	<input type="checkbox"/> Work Vest/Life Jacket <input type="checkbox"/> Full Body Harness <input type="checkbox"/> Double Lanyard w/Shock Abs. <input type="checkbox"/> Life Line <input type="checkbox"/> Safety Cable <input type="checkbox"/> Safety Barricade <input type="checkbox"/> Caution Tape <input type="checkbox"/> Clothing <input type="checkbox"/> Work Permit	<input type="checkbox"/> Respirator <input type="checkbox"/> Fire Extinguisher <input type="checkbox"/> Fire Retardant Tarps <input type="checkbox"/> Lock Out/Tag Out <input type="checkbox"/> Gas Detector <input type="checkbox"/> Hearing Protection <input type="checkbox"/> Absorbent Pads <input type="checkbox"/> Containment Pans <input type="checkbox"/> Proper Tools	OTHER _____ _____ _____ _____ _____ _____ _____ _____
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## STEP 2: Tools needed and assign employee responsible

## STEP 3: Other necessary steps and/or necessary communications with others.

### STEP 4:

A. SEQUENCE OF BASIC JOB STEPS	B. POTENTIAL ACCIDENTS OR HAZARDS AT EACH STEP	C. RECOMMENDATIONS TO ELIMINATE/REDUCE ACCIDENTS	D. EMPLOYEE NAME

**STEP 5:**

Chemical Exposure  
 Hazardous Atmosphere  
 Confined Spaces  
 Noise  
 Working/Walking Surfaces  
 Environment/Weather

**HAZARD RECOGNITION**

Arc/Flash  
 Open Hole  
 Ignition Sources  
 Pressure  
 Lifting  
 Overhead  
 Falls  
 Machinery  
 Heat Stress  
 Fire/Explosion  
 Spills  
 Slips/Trips  
 Chips/Slivers  
 Pinch Points  
 Hot Surface  
 Simultaneous Operation  
 Other

**STEP 6:**

Physical Barriers  
 Special Safety Equipment  
 Ignition Source Controls  
 Lock Out/Tag Out  
 Required Work Permits

**HAZARD CONTROLS AND EMERGENCY/CONTINGENCY PLANS**

Fire Fighting  
 Emergency Evacuation Procedures  
 Eyewash/Safety Shower Location  
 Material Safety Data Sheets  
 Simultaneous Operations  
 Hot Boiling Policy  
 Fall Protection/Open  
 Hole Policy  
 Spill Control/Contingency Plan

**STEP 7:****ZERO DISCHARGE ANALYSIS**

Potential spill sources or items that could be dropped overboard \_\_\_\_\_ Recommendations to prevent discharge and back up containment procedures.

**STEP 8: Is there a WEAK LINK in the process sequence TODAY? If so, what is it and what actions are necessary?**

**Machinery**      **Material**      **Manpower**      **Methods**      **Weather**      **Other**



<b>If your step includes this activity</b>	<b>Consider these possible hazards</b>	<b>Utilize these precautions for performing these steps safely</b>
Lifting	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Being struck by other objects</li> <li>• Caught in between objects</li> <li>• Fall to the same level</li> <li>• Fall to a different level</li> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Wear proper protection when handling chemicals</li> <li>• Get assistance when needed</li> </ul>
Pipe handling	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Being struck by other objects</li> <li>• Caught in between objects</li> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> <li>• Blown, chipped, splashed particles</li> <li>• Pollution</li> <li>• Extreme temperature or weather</li> <li>• Arc/X-ray exposure</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Wear full body harness when working 6' above deck and secured lanyard</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Wear proper eye protection</li> <li>• Wear proper protection for extreme cold or hot temps.</li> <li>• Wear proper eye protection around welding</li> </ul>
Pulling	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Being struck by other objects</li> <li>• Caught in between objects</li> <li>• Fall to the same level</li> <li>• Fall to a different level</li> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Wear full body harness when working 6' above deck and secured lanyard</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Wear proper eye protection</li> </ul>

# JSA ACTIVITY MEMORY JOGGER

If your step includes this activity	Consider these possible hazards	Utilize these precautions for performing these steps safely
Carrying objects	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Being struck by other objects</li> <li>• Caught in between objects</li> <li>• Fall to a different level</li> <li>• Fall to the same level</li> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> <li>• Absorption through skin</li> <li>• Pollution</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Wear full body harness when working 6' above deck and secured lanyard</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Wear proper protection when handling chemicals</li> <li>• Ensure proper seals on liquids being transferred</li> <li>• Keep one hand free</li> </ul>
Climbing	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Fall to a different level</li> <li>• Slip</li> <li>• Overexertion, strain sprain</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Wear full body harness when working 6' above deck with lanyard or Arrestive Fall Device (A.F.D.)</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> </ul>

<b>If your step includes this activity</b>	<b>Consider these possible hazards</b>	<b>Utilize these precautions for performing these steps safely</b>
Cleaning	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Being struck by other objects</li> <li>• Caught in between objects</li> <li>• Fall to the same level</li> <li>• Fall to a different level</li> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> <li>• Absorption through skin</li> <li>• Blown, chipped, splashed particles</li> <li>• Pollution</li> <li>• Extreme temperature of weather</li> <li>• Electric shock</li> <li>• Inhalation</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Wear full body harness when working 6' above deck and secured lanyard</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Wear proper protection when handling chemicals</li> <li>• Wear proper eye protection</li> <li>• Ensure proper seals on liquid being transferred</li> <li>• Wear proper protection for extreme cold or hot temps.</li> <li>• Wear proper breathing apparatus to avoid inhaling</li> </ul>
Descending	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Fall to the same level</li> <li>• Fall to a different level</li> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings and secure lanyards</li> <li>• Wear full body harness when working 6' above deck and secured lanyard</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Use Hand Rails</li> </ul>

# JSA ACTIVITY MEMORY JOGGER

If your step includes this activity	Consider these possible hazards	Utilize these precautions for performing these steps safely
Pushing	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Being struck by other objects</li> <li>• Caught in between objects</li> <li>• Fall to the same level</li> <li>• Fall to a different level</li> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Wear full body harness when working 6' above deck and secured lanyard</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Wear proper eye protection</li> <li>• Expect the unexpected</li> </ul>
Using hand tools	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Being struck by other objects</li> <li>• Caught in between objects</li> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> <li>• Blown, chipped splashed particles</li> <li>• Extreme temperature or weather</li> <li>• Electric shock</li> <li>• Arc/X-ray exposure</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Wear proper protection when handling chemicals</li> <li>• Wear proper eye protection</li> <li>• Wear proper protection for extreme cold or hot temps.</li> <li>• Wear proper eye protection around welding</li> <li>• Use proper tool for the job</li> <li>• Inspect tools for damage</li> </ul>

<b>If your step includes this activity</b>	<b>Consider these possible hazards</b>	<b>Utilize these precautions for performing these steps safely</b>
Equipment/ machinery operation	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Being struck by other objects</li> <li>• Caught in between objects</li> <li>• Fall to the same level</li> <li>• Fall to a different level</li> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> <li>• Blown, chipped, splashed particles</li> <li>• Pollution</li> <li>• Extreme temperature or weather</li> <li>• Electric shock</li> <li>• Inhalation</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Wear full body harness when working 6' above deck and secured lanyard</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Wear proper protection when handling chemicals</li> <li>• Wear proper eye protection</li> <li>• Ensure proper seals on liquids being transferred</li> <li>• Wear proper protection for extreme cold or hot temps.</li> <li>• Wear proper breathing apparatus to avoid inhaling</li> <li>• No loose clothing, etc.</li> </ul>
Handling liquids/ materials	<ul style="list-style-type: none"> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> <li>• Absorption through skin</li> <li>• Blown, chipped, splashed particles</li> <li>• Pollution</li> <li>• Extreme temperature or weather</li> <li>• Inhalation</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Wear proper protection when handling chemicals</li> <li>• Wear proper eye protection</li> <li>• Ensure proper seals on liquids being transferred</li> <li>• Wear proper protection for extreme cold or hot temps.</li> <li>• Wear proper breathing apparatus to avoid inhaling</li> </ul>

## JSA ACTIVITY MEMORY JOGGER

If your step includes this activity	Consider these possible hazards	Utilize these precautions for performing these steps safely
Welding	<ul style="list-style-type: none"> <li>• Striking against other objects</li> <li>• Being struck by other objects</li> <li>• Caught in between objects</li> <li>• Fall to the same level</li> <li>• Fall to a different level</li> <li>• Slip</li> <li>• Overexertion, strain, sprain</li> <li>• Blown, chipped, splashed particles</li> <li>• Pollution</li> <li>• Extreme temperature or weather</li> <li>• Electric shock</li> <li>• Inhalation</li> <li>• Arc/X-ray exposure</li> </ul>	<ul style="list-style-type: none"> <li>• Be aware of surroundings</li> <li>• Wear full body harness when working 6' above deck and secured lanyard</li> <li>• Maintain proper footing</li> <li>• Maintain proper body positioning at all times</li> <li>• Wear proper eye protection</li> <li>• Wear proper protection for extreme cold or hot temps.</li> <li>• Wear proper breathing apparatus to avoid inhaling</li> <li>• Wear proper eye protection around welding</li> <li>• Secure work area</li> </ul>

# SMOKING POLICY

Smoking is allowed only in the designated smoking areas.

## TOOLS AND EQUIPMENT

### Bolted Joint Assembly Procedures

This procedure shall be used for joint systems designed using SA-I93-B7 low-alloy steel bolts, except for joint systems using ring-joint gaskets.

Refer to SME PCC-I-2000 Tables 1, 2, 4, and Figures 3, 4

Guidelines for Pressure Boundary Bolted Flange Joint Assembly  
Target Torque Values for Low-Alloy Steel Bolting  
(U.S. Customary Units)

Nominal Bolt Size, in.	Target Torque (ft-lb)	
	Noncoated Bolts [Note (1)]	Coated Bolts [Notes (1), (2), and (3)]
1/2	60	45
5/8	120	90
3/4	210	160
7/8	350	250
1	500	400
1-1/8	750	550
1-1/4	1,050	800
1-3/8	1,400	1,050
1-1/2	1,800	1,400
1-5/8	2,350	1,800
1-3/4	2,950	2,300
1-7/8	3,650	2,800
2	4,500	3,400
2-1/4	6,500	4,900
2-1/2	9,000	6,800
2-3/4	12,000	9,100
3	15,700	11,900
3-1/4	20,100	15,300
3-1/2	25,300	19,100
3-3/4	31,200	23,600
4	38,000	28,800

Step	Torque Increment	
	Loading	
Install	Hand tighten, then “snug up” to 15 N.m (10 ft-lb) to 30 N.m (20 ft-lb) (not to exceed 20% of Target Torque). Check flange gap around circumference for uniformity. If the gap around the circumference is not reasonably uniform, make the appropriate adjustments by selective tightening before proceeding.	
Round 1	Tighten to 20% to 30% of Target Torque (see page 37). Check flange gap around circumference for uniformity. If the gap around the circumference is not reasonably uniform, make the appropriate adjustments by selective tightening before proceeding.	
Round 2	Tighten to 50% to 70% of Target Torque (see page 37). Check flange gap around circumference for uniformity. If the gap around the circumference is not reasonably uniform, make the appropriate adjustments by selective tightening before proceeding.	
Round 3	Tighten to 100% of Target Torque (see page 37). Check flange gap around circumference for uniformity. If the gap around the circumference is not reasonably uniform, make the appropriate adjustments by selective tightening before proceeding.	
Round 4	Continue tightening the bolts, but on a rotational clockwise pattern until no further nut rotation occurs at the Round 3 Target Torque value. For indicator bolting, tighten bolts until the indicator rod retraction readings for all bolts are within the specified range.	
Round 5	Time permitting, wait a minimum of 4 hours and repeat Round 4; this will restore the short-term creep relaxation/embedment losses. If the flange is subjected to a subsequent test pressure higher than its rating, it may be desirable to repeat this round after the test is completed.	

No of Bolts	Cross-Pattern Tightening Sequence	
	Sequence [Note (1)]	
4	1-3-2-4	
8	1-5-3-7 → 2-6-4-8	
12	1-7-4-10 → 2-8-5-11 → 3-9-6-12	



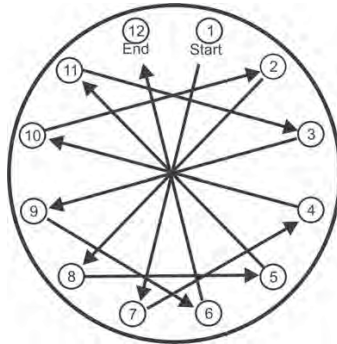
16	1-9-5-13 → 3-11-7-15 → 2-10-6-14 → 4-12-8-16
20	1-11-6-16 → 3-13-8-18 → 5-15-10-20 → 2-12-7-17 → 4-14-9-19
24	1-13-7-19 → 4-16-10-22 → 2-14-8-20 → 5-17-11-23 → 3-15-9-21 → 6-18-12-24
28	1-15-8-22 → 4-18-11-25 → 6-20-13-27 → 2-16-9-23 → 5-19-12-26 → 7-21-14-28 → 3-17-10-24
32	1-17-9-25 → 5-21-13-29 → 3-19-11-27 → 7-23-15-31 → 2-18-10-26 → 6-22-14-30 → 4-20-12-28 → 8-24-16-32
36	1-2-3 → 19-20-21 → 10-11-12 → 28-29-30 → 4-5-6 → 22-23-24 → 13-14-15 → 31-32-33 → 7-8-9 → 25-26-27 → 16-17-18 → 34-35-36
40	1-2-3-4 → 21-22-23-24 → 13-14-15-16 → 33-34-35- 36 → 5-6-7-8 → 25-26-27-28 → 17-18-19-20 → 37-38-39-40 → 9-10-11-12 → 29-30-31-32
44	1-2-3-4 → 25-26-27-28 → 13-14-15-16 → 37-38-39-40 → 5-6-7-8 → 29-30-31-32 → 17-18-19-20 → 41-42-43- 44 → 9-10-11-12 → 33-34-35-36 → 21-22-23-24
48	1-2-3-4 → 25-26-27-28 → 13-14-15-16 → 37-38-39- 40 → 5-6-7-8 → 29-30-31-32 → 17-18-19-20 → 41-42-43-44 → 9-10-11-12 → 33-34-35-36 → 21-22- 23-24 → 45-46-47-48
52	1-2-3-4 → 29-30-31-32 → 13-14-15-16 → 41-42-43- 44 → 5-6-7-8 → 33-34-35-36 → 17-18-19-20 → 45-46-47-48 → 21-22-23-24 → 49-50-51-52 → 25-26-27-29 → 9-10-11-12 → 37-38-39-40
56	1-2-3-4 → 29-30-31-32 → 13-14-15-16 → 41-42-43- 44 → 21-22-23-24 → 49-50-51-52 → 9-10-11-12 → 37-38-39-40 → 25-26-27-28 → 53-54-55-56 → 17-18-19- 20 → 45-46-47-48 → 5-6-7-8 → 33-34-35-36
60	1-2-3-4 → 29-30-31-32 → 45-46-47-48 → 13-14-15- 16 → 5-6-7-8 → 37-38-39-40 → 21-22-23-24 → 53-54-55-56 → 9-10-11-12 → 33-34-35-36 → 49-50- 51-52 → 17-18-19-20 → 41-42-43-44 → 57-58-59-60 → 25-26-27-28
64	1-2-3-4 → 33-34-35-36 → 17-18-19-20 → 49-50-51- 52 → 9-10-11-12 → 41-42-43-44 → 25-26-27-28 → 57-58-59-60 → 5-6-7-8 → 37-38-39-40 → 21-22- 23-24 → 53-54-55-56 → 13-14-15-16 → 45-50-51-52

**Note:**

**(1) See the following figures for illustrations of cross-pattern tightening sequences.**

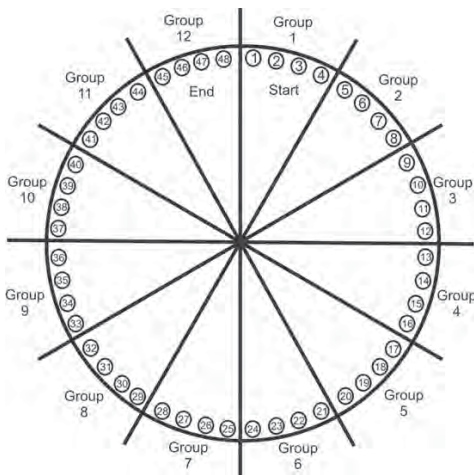
**12-Bolt Flange Tightening Sequence**

1-7-4-10 → 2-8-5-11 → 3-9-6-12



Tightening Sequence for 12 bolts [Round 1 through Round 3]

**48-Bolt Flange Tightening Sequence**



Group	Bolts
1	1-2-3-4
2	5-6-7-8
3	9-10-11-12
4	13-14-15-16
5	17-18-19-20
6	21-22-23-24
7	25-26-27-28
8	29-30-31-32
9	33-34-35-36
10	37-38-39-40
11	41-42-43-44
12	45-46-47-48

Tightening sequence for 12 groups:

1-7-4-10  
2-8-5-11  
3-9-6-12

[The 12-group sequence is the same as a 12-bolt sequence; see Figure.]

# FLANGE CHARTS

## SERIES 150 FLANGE

Pipe Size	Wrench Size	Flange Bolts		Raised Face			Flange Dia.	Ring Joint	
		Quan.	Size	Stud L'gth	Gasket			Stud L'gth	Ring No.
					I.D.	O.D.			
1	7/8	4	1/2	2 1/2	1	2 5/8	4 1/4	3	R15
1 1/2	7/8	4	1/2	2 3/4	1 1/2	3 3/8	5	3 1/4	R19
2	1 1/16	4	5/8	3 1/4	2	4 1/2	6	3 3/4	R22
3	1 1/16	4	5/8	3 1/2	3	5 3/8	7 1/2	4 1/4	R29
4	1 1/16	8	5/8	3 1/2	4	6 7/8	9	4 1/4	R36
6	1 1/4	8	3/4	4	6	8 3/4	11	4 1/2	R43
8	1 1/4	8	3/4	4 1/4	8	11	13 1/2	4 3/4	R48
10	17/16	12	7/8	4 3/4	10	13 3/8	16	5 1/4	R52
12	17/16	12	7/8	4 3/4	12	16 1/8	19	5 1/2	R56
14	1 5/8	12	1	5 1/4	13 1/4	17 3/4	21	6	R59
16	1 5/8	16	1	5 1/2	15 1/4	20 1/4	23 1/2	6	R64
18	1 13/16	16	1 1/8	6	17 1/4	21 5/8	25	6 1/2	R68
20	1 13/16	20	1 1/8	6 1/4	19 1/4	23 7/8	27 1/2	7	R72
24	2	20	1 1/4	7	23 1/4	28 1/4	32	7 3/4	R76

## SERIES 300 FLANGE

Pipe Size	Wrench Size	Flange Bolts		Raised Face			Flange Dia.	Ring Joint	
		Quan.	Size	Stud L'gth	Gasket			Stud L'gth	Ring No.
					I.D.	O.D.			
1	1 1/16	4	5/8	3	1	2 7/8	4 7/8	3 1/4	R16
1 1/2	1 1/4	4	3/4	3 1/2	1 1/2	3 3/4	6 1/8	4	R20
2	1 1/16	8	5/8	3 1/2	2	4 3/8	6 1/2	4 1/4	R23
3	1 1/4	8	3/4	4 1/4	3	5 7/8	8 1/4	5	R31
4	1 1/4	8	3/4	4 1/2	4	7 1/2	10	5 1/4	R37
6	1 1/4	12	3/4	4 3/4	6	9 7/8	12 1/2	5 3/4	R45
8	17/16	12	7/8	5 1/2	8	12 1/8	15	6 1/4	R49
10	1 5/8	16	1	6 1/4	10	14 1/4	17 1/2	7 1/4	R53
12	1 13/16	16	1 1/8	6 3/4	12	16 5/8	20 1/2	7 1/2	R57
14	1 13/16	20	1 1/8	7	13 1/4	19 1/8	23	7 3/4	R61
16	2	20	1 1/4	7 1/2	15 1/4	21 1/4	25 1/2	8 1/2	R65
18	2	24	1 1/4	7 3/4	17	23 1/2	28	8 1/4	R69
20	2	24	1 1/4	8 1/4	19	25 3/4	30 1/2	9 1/4	R73
24	2 3/8	24	1 1/2	9 1/4	23	30 1/2	36	10 1/4	R77

### SERIES 600 FLANGE

Pipe Size	Wrench Size	Flange Bolts		Raised Face			Flange Dia.	Ring Joint	
		Quan.	Size	Stud L'gth	Gasket			Stud L'gth	Ring No.
					I.D.	O.D.			
1	1 1/16	4	5/8	3 1/2	1 5/16	2 7/8	4 7/8	3 1/2	R16
1 1/2	1 1/4	4	3/4	4 1/4	1 29/32	3 3/4	6 1/8	4 1/4	R20
2	1 1/16	8	5/8	4 1/4	2	4 3/8	6 1/2	4 1/2	R23
3	1 1/4	8	3/4	5	3	5 7/8	8 1/4	5 1/4	R31
4	1 7/16	8	7/8	4 3/4	4	7 5/8	10 3/4	6	R37
6	1 5/8	12	1	6 3/4	6	10 1/2	14	7	R45
8	1 13/18	12	1 1/8	7 3/4	7 7/8	12 5/8	16 1/2	8	R49
10	2	16	1 1/4	8 1/2	9 3/4	15 3/4	20	8 3/4	R53
12	2	20	1 1/4	8 3/4	11 3/4	18	22	9	R57
14	2 13/16	20	1 3/8	9 1/4	12 7/8	19 3/8	23 3/4	9 1/2	R61
16	2 3/8	20	1 1/2	10	14 3/4	22 1/4	27	10 1/4	R65
18	2 9/18	20	1 5/8	10 3/4	16 1/2	24 1/8	29 1/4	11	R69
20	2 9/16	24	1 5/8	11 1/2	18 1/4	26 7/8	32	11 3/4	R73
24	2 15/16	24	1 7/8	13	22	31 1/8	37	13 1/2	R77

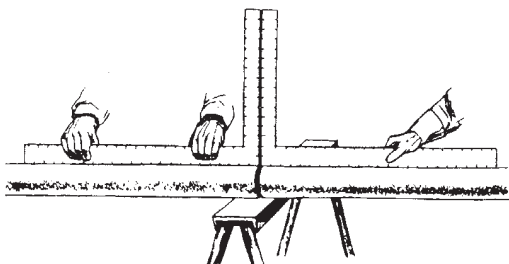
### SERIES 900 FLANGE

Pipe Size	Wrench Size	Flange Bolts		Raised Face			Flange Dia.	Ring Joint	
		Quan.	Size	Stud L'gth	Gasket			Stud L'gth	Ring No.
					I.D.	O.D.			
1	1 7/16	4	7/8	5	1 5/16	3 1/8	5 7/8	5	R16
1 1/2	1 5/8	4	1	5 1/2	1 29/32	3 7/8	7	5 1/2	R20
2	1 7/16	8	7/8	5 3/4	2	5 1/2	8 1/2	6	R24
3	1 7/16	8	7/8	5 3/4	3	6 1/2	9 1/2	6	R31
4	1 13/16	8	1 1/8	6 3/4	4	8 1/2	11 1/2	7	R37
6	1 13/16	12	1 1/8	7 3/4	6	11 3/8	15	8	R45
8	2 3/16	12	1 3/8	8 3/4	7 1/8	14 1/2	18 1/2	9	R49
10	2 3/16	16	1 3/8	9 1/4	9 3/4	17 1/2	21 1/2	9 1/2	R53
12	2 3/16	20	1 3/8	10	11 3/4	19 5/8	24	10 1/4	R57
14	2 3/8	20	1 1/2	10 3/4	12 7/8	20 1/2	25 1/4	11 1/4	R62
16	2 9/16	20	1 3/8	11 1/4	14 3/4	22 5/8	27 3/4	11 3/4	R66
18	2 15/18	20	1 7/8	13	16 1/2	25 1/8	31	13 1/2	R70
20	3 1/8	20	2	13 3/4	18 1/4	27 1/2	33 3/4	14 1/2	R74
24	3 7/8	20	2 1/2	17 1/4	22	33	41	18 1/4	R78

## PIPE ALIGNMENT

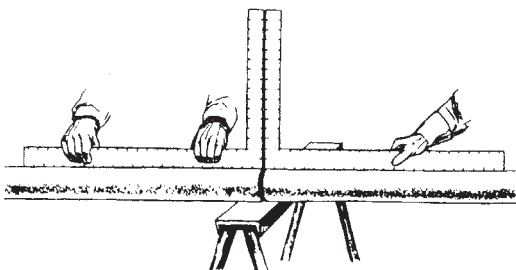
Proper alignment is one of the most important tasks performed by the pipe fitter. If done correctly, welding will be much easier and the piping system will be properly fabricated. If alignment is poor, however, welding will be difficult and the piping system may not function properly.

Many devices are available to aid alignment and methods of alignment vary widely throughout the trade. There is no best system ... any number of methods have proven successful. The procedures suggested by this manual are popular with many craftsmen and will enable you to quickly obtain good alignment.



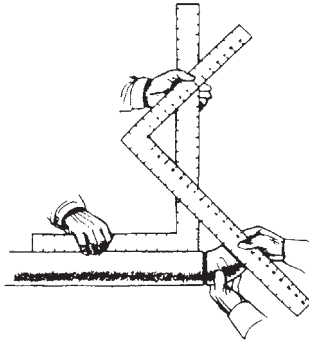
### PIPE-TO-PIPE

Move pipe lengths together until bevels are nearly flush, allowing space for welding gap. Center squares on top of both pipes and move pipe up and down until squares are aligned. Tack weld top and bottom. Repeat procedure by placing squares on side of pipe. Correct alignment by moving pipe left or right. Tack weld each side.



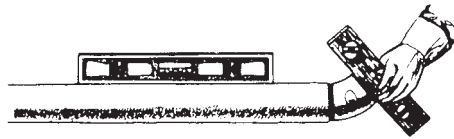
### 90° ELBOW-TO-PIPE

Place fitting bevel in line with bevel of pipe, allowing for welding gap. Tack weld on top. Center square on top of pipe. Center second square on elbow's alternate face. Move elbow until squares are aligned.



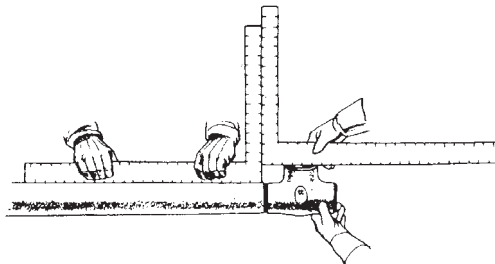
### 45° ELBOW-TO-PIPE

Follow diagram as shown above except squares will cross. To obtain correct 45° angle, align the same numbers on the inside scale of the tilted square (note: The numbers 4 and 7 are used in the illustration.)



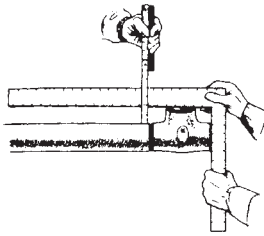
### Alternate Method

Use same procedure to abut pipe and fitting. Center spirit level on pipe. Next, center 45° spirit level on face of elbow and move elbow until 45° bubble is centered.



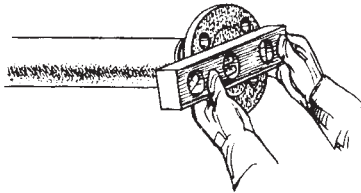
### TEE-TO-PIPE

Abut bevels, allowing for welding gap. Tack weld on top. Center square on top of pipe. Place second square on center of branch outlet. Move tee until squares are aligned.



### Alternate Method

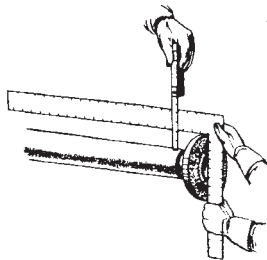
Follow same procedure to abut pipe and fitting. Place square on tee as illustrated. Center rule on top of pipe. Blade of square should be parallel with pipe. Check by measuring with rule at several points along the pipe.



### FLANGE-TO-PIPE

#### Step 1.

Abut flange to pipe. Align top two holes of flange with spirit level. Move flange until bubble is centered. Make one tack weld on top.



#### Step 2.

Center square on face of flange. Center rule on top of pipe. Move flange until square and pipe are parallel. Tack weld bottom.

#### Step 3.

Center square on face of flange. Center rule on side of pipe and align as in Step 2. Tack both sides.

# PIPE HANGERS



Band Hanger



Adjustable Split Ring Swivel Type



Adjustable Ring



Extension Split Pipe Clamp



Tin Clip



One Hole Clamp



Wrought Short Clip



"U" Bolt



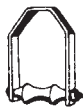
Return Line "J" Hook



Adjustable Solid Ring Swivel Type



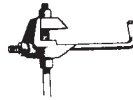
Wrought Clevis



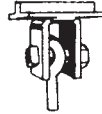
Roller Hanger



Beam Clamp



Side Beam Clamp



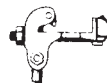
Welded Beam Attachment



"C" Clamp



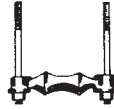
Eye Socket



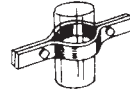
Angle and Channel Clamp



Pipe Roll and Plate



Single Pipe Roll



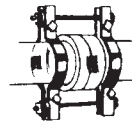
Riser Clamp



Double Bolt Pipe Clamp



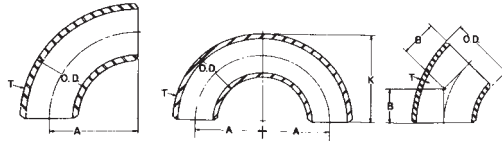
Anchor Chair



Socket Clamp

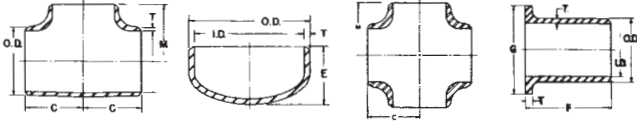


# TUBE TURNS® WELDING



NOM PIPE SIZE	OD	WALL THICKNESS <b>T</b>				90° ELBOWS	
		<b>ST</b>	<b>XS</b>	<b>160</b>	<b>XX</b>	LONG R <b>A</b>	SHORT R <b>A</b>
½	.840	.109	.147	—	—	1½	—
¾	1.050	.113	.154	—	.308	1⅞	—
1	1.315	.133	.179	.250	.358	1½	1
1¼	1.660	.140	.191	.250	.382	1⅞	1¼
1½	1.900	.145	.200	.281	.400	2¼	1½
2	2.375	.154	.218	.344	.436	3	2
2½	2.875	.203	.276	.375	.552	3¾	2½
3	3.500	.216	.300	.438	.600	4½	3
3½	4.000	.226	.318	—	.636	5¼	3½
4	4.500	.237	.337	.531	.674	6	4
5	5.563	.258	.375	.625	.750	7½	5
6	6.625	.280	.432	.719	.864	9	6
8	8.625	.322	.500	.906	.875	12	8
10	10.750	.365	.500	1.125	1.000	15	10
12	12.750	.375	.500	1.312	1.000	18	12
14	14.000	.375	.500	—	—	21	14
16	16.000	.375	.500	—	—	24	16
18	18.000	.375	.500	—	—	27	18
20	20.000	.375	.500	—	—	30	20
22	22.000	.375	.500	—	—	33	22
24	24.000	.375	.500	—	—	36	24
26	26.000	.375	.500	—	—	39	—
30	30.000	.375	.500	—	—	45	—
34	34.000	.375	.500	—	—	51	—
36	36.000	.375	.500	—	—	54	—
42	42.000	.375	.500	—	—	63	—

# FITTING DIMENSIONS



180° RETURNS		45° ELBOWS	TEES	CAPS	CROSSES	STUB ENDS	
LONG R K	SHORT R K	B	C & M	E	C & M	F	G
1 7/8	—	5/8	1	1	1	3	1 3/8
1 11/16	—	7/16	1 1/8	1 1/4	1 1/8	3	1 11/16
2 3/16	1 5/8	7/8	1 1/2	1 1/2	1 1/2	4	2
2 3/4	2 1/16	1	1 7/8	1 1/2	1 7/8	4	2 1/2
3 1/4	2 7/16	1 1/8	2 1/4	1 1/2	2 1/4	4	2 7/8
4 3/16	3 3/16	1 3/8	2 1/2	1 1/2*	2 1/2	6	3 3/8
5 3/16	3 5/16	1 3/4	3	1 1/2*	3	6	4 1/8
6 1/4	4 3/4	2	3 3/8	2*	3 3/8	6	5
7 1/4	5 1/2	2 1/4	3 3/4	2 1/2*	3 3/4	6	5 1/2
8 1/4	6 1/4	2 1/2	4 1/8	2 1/2*	4 1/8	6	6 3/16
10 5/16	7 3/4	3 1/8	4 7/8	3*	4 7/8	8	7 1/16
12 3/16	9 5/16	3 3/4	5 5/8	3 1/2*	5 5/8	8	8 1/2
16 5/16	12 3/16	5	7	4*	7	8	10 9/8
20 3/8	15 3/8	6 1/4	8 1/2	5*	8 1/2	10	12 3/4
24 3/8	18 3/8	7 1/2	10	6*	10	10	15
28	21	8 3/4	11	6 1/2*	11	12	16 1/4
32	24	10	12	7*	12	12	18 1/2
36	27	11 1/4	13 1/2	8*	13 1/2	12	21
40	30	12 1/2	15	9*	15	12	23
44	33	13 1/2	16 1/2	10	16 1/2	12	25 1/4
48	36	15	17	10 1/2*	17	12	27 1/4
—	—	16	19 1/2	10 1/2	19 1/2	—	—
—	—	18 1/2	22	10 1/2	22	—	—
—	—	21	25	10 1/2	25	—	—
—	—	22 1/4	26 1/2	10 1/2	—	—	—
—	—	26	30**	12	—	—	—

# USEFUL FORMULAS

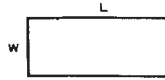
## Where:

A = Area; A<sub>1</sub> = Surface area of solids;

V = Volume; C = Circumference

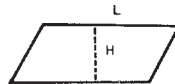
### Rectangle

$$A = W \times L$$



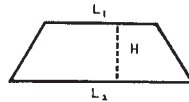
### Parallelogram

$$A = H \times L$$



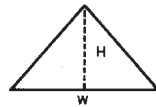
### Trapezoid

$$A = H \times \frac{L_1 + L_2}{2}$$



### Triangle

$$A = \frac{W \times H}{2}$$



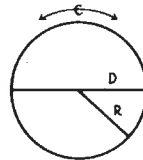
### Circle

$$A = 3.142 \times R \times R$$

$$C = 3.142 \times D$$

$$R = \frac{D}{2}$$

$$D = 2 \times R$$



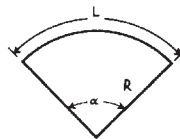
### Sector of circle

$$A = \frac{3.142 \times R \times R \times \alpha}{360}$$

$$L = .01745 \times R \times \alpha$$

$$\alpha = \frac{L}{.01745 \times R}$$

$$R = \frac{L}{.01745 \times \alpha}$$



# DECIMAL EQUIVALENTS

Fraction	Decimal	Millimeter	Fraction	Decimal	Millimeter
1/64	.015625	.397	33/64	.515625	13.097
1/32	.031250	.794	17/32	.531250	13.494
3/64	.046875	1.191	35/64	.546875	13.891
<b>1/16</b>	<b>.062500</b>	<b>1.588</b>	<b>9/16</b>	<b>.562500</b>	<b>14.288</b>
5/64	.078125	1.984	37/64	.578125	14.684
3/32	.093750	2.381	19/32	.593750	15.081
7/64	.109375	2.778	39/64	.609375	15.478
<b>1/8</b>	<b>.125000</b>	<b>3.175</b>	<b>5/8</b>	<b>.625000</b>	<b>15.875</b>
9/64	.140625	3.572	41/64	.640625	16.272
5/32	.156250	3.969	21/32	.656250	16.669
11/64	.171875	4.366	43/64	.671875	17.066
<b>3/16</b>	<b>.187500</b>	<b>4.763</b>	<b>11/16</b>	<b>.687500</b>	<b>17.463</b>
13/64	.203125	5.159	45/64	.703125	17.859
7/32	.218750	5.556	23/32	.718750	18.256
15/64	.234375	5.953	47/64	.734375	18.653
<b>1/4</b>	<b>.250000</b>	<b>6.350</b>	<b>3/4</b>	<b>.750000</b>	<b>19.050</b>
17/64	.265625	6.747	49/64	.765625	19.447
9/32	.281250	7.144	25/32	.781250	19.844
19/64	.296875	7.541	51/64	.796875	20.241
<b>5/16</b>	<b>.312500</b>	<b>7.938</b>	<b>13/16</b>	<b>.812500</b>	<b>20.638</b>
21/64	.328125	8.334	53/64	.828125	21.034
11/32	.343750	8.731	27/32	.843750	21.431
23/64	.359375	9.128	55/64	.859375	21.828
<b>3/8</b>	<b>.375000</b>	<b>9.525</b>	<b>7/8</b>	<b>.875000</b>	<b>22.225</b>
25/64	.390625	9.922	57/64	.890625	22.622
13/32	.406250	10.319	29/32	.906250	23.019
27/64	.421875	10.716	59/64	.921875	23.416
<b>7/16</b>	<b>.437500</b>	<b>11.113</b>	<b>15/16</b>	<b>.937500</b>	<b>23.813</b>
29/64	.453125	11.509	61/64	.953125	24.209
15/32	.468750	11.906	31/32	.968750	24.606
31/64	.484375	12.303	63/64	.984375	25.003
<b>1/2</b>	<b>.500000</b>	<b>12.700</b>	<b>1</b>	<b>1.000000</b>	<b>25.400</b>

# TABLE OF CONVERSION FACTORS

## Length

$$1 \text{ ft} = 12 \text{ in.}$$

$$1 \text{ yd} = 3 \text{ ft}$$

$$1 \text{ mi} = 5280 \text{ ft}$$

$$1 \text{ m} = 100 \text{ cm} = 1000 \text{ mm}$$

$$1 \text{ in.} = 2.540 \text{ cm} = 25.40 \text{ mm}$$

$$1 \text{ ft} = 0.3048 \text{ m}$$

$$1 \text{ m} = 3.281 \text{ ft} = 39.37 \text{ in.}$$

## Area

$$1 \text{ ft}^2 = 144 \text{ in.}^2 = 0.09290 \text{ m}^2$$

$$1 \text{ in.}^2 = 6.452 \text{ cm}^2$$

$$1 \text{ m}^2 = 10.76 \text{ ft}^2$$

## Volume

$$1 \text{ ft}^3 = 1728 \text{ in.}^3 = 0.02832 \text{ m}^3$$

$$1 \text{ in.}^3 = 16.39 \text{ cm}^3$$

$$1 \text{ l (liter)} = 1000 \text{ cm}^3 = 1000 \text{ ml (milliliter)} = 61.02 \text{ in.}^3$$

$$1 \text{ m}^3 = 35.32 \text{ ft}^3$$

$$1 \text{ U.S. gal} = 4 \text{ qt} = 231 \text{ in.}^3 = 3.785 \text{ l} = 0.1337 \text{ ft}^3$$

$$1 \text{ qt} = 2 \text{ pints} = 32 \text{ fluid oz} = 57.75 \text{ in.}^3 = 0.9464 \text{ l}$$

## Time

$$1 \text{ hour} = 1 \text{ h} = 60 \text{ min} = 3600 \text{ seconds} = 3600 \text{ s}$$

$$1 \text{ min} = 60 \text{ s}$$

## Force & Weight

$$1 \text{ lb} = 16 \text{ oz} = 4.448 \text{ N (newtons)}$$

$$1 \text{ N} = 0.2248 \text{ lb} = 10^5 \text{ dynes}$$

$$1 \text{ ton} = 2000 \text{ lb}$$

## Torque

$$1 \text{ ft-lb} = 1.356 \text{ N-m}$$

## Velocity

$$1 \text{ mi/h} = 1.467 \text{ ft/s} = 0.4470 \text{ m/s} = 1.609 \text{ km/h}$$

$$1 \text{ ft/s} = 0.3048 \text{ m/s}$$

## Mass

$$1 \text{ slug} = 14.59 \text{ kg} = 32.17 \text{ lb (mass)}$$

$$1 \text{ lb (mass)} = 0.03108 \text{ slug} = 0.4536 \text{ kg}$$

$$1 \text{ kg} = 0.06852 \text{ slug} = 2.205 \text{ lb (mass)}$$

## Specific Weight

$$1 \text{ lb/ft}^3 = 157.1 \text{ N/m}^3$$

# SOFT LUMBER SIZES

Nominal Size Inches	Actual Size Dry (Inches)(mm)	Actual Size Green (Inches) (mm)
------------------------	---------------------------------	------------------------------------

## THICKNESS:

1	.3/4	.19	.25/32	.20
1-1/4	.1	.25	1-1/32	.26
1-1/2	1-1/4	.32	1-9/32	.33
2	1-1/2	.38	1-9/16	.40
2-1/2	.2	.51	2-1/16	.52
3	2-1/2	.64	2-9/16	.65
3-1/2	.3	.76	3-1/16	.78
4	3-1/2	.89	3-9/16	.90
4-1/2	.4	102	4-1/16	103
6	5-1/2		5-9/16	
8	7-1/2		7-9/16	

## FACE WIDTH:

2	1-1/2	.38	1-9/16	.40
3	2-1/2	.64	2-9/16	.65
4	3-1/2	.89	3-9/16	.90
5	4-1/2	114	4-5/8	117
6	5-1/2	140	5-5/8	143
7	6-1/2	165	6-5/8	168
8	7-1/4	184	7-1/2	190
9	8-1/4	210	8-1/2	216
10	9-1/4	235	9-1/2	241
11	10-1/4	260	10-1/2	267
12	11-1/4	286	11-1/2	292
14	13-1/4	337	13-1/2	343
16	15-1/4	387	15-1/2	394

Dry lumber is defined as lumber with less than 19 percent moisture and unseasoned or green is greater than 19 percent. All sizes listed above, both nominal and actual, conform to standards set by the American Softwood Lumber Standards.

Lumber is sold by a "feet board measure" or "board foot" rating.  
 board foot = 144 cubic inches (for example 12 inch x 12 inch x 1 inch or 2 inch x 6 inch x 12 inch). Board feet = thickness (in) x face width (in) x length (in)/144 or = thickness (in) x face width (in) x length (ft)/12

## SOFT LUMBER SIZES (continued)

The following are quick approximations for calculating board feet:

- for a 1 x 4, divide linear length (feet) by 3
- for a 1 x 6, divide linear length (feet) by 2
- for a 1 x 8, multiply linear length (feet) by 0.66
- for a 1 x 12, linear length (feet) = board feet
- for a 2 x 4, multiply linear length (feet) by 0.66
- for a 2 x 6, linear length (feet) = board feet
- for a 2 x 8, multiply linear length (feet) by 1.33
- for a 2 x 12, multiply linear length (feet) by 2

## RISE & RUN OF STAIRS

\*Not intended to replace design on engineered drawings/specification.

Angle to horizontal	Rise (in inches)	Tread run (in inches)
30 deg. 35'	.6-1/2	11
32 deg. 08'	.6-3/4	10-3/4
33 deg. 41'	.7	10-1/2
35 deg. 16'	.7-1/4	10-1/4
36 deg. 52'	.7-1/2	10
38 deg. 29'	.7-3/4	9-3/4
40 deg. 08'	.8	9-1/2
41 deg. 44'	.8-1/4	9-1/4
43 deg. 22'	.8-1/2	9
45 deg. 00'	.8-3/4	8-3/4
46 deg. 38'	.9	8-1/2
48 deg. 16'	.9-1/4	8-1/4
49 deg. 54'	.9-1/2	8

# COMMUNICATING IN SPANISH

## COMMON GREETINGS & PHRASES

<b>Good morning</b>	(BWEHN-ohs DEE-ahs)	Buenos días
<b>Good afternoon</b>	(BWEHN-ohs TAR-dehs)	Buenas tardes
<b>How is it going?</b>	(KOH-moh BHAH)	¿Cómo va?
<b>Please</b>	(pohr-fah-BHOHR)	Por favor
<b>Thanks</b>	(GRAH-see-ahs)	Gracias
<b>Yes</b>	(see)	Sí
<b>No</b>	(noh)	No
<b>Don't</b>	(noh)	No
<b>Stop</b>	(al-TOE)	Alto
<b>Come with me</b>	(BHEHNG-ah kohn-MEE-goh)	Venga conmigo
<b>Come here</b>	(BHEHNG ah-KEE)	Venga aquí
<b>Lets go</b>	(BHAH-moh-nohs)	Vamonos
<b>Lets go to work</b>	(BHAH-moh-nohsa trah-bah-HAR)	Vamonosa Trabajar
<b>Go with him</b>	(BHAH-ya kohn EL)	Vaya con él
<b>Wait</b>	(ehs-PEH-reb)	Espere
<b>No more for now</b>	(Yahnob MAHS)	Yano mas
<b>What is your name?</b>	(KOH-mob seh YAH-mah)	¿Como Sellama?
<b>Understand?</b>	(kohm-PREHN-deh?)	¿Comprende?
<b>Where is?</b>	(DOHN-deh ehs-TAH?)	¿Dónde está?



<b>How do you say?</b>	¿Como Sedice? (KOH-moh seh DEE-seh)
<b>In Spanish</b>	En español (EHN eh-SPAHN-YOHL)
<b>What do you call this?</b>	¿Como Sellama Esto? (KOH-moh seb YAH-mab EH-stoh?)
<b>My name is</b>	Mi Llamo (Meh YAH-moh)
<b>I do not understand</b>	No Comprendo (Noh kohm-PREHN-doh)
<b>Speak more slowly</b>	Hable Mas Despacio (AH-bleh mahs deh-SPAH-syoh)
<b>Tell him</b>	Dígale (dee-GAH-leb)
<b>Repeat that</b>	Repita esto (reh-PEE-tah EH-stob)
<b>I need one worker please</b>	Necesito trabajador por favor (Neb-seb-SEE-tohoon trah-bah-hah-DOHR, PHOR fah-BHOHR)
<b>Two workers</b>	Dos trabajadores (Dohs trah-bah-hah-DOH-rehs)
<b>Next time</b>	LA próxima Vez (lah PROH-ksee-mak BHEHS)

## **WORKER INFORMATION**

<b>We start at</b>	Empezamos a las (Ehm-peh-SAH-mohs a lahs)
<b>We stop at</b>	Paramos a las (Pah-RAH-mohs ah lahs)
<b>Take a break</b>	Tomen un Descanso (TOH-mehn oon dehs-KAHN-soh)
<b>What is your address?</b>	¿Cual es su direccion? (KWAHL ehs soo dee-rehk-SYOHN?)
<b>What is your telephone number?</b>	¿Cual es el numero de su telefono? (KWAHL ehs ehl NOO-meh-roh deh soo teh-LEH-foh-noh?)

## **SCHEDULE**

<b>Quitting time</b>	Hora de terminar (OH-rah deh tehr-mee-NAHR)
<b>Do not be late</b>	No llegue tarde (no YEH-geh TAHR-deh)
<b>Be here tomorrow at</b>	Esté aquí mañana a las (ehs-SETH ah-KEE mahn-YAHN-nah ah lahs)
<b>Lunch time</b>	Lonche (LOHN-cheh)
<b>Time to eat</b>	Es la hora de comer (Ehs lab OH-rab deh kob-MEHR)

## **WORK INSTRUCTIONS**

<b>Move that over here</b>	Mueva eso aquí (MWEH-vah EH-soh ah-KEE)
<b>Bring that to me</b>	Tráigame eso (TRY-gah-meh EH-soh)
<b>Give me that</b>	de'me lo (DEH-meh loh)
<b>Where is it necessary?</b>	¿Dónde es necesario? (DOHN-deh ehs neb-she-SAH-ree-oh)
<b>Here</b>	Aquí (ah-KAH)
<b>Remove these things</b>	Quite estas cosas (KEE-the EH-stahs KOH-sahs)
<b>Pick up all of these</b>	Recoja todo éstos (Reh-KOH-hah TOH-doh EHS-toh)
<b>Put it here</b>	Póngalo allí (POHNG-gah-loh ah-YEE)
<b>Carry this</b>	Lleve esto (YEH-veh EH-stoh)
<b>Put this on that</b>	Ponga esto (encima) de eso (POHNG-ah EH-stoh ehn-SEE-mah) deh EH-soh)
<b>Above</b>	Arriba (ah-RREE-bah)
<b>Around</b>	Alrededor (ahl-reh-deh-DOHR)

<b>Below</b>	(ah-BAH-hoh)	Abajo
<b>Outside</b>	(ah-FWEH-rah)	Afuera
<b>Inside</b>	(ah DEHN-troh)	A dentro
<b>Clean</b>	(LIM-pee-yeh)	Limpie
<b>Cut</b>	(KOHR-the)	Corte
<b>Do</b>	(AH-gah)	Haga
<b>Hold</b>	(dehs-TEHN-gah)	Destenga
<b>Lift</b>	(leh-BHAHN-teh)	Levante
<b>Mix</b>	(MEHS-kleh)	Mezcle
<b>Paint</b>	(PEEN-th)	Pinte
<b>Plant</b>	(PLAHN-the)	Plante
<b>Pull</b>	(HAH-leh)	Jale
<b>Push</b>	(ehm-POO-heh)	Empuje
<b>Remove</b>	(KEE-the)	Quite
<b>Spread</b>	(eh-SPAHR-she)	Esparse
<b>Take</b>	(TOH-meh)	Tome
<b>Trim</b>	(reh-KOHR-teh)	Recorte
<b>Use</b>	(OO-seh)	Use
<b>Glue it</b>	(PEH-geh loh)	Pege lo
<b>Bend it</b>	(DOH-bleh loh)	Doble lo

<b>Break it</b>	(ROHM-peh-loh)	Rompe lo
<b>Empty it</b>	(BHA-see-yeh loh)	Vacíe lo
<b>Fill</b>	(YEHN-eh)	Llene
<b>Get</b>	(ah-GAH-rrah)	Agarra
<b>Hit</b>	(GOHL-peh-eh)	Golpee
<b>Move</b>	(MWEH-veh)	Mueve
<b>Open</b>	(AHB-reh)	Abre
<b>Pour</b>	(EH-cheh)	Eche
<b>Bring it here</b>	(TRANG-alo ah-KEE)	traigalo aqui
<b>Dig</b>	(ehks-KAH-veh)	Excave
<b>Drill</b>	(tah-LAH-dreh)	Taladre
<b>Sand</b>	(LEE-heh)	Lije
<b>Scrape</b>	(RAH-speh)	Raspe
<b>Work</b>	(teah-BAH-heh)	Trabaje

## **SPECIFIC INSTRUCTIONS**

<b>Clean the floor</b>	(LIM-pee-yeh ehl PEE-soh)	Limpie el piso
<b>Clean the Area</b>	(LIM-pee-yeh ehl airr-EE-ah)	Limpie el 'area
<b>Clean the room</b>	(LIM-pee-yeh ehl KWAHR-toh)	Limpie el cuarto
<b>Clean the windows</b>	(LIM-pee-yeh lahs bhehn-TAH-nahs)	Limpie las ventanas

## **NUMBERS**

One		Uno
	(OO-noh)	
Two		Dos
	(dohs)	
Three		Tres
	(trehs)	
Four		Cuatro
	(KWAH-troh)	
Five		Cinco
	(SEEN-koh)	
Six		Seis
	(SEH-ees)	
Seven		Siete
	(SYEH-teh)	
Eight		Ocho
	(OH-choh)	
Nine		Nueve
	(NWEH-veh)	
Ten		Diez
	(dyehs)	
Eleven		Once
	(ON-say)	
Twelve		Doce
	(DOH-say)	

## **DAYS OF THE WEEK**

<b>Monday</b>		Lunes
	(LOO-nehs)	
<b>Tuesday</b>		Martes
	(MAHR-tehs)	
<b>Wednesday</b>		Miércoles
	(mee-HER-koh-lehs)	
<b>Thursday</b>		Jueves
	(HWEH-bhehs)	
<b>Friday</b>		Viernes
	(BHYEHR-nehs)	
<b>Saturday</b>		Sábado
	(SAH-bah-doh)	
<b>Sunday</b>		Domingo
	(doh-MEEN-goh)	

## **SAFETY**

<b>Careful</b>	(kwee-DAH-doh)	Cuidado
<b>Danger</b>	(peh-LEE-groh)	Peligro
<b>Tell me if you get hurt</b>	(DEE-gah-meh see she lah-STEE-mah)	Dígame si se lastima
<b>Pain</b>	(doh-LOR)	Dolor
<b>Wear</b>	(OO-seh)	Use
<b>Use</b>	(OO-seh)	Use
<b>Boots</b>	(lahs WAHN-tehs)	las botas
<b>Goggles</b>	(lohs ahn-teh-OH-hohs)	los anteojos
<b>Helmet</b>	(oon KAHS-koh)	Un casco
<b>Fire!</b>	(foo-WAY-go)	Fuego!
<b>Sick</b>	(in-FWEAR-mo)	Enfermo

