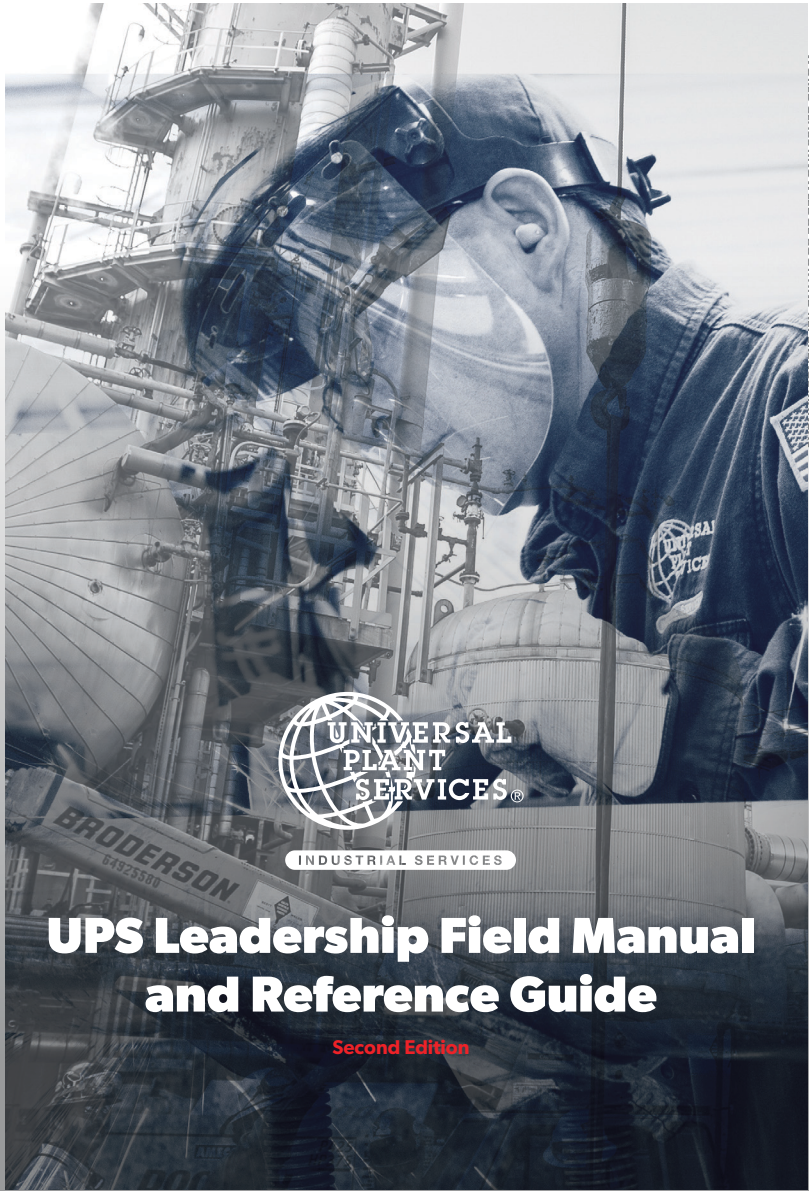


# UPS Leadership Field Manual and Reference Guide

Second Edition

Inside Cover, Blank Intentionally

# FOREWORD

UPS management and employees contributed to the contents of this book to make it as useful as possible to assist our valued craftsman in their everyday tasks and help them identify hazards on the job. Within it you will find.

- Important Safety Tips
- Tool Use and Inspection
- Quality reference and expectations
- Bolt and pipe fitting Charts and Weight References
- Employee Roles & Responsibilities.
- Much more

First and foremost this manual is a reference to assist you in identifying known hazards that exist with tools we have used every day of our professional lives but have not always identified before starting a task. If you truly use the UPS Safety$^2$ process of identifying a hazard and eliminating it before starting work. This book will help find hazards that you may have not realized existed or have become complacent to that are associated with a tool you are about to use. Before you begin your work take the time to review those hazards not just in the work area but also with your tools.

You will find inside many reference charts containing information gathered from several different sources that we use daily on the job. Information within has come from many different sources including the Internet, UPS subject matter experts or from our past 30 years of experience collecting useful information to better perform our crafts.

An informed craftsman is a safe craftsman. Please keep this tool handbook as a reference through your entire work day. Refer to it to assist in building a good PHA card, saving steps gathering material, or to answer a simple question about a task.

Your safety is paramount at UPS it is the intent of all our programs to assist you in going home the same way you came to work. This tool manual is one component of that program please read it, use it daily for reference to assist in identifying hazards associated with your job.

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## SECTION 1:

# UPS LEADERSHIP, EXPECTATIONS & RESPONSIBILITIES

# UPS LEADERSHIP PROGRAM

**Leadership:** The most important factor in building, training, and developing high performing teams

**Team:** A group of individuals working together to accomplish a mission, project, or task

**Leader:** A Leader develops effective interpersonal relationships that makes others want to follow his or her direction. A leader leads by example

Leadership has nothing to do with seniority, position or hierarchy within a company. Leadership isn't management. Leaders build relationships and accomplish goals, whereas managers build systems and processes.

At UPS, the only meaningful measure for a leader is whether the team succeeds or fails. For all definitions, descriptions, and characterizations of leaders there are only two that matter: effective or ineffective. The UPS Leadership Program focuses on practices and personal character traits that make effective leaders. The purpose and intent of this program is to develop and improve leadership skills in each of our supervisors and employees to further develop high performing teams within UPS. Leadership applies to everything we do.

The Following are Base Leadership Principles for UPS Leader

- **Relationships:** The ability to make, build, create or improve relationships is the single most important leadership principle. You cannot lead, influence or inspire anyone that you do not have a relationship with.
- **Integrity:** Integrity means doing the right thing because it is the right thing to do. The quality of having strong moral principles that you refuse to compromise or change. Integrity is the supreme quality of leadership; without it, no real success is possible.
- **Humility:** Ego is your opinion of yourself; your feeling about your level of ability, Intelligence and your importance as a person. "Checking your ego" demonstrates a leader's ability to take charge of himself: it is managing the negative aspects of your ego.
- **Self Assessment:** Self-assessments are a continuing process through which leaders evaluate their performance and determine what improvements are required. Ego is the biggest obstacle for a leader in performing self-assessments. A "brutally honest" assessment of your own performance is essential for leadership development and improvement.

# UPS LEADERSHIP PROGRAM

## Extreme Ownership is the Foundation of the UPS Leadership Doctrine

- You accept responsibility of the mission or job and you are responsible for the performance of your team and the outcome of the mission or job. Blame shifting is not an option.
- You own everything that affects your job: every success, every failure, every problem and every solution. Just by simply saying something is your fault does not mean you have taken ownership of the problem. You must provide a solution to solve the problem.
- Ultimately, Extreme Ownership is about you. You step up and make the change in behavior instead of expecting others to change - you accept that you can do better.
- Extreme Ownership starts with you and it spreads to each team member until Extreme Ownership becomes the new standard or culture within your team.

## 4-Laws of Combat are the fundamental Principles of the UPS Leadership Doctrine

- **Cover and Move:** Cover and Move is teamwork. Not just teamwork within your group but establishing teamwork with all groups necessary to complete the mission or job.
- **Simple:** Keep plans simple, not complex. If you get into a situation where things are complex, stop and simplify the plan. It is important that your people understand the plan, they know their assignments and understand the "why". Once you have communicated the plan, ask your team members to explain it back to you.
- **Prioritize and Execute: I**n a turnaround environment, priorities shift and situations develop that can sometimes become overwhelming. As a leader, you need to analyze the situation, respond and move to the next priority. Do not become fixated on one priority (target fixation) and lose the ability to see other developing problems. It is important to remain calm and make good decisions under pressure.
- **Decentralized Command:** Basically, leaders at all levels (Project Managers down to Foreman) are empowered to lead in key tasks necessary to effectively complete the job. Junior supervision must understand the end goal and the "why" to attain that goal; they also need to know the limits of their authority.

# UPS LEADERSHIP PROGRAM

## Default Aggressive Mindset

As a leader you must make things happen, you cannot sit on problems or issues and do nothing; all decision making is wasted time if you don't act. An aggressive mindset and the act of moving forward will yield the best result and will often improve your odds for success: it also means you are taking ownership.

## Taking Care of your People

- Taking care of your people is about making them better and holding them to high standards.
- Providing them honest assessments and feedback.
- Teach them so they can be more proficient in their jobs.
- Giving them ownership.
- You can't be a friend first and a leader second.
- You can't accept sub-standard performance.
- You must hold your people accountable for their actions.

# UPS LEADERSHIP PROGRAM

## 3-Reasons Why Your Team is Failing

- **You have not explained to your team what they need to do, how they need to perform and "why" they are doing what you are asking. Many times, this is a result of miscommunication or a lack of communication from you. Once you have communicated your plan, you should have each team member explain it back to you to ensure the plan is understood and the "why" is defined.**
- **You have not provided or there is not adequate support for your team (logistics, tools, materials, procedures, etc.). Support may not always be in your control, but you must look ahead and be diligent to make sure those in control of your support are aware of your needs and the needs of your team.**
- **You have not held team members accountable or terminated team members for substandard performance. Quite often a leader will add a friend or family member to their team but will not hold those members fully accountable due to the personal relationship they share. A leader cannot make his team better if he does not hold all team members to equivalent standards.**

## Individual Leadership Development

The leadership principles listed are highlights of the UPS Leadership Program. Now that you have read these where do you go from here?

**Build on these principles - become a better leader.**

Here are a few suggestions:

- Find a Mentor (all Great Leaders have Mentors).
- Step back and take a "brutally honest" self-assessment. Make a list of areas to improve and start working on them.
- Read, there are many books on leadership that are great reads.

# UPS LEADERSHIP PROGRAM

"**Don't just read.**

**Don't just take notes.**

**Don't just get motivated.**

**Don't just talk.**

**The only thing that matters is that you actually do.**

**So: DO"** —Jocko Willink

# FOREMAN EXPECTATIONS

## Safety[2]

- Foremen are responsible for making and keeping safety the number one priority of the job.
- Stay in constant communication with your crew.
- Make sure to have an accurate head count; you should always know where your employees are in case of emergency.
- Maintain a good attitude and respect everyone. Provide encouragement and positive support.
- Think! Look at the work, the environment and the situation. If a situation doesn't seem safe, stop work and make it safe. There is no substitute for common sense and thinking.
- Use your and employee's Stop Work Authority any time something doesn't seem or feel safe.
- Support an employee's decision to be safe and defend their efforts to be proactive.
- You are accountable for the decisions and actions of your crew. If someone decides to perform an unsafe act or violate any policy, it is a reflection of your priorities and leadership.
- All foreman and crew must attend daily safety meetings.
- Make sure all employees follow the unit entry and exit procedures, signing in and out as required.
- Review permits with crew and make sure everyone knows what work is authorized under the permit and what PPE is required on the permit.
- Make sure permits are closed out upon completion.
- The JSA must be reviewed with the entire crew. Make sure no one starts work without the JSA and PHA being signed and be sure all JSAs and addendums are completely and properly filled out with correct date before signing.
- If the task changes or a new crew member joins the team then the JSA and PHA must be reviewed and updated.
- Foremen are expected to actively and personally participate and promote the Observation process, either UPS Hazard Card or an equivalent client safety audit process.
- Ensure that proper tools are available and used on a job; do not allow any tools to be altered or the guards removed!
- Do not let anyone operate any equipment without having verified their proper training and qualification, license, or certification.
- Make sure employees on your crew have all the required PPE on them at all times.
- Ensure that housekeeping is an ongoing process. You are expected to keep your work area safe and clean.
- Do not assume Operations has inspected the work area simply because they issued a permit. Do not trust a permit merely because it is signed. Make an independent assessment of the conditions and the wor and raise issues with Operators.
- MAINTAIN SAFETY AT ALL LEVELS!

# FOREMAN EXPECTATIONS

## Line up List

**Foreman instructions on how to line up your crew at the first of the job.**

You are responsible for ensuring that work is done right the first time.

- Talk personally to each crew member briefly just to make sure they are ready for a day's work and get to know them better as a person. If they have a connection to you, they will want to do what makes your team look good and perform well.
- Safety meeting times and that they are not an option and a meeting place to gather each morning afterwards.
- Call in numbers and names of who to contact if they are not going to be in that day, with the expectation if they do not call, we have option to terminate.
- Brief talk about what they were hired for and the quality we expect when completing the task of the day. Review what the paperwork is required when we complete a task and who it goes too.
- Make sure they understand who they report too and if you move them to another crew have the conversation with the new supervisor and employee.
- Review every day the stop work authority and reinforce it when you are doing your daily walk with your team and review their individual PHA cards for quality identification of a hazard associated with the task at hand.
- Review and reward those that found and reported a good safety mitigation.
- Explain your expectations for how the job will be carried out that does not include the details on how to do the work. Talking only about the work sends a message that only the work is important. How the work is performed is the last part of the lineup.
    - Keeping work area clean and orderly materials organized and trash disposed of and someone assigned to keeping the area clean.
    - Explain how the PHA should be filled out and any safety issues that were brought up in the earlier meeting and how those apply to the job they are about to start.
    - Go over quality expectations on how the final bolt up should look or that they should call for a double check before the cut is made, leave a window for inspection to view the root pass before closing, take the time to go over the relevant, direct information in the package they should know…bolt spec, gasket spec, material type and rating. Not trusting they read it on their own
    - Go over a plan on where to meet if there is an evacuation.
    - Expectations for staying on track when you are not there watching.
    - Taking the time to read through a permit with the crew before they start work so they all know what's on it and understand it.
    - Review PPE requirements with the FW/Entry attendant and how you expect that person to look out for your people.
    - Assign each one to a task that involves the team's success, one guy is in charge of inspecting the scaffold and making sure its updated, one guy is in charge of barricades, another in charge of housekeeping ECT….

# FOREMAN EXPECTATIONS
## Line up List

**When bringing in a new crew member onto an in-progress project:**

**Bringing in a new person to a crew that's in the middle of a job has been a historically hazardous situation. It's very important that each person should get the same instructions no matter when they enter into the job.**

- Review the same requirements you went over with your crew with the newly added craftsman.
- Make sure he knows where the permit is and has read it the same as the rest of the crew
- Explain your objectives for his performance while on your crew
- Share the same quality hold points with them as you did the original crew.
- Explain to them who is in charge when you're not at the job and who is the senior member of the crew.

Since our work constantly changes as a day progresses make this situation a good time to pull the entire crew back together and revisit the PHA, Standing JSA and addendum to make sure they are still accurate for where you are now.

# FOREMAN EXPECTATIONS
## Quality of Work

High quality work is one of the main reasons UPS Industrial Services continues to keep getting work. The quality of our work has a direct effect on safety and cost to the job. If work isn't done right the first time, we increase the chance of an injury or accident, and certainly increase the cost of the job due to rework.

- You are responsible for ensuring that work is done right the first time.
- Ensure that you have the right person on each job, with skills, certification, training and experience matched to the task.
- Follow UPS Industrial Services tagging and flange management system and do not remove any spools without having tags on them first.
- Make sure that all flanges are inspected for defects as soon as flanges are separated.
- Verify proper fit-ups.
- Make sure you have seen the applicable welding procedure before welding on ANYTHING. Ensure that the welder is qualified to weld on what they are about to weld.
- Make sure welding rod slips are being used on every job.
- Verify that the flanges have the correct bolts and gaskets that meet the specifications required.
- Make sure to use proper torque specs, and verify those specs to your work plan .
- Ensure that torque tags are hung with all of the required information .
- Make sure that the crew uses the proper handling and bolt up procedures with any plastic or fiberglass pipe or cast iron valve body flanges.
- Make sure that items are cleaned out or washed as soon as possible to prevent any damage to equipment or items.
- Ensure that any equipment that is unbolted from its position is properly tagged before going to the wash slab.
- Follow the UPS Industrial Services material management system in the QC Manual.
- Inspect jobs and be sure they are correct and complete before calling for Inspection to QC job.
- TAKE OWNERSHIP OF QUALITY!

# FOREMAN EXPECTATIONS
## Production

- Everyone is expected to show up on time and be at work every scheduled workday.
- Make sure every employee sign in and sign out, identifying proper times.
- Ensure your crew knows to call in if they are going to be late or call in prior to start of shift if they will not be showing up that day.
- You need to make sure your crew is as efficient and productive as possible.
- You are expected to plan work properly and keep crews working at a steady pace.
- Make sure your crews' transition from the safety meeting to their pre-job processes promptly getting permits, tools. JSA, etc.
- It is an expectation that UPS Industrial Services tools and equipment will be taken care of properly. You are expected to take immediate action to prevent or stop misuse of tools.
- All tools will be checked back in at the end of every shift unless approved by supervision.
- Make sure job packages are on site at every job for employees to review including weld procedures.
- Do the job safely and in the most efficient way possible. If you identify a better method than the work plan, get management approval (and client if necessary) before starting a new plan.
- Ensure your crew knows that they should not take direction from anyone except you, and you should not take direction from anyone except your supervisor.
- Understand and follow the work list or schedule; stay in contact with the coordinators and / or supervision.
- Update the schedule or work list accurately.
- Foremen are expected to be in the field with their crews at all times.
- Shift roll-overs will be done usually 1 hour before each shift. All Supt., GFs, Foreman, and Safety Leads need to be there, and logbooks updated at shift change.
- Shift roll-overs between foremen are expected.
- Foremen are expected to fill out delay slips thoroughly and accurately, and to turn the slips in to their GFs at the end of shift.
- Always conduct yourself as a professional.

# WELDERS RESPONSIBILITIES

The following is a list of expectations that are required of each employee that is working as a Welder for UPS Industrial Services.

| | EXPECTATION |
|---|---|
| Safety | Wear appropriate safety equipment as required per tasks |
| | Follow the Safety Mitigation Process |
| | Follow the Safety$^2$ process |
| | Follow Stop Work Authority Process as necessary |
| | All heat affected zones to be properly prepared before welding. |
| | Always use fire blanket and barricades for personnel and equipment protection. |
| | Always connect ground to the work piece you are welding to. Near equipment ground needs to be a minimum of 18" |
| Profes-sional | Show up to work as scheduled on time every day |
| | Show up prepared with all your equipment/tools as expected |
| | Treat others as you expect to be treated (Golden Rule) |
| Leader-ship | Follow appropriate chain of command on site and in work area |
| | Own your actions good or bad (Extreme Ownership) |
| | Take pride in your work and that of your team |
| Quality | Welders may only weld in the process (es) for which he/she is qualified. |
| | The first two (2) production butt welds are subject to x-ray, all other production welds including socket welds may be subject to x-ray. A QC inspector will visually inspect all welds. Rejected welds will be reported to welder's supervisor. |
| | All welds are to be stenciled with assigned welders stencil in an appropriate visible place. |
| | Fill out Rod Issue Forms correctly with applicable approvals and proper filler material annotated |
| | Welders need to review and verify the weld procedure for their specific job, before the start of welding. |
| | All welds will be free of slag, splatter balls, arc strikes and must be brushed at completion of the weld. |
| | Excessive weld reinforcement on (ROOT, CAP OR CROWN) is unacceptable |
| | There will be no mixing of filler material in containers or portable rod caddies. |
| | **All E70XX, 80XX, and 90XX electrodes will be maintained in rod caddies, which will be plugged in at all times (NO EXCEPTIONS)** |
| | Arc marks and undercut are at zero tolerance. (NO EXCEPTIONS). No weld shall be 'ringed' with a file or saw blade! |
| | Completely grind off all fit-up dogs flush with the base metal without going below the surface of the base metal, THIS MEANS NO KNOCKING OFF DOGS WITH HAMMERS!!! Repairs of base metal defects made during fit-up must be approved by QA/QC without exceptions. |
| | No extra work should be performed without proper approval |

# WELDERS RESPONSIBILITIES

| | EXPECTATION |
|---|---|
| Work Know-ledge | Proper preheat and inter-pass temperatures will be maintained at all times. |
| | Socket welds will be a full fillet with a minimum of two (2) passes. Socket welds must have a minimum of 1/16" and a maximum of 1/4" gap before welding. |
| | All 5 1/2" and under diameter open butt welds will be made using GTAW (UNLESS OTHERWISE NOTED) |
| | **Stainless steel and E6010 electrodes are not permitted in rod caddies/ovens** |
| | All welding filler materials, containers, or portable rod caddies will be returned to the rod room at the end of each shift (NOT LEFT IN THE FIELD OR GANG BOX) |
| | Welders will use stub buckets for used electrodes, (strictly enforced). |
| | All stencil markers, gloves, lenses, temp sticks, etc. furnished by Universal Plant Industrial Services Items will be replaced only with exchange items. |

# BOILER MAKER EXPECTATIONS

The following is a list of expectations that are required of each employee that is working as a Boiler Maker for UPS Industrial Services.

| | EXPECTATION |
|---|---|
| Safety | Wear appropriate safety equipment as required per tasks |
| | Follow the Safety Mitigation Process |
| | Follow the Safety$^2$ process |
| | Follow Stop Work Authority Process as necessary |
| Profes-sional | Show up to work as scheduled on time every day |
| | Show up prepared with all your equipment/tools as expected |
| | Treat others as you expect to be treated (Golden Rule) |
| Leader-ship | Follow appropriate chain of command on site and in work area |
| | Own your actions good or bad (Extreme Ownership) |
| | Take pride in your work and that of your team |
| | No extra work should be performed without proper approval |
| Flange Make-up | Tighten flanges to specifications without having someone come back and tighten loose bolts |
| | Joint alignment - should have even gap all around no high low |
| | Joint alignment - bolts should be uniform with bolts having at least 1 thread outside of nuts (site requirements may vary on this ensure you get clear expectation from your supervisor) |
| | Joint alignment – nuts should have stamped side out |
| | Joint alignment – all bolts should be tight with no loose nuts |
| | If bolts have to be cut, always ensure to cut them from one end and leave stamped end for identification |
| | Spiral wound and metal gaskets have sharp edges and must be handled with **Kevlar gloves** |
| | Removing/Installing – Gaskets/Blinds – only 1 less than half of the bolts need to be removed from pipe flange |
| | Removing/Installing – Gaskets/Blinds – Inspect all gasket sealing surfaces for damage prior to making back up |
| | Anti- Seize – ensure that you follow client requirements on application specifications |
| Tool Use | Impact Wrench – personally inspect all wrenches |
| | Impact Wrench – ensure sockets are free of cracking or damage that could cause breakage |
| | Impact Wrench – ensure correct size retainer rings in place used every time |
| | **Face Shields are to be worn and down every time you are using impact or torque wrench** |
| | Clear water from air hoses by blowing them down when connected to a compressor prior to use |
| | House cleaning - Use proper pins with hoses in use, and roll up hoses when not in use |

# BOILER MAKER EXPECTATIONS

| | EXPECTATION |
|---|---|
| Tool Use | Hoses – know the differences, colors, fittings, use and client requirements |
| | Hoses – Red – air and water – crows foot or cleco (sometimes clients don't allow red for water |
| | Hoses – Yellow – nitrogen – Chicago, black – steam hammer union |
| | Hoses – Blue – water – crows foot or cleco |
| | Harness – If you leave the ground for work have a harness on or with you for easy accessibility. |
| Work Knowledge | Know the difference between a valve that has flow direction and one that does not (common directional valves include check valve, globe valve and control valve) |
| | Installing Flow Directional Valves – **ensure that you have checked with your supervisor or operational contact for flow direction of product line** |
| | Must know the parts to an exchanger (ask your supervisor if you have any questions) |
| | Know the difference between removable tube bundle exchangers and fixed straight tube condensers |
| | Know the difference between removable straight tube and U-tube bundles |
| | Know that unless a client request, bell heads on a straight tube bundle with no split rings do not have to be removed |
| | Know how to install gaskets and heads on an exchanger |
| | Know that grafoil tape is not necessary for gasket seal |
| | Know what tapered plugs are and when to use them |
| | Know how to hook up and hydro exchangers and detect leaks (shell and tube side) |
| | Know how to hook up, drain, and hydro a test piping system – **always open a high point bleed to drain any hydro test** |
| | Never hydro through a control valve unless client request and signed off on the procedure |
| | Know when to remove internals on check valves for hydro and have a check list with the quality department to insure they are reinstalled prior to turning line over to client operations |
| | When removing PSVs or control valves, inlet and outlet flanges have to be covered with blinds, plastic, or temporary spool while awaiting reinstall (client requirements vary) |
| | Always transport a relief valve in the upright position |
| | Never lay a RV on its side |
| | You must be fit tested to wear and use fresh air equipment (5 and 30 minute packs) |
| | Teflon Tape - Know the proper application to threaded fittings |
| | Pipe unions – know that they are flow directional and ensure to have the direction of flow prior to installation. |
| | Must understand and be able to use basic rigging hand signals for signaling a crane |
| | Must be competent at basic rigging skills to support this skill |

# CRANE & RIGGING EXPECTATIONS

The following is a list of expectations that are required of each employee that is working Crane & Rigging for UPS Industrial Services. The mechanical and piping groups do a lot of their own rigging here at UPS IS and we need to help them along the way. Take pride in every lift you make. If you are lifting a load and it takes you 20 times to get it right, then that is what must be done.

| | EXPECTATION |
|---|---|
| Safety | Wear appropriate safety equipment as required per tasks |
| | Follow the Safety Mitigation Process |
| | Follow the Safety² process |
| | Follow Stop Work Authority Process as necessary |
| | You must never override or alter any safety device in any crane. |
| | You must mitigate any equipment issue prior to using it for rigging. |
| Professional | Documentation from a medical officer or official will be required if you missed for a medical reason. |
| | Show up to work as scheduled on time every day |
| | Take Pride in your work, do your job right the first time, when you leave your job site leave it better than you found it. |
| | Show up prepared with all your equipment/tools as expected |
| | Treat others as you expect to be treated (Golden Rule) |
| | Managing your time is key to your success |
| | You must show up when scheduled to work. You will be terminated if you have 2 unexcused absences or more. |
| | You will be considered absent if you have 2 late arrivals or 2 early outs. |
| Leadership | Follow appropriate chain of command on site and in work area |
| | Own your actions good or bad (Extreme Ownership) |
| | Take pride in your work and that of your team |
| | It is mandatory to complete an inspection on all equipment that you will be operating on prior to use: cranes, forklifts, aerial lifts, and scissors. |
| | Document your equipment inspections on an inbound inspection sheet before using the equipment. |
| | Document your equipment inspections on outbound inspection sheet when returning the equipment to client or rental company once job is complete. |
| | Turn in inspection sheets to the Safety Department upon job completion |
| | No extra work should be performed without proper approval |
| Respect | We believe that UPS representatives should always be considerate, respectful and curteous to all persons. This belief applies regardless of what your job title may be. We ask that you treat others the way you would want to be treated. |

# CRANE & RIGGING EXPECTATIONS

| | EXPECTATION |
|---|---|
| Relationships | A lot of our business comes from the relations we have with our clients. We ask that you maintain a positive attitude. |
| | Don't burn bridges with pettiness. |
| | Our approach, attitude and performance are trust builders and trust is the number one influencing factor to the success of any relationship |
| Paperwork | You must maintain the 3 Ring Binder that was issued to you by Crane & Rigging Manager |
| | The binder will have at a minimum: UPS Crane & Rigging Policy, daily crane inspections, and lift plans. Binder will contain the client Crane & Rigging material if mandated by client, along with their lift plans and documentation that will be required to work at that particular facility |
| | Ensure that you conduct a thorough inspection of cranes prior to use and if you find any issues address it immediately at the beginning of the shift |
| | Red tag cranes that are inoperable until applicable repairs have been completed and verified |
| Daily Inspections | It is a requirement to do a proper inspection at the beginning of each shift. If there is a problem with the equipment, it needs to be addressed immediately. |
| | If the equipment needs repair, we will red tag the machine and take it out of service until the equipment is fixed and verified. We will not override the "turn the key" or alter any safety device on any crane at any time. |
| Inbound/ Outbound Inspections | We will inspect every piece of equipment (cranes, forklifts, Aerial lifts, and scissor lifts) that we receive on every job prior to putting it to use. |
| | We will document these inspections on an inbound inspection sheet before using it and we will do an outbound inspection when we are returning the equipment to the client or rental company once the job is complete |
| | At the end of the job all of this documentation will be turned over to the safety department |
| Forklifts | You must use a ratchet strap and or secure every load that you haul |
| | You must complete an inspection on the forklift prior to use |
| | Your forklift will be equipped with a minimum of one 2" ratchet strap prior to moving any load. |
| | **YOU MUST NEVER USE RIGGING OVER OUR FORKS TO LIFT EQUIPMENT** |
| | **If chokers are involved, we will use an engineered lifting device only** |

# CRANE & RIGGING EXPECTATIONS

| | EXPECTATION |
|---|---|
| Compensation | Pay rates and classifications vary depending on the contract we are working under. |
| | It needs to be understood that if you hire in with a ll of the required certifications, but you do not have the experience we are looking for, you may be removed from the project or your wages may change according to your skill set. |
| Rigging | UPSIS rigging techniques will be utilized at all times |
| | You must use Shackles on all chokes |
| | You must use Softeners on all sharp edges |
| | You must use steel rigging on beams |
| | You must use nylon rigging on all painted surfaces, and steel on any valve over ten inches for example |
| | You must use taglines on all single crane picks, barricades with tags are mandatory and will be put up around lift area if spotters are not available |
| | You must use the proper rigging for the lift. It must be inspected and in good working condition every time. |
| | Anytime there is any doubt we need to stop everything until all concerns are addressed and mitigated properly. |

# HELPER, FIRE WATCH, HOLE WATCH EXPECTATIONS

The following is a list of expectations that are required of each employee that is working as a Helper for UPS Industrial Services. Your job as a helper is not only to help in any capacity that you are asked but also to learn each area that you are assigned to. Our expectations of Helpers is that this will only be your first step towards a career with UPS.

| | EXPECTATION |
|---|---|
| Safety | Wear appropriate safety equipment as required per task. |
| | Follow the Safety Mitigation Process |
| | Follow the Safety$^2$ process |
| | Follow Stop Work Authority Process as necessary. |
| | You must be able to carry your own assigned tools and fire extinguisher to be assigned as a helper with UPS. |
| | You must know what you are required to do with a permit and JSA |
| Professional | Show up to work as scheduled on time every day |
| | Take Pride in your work, do your job right the first time, when you leave your job site leave it better than you found it. |
| | Show up prepared with all your equipment/tools as expected |
| | Treat others as you expect to be treated (Golden Rule) |
| | Managing your time is key to your success |
| | While assigned on a project it is imperative that you are dependable. Days off are rarely approved while on projects. |
| | You must let your foreman know where you are at all times. There will be times when you are asked to help in other areas that you were originally assigned. Ensure you update your foreman when this occurs. |
| Leadership | Follow appropriate chain of command on site and in work area |
| | Own your actions good or bad (Extreme Ownership) |
| | Take pride in your work and that of your team |
| | No extra work should be performed without proper approval |
| Work Knowledge | You must have a general knowledge in our craft groups: Piping, Mechanical, and Towers. Ensure you ask your foreman to review these with you. |
| | Helpers are expected to be versatile and work as helpers, entry attendants, firewatch, bottle watch, and basically in any capacity that your assigned foreman finds prudent. |
| | A main part of your job is to assist with project house cleaning—you must be willing to aid as requested but also do it without being asked. |

# HELPER, FIRE WATCH, HOLE WATCH EXPECTATIONS

| | EXPECTATION |
|---|---|
| Helper Knowledge | Know the procedures to take tools out of service. Ask your foreman if you have any questions. |
| | Know how to setup a job using pneumatic tools and not have chords, hoses, or welding leads in walk ways. Attention should be made not to create tripping hazards. |
| | A seasoned UPS helper will know how to identify the different types of Flanges. |
| | A seasoned UPS helper will know how to identify the different types of Unions. |
| | You must have general knowledge on tools that we use in our industry. |
| | You must become familiar with UPS tool coloring codes. Ask your foreman to provide. |
| | You must inspect your tools at a minimum when you initially check the tool out from the tool room and at the job site prior to tool use. |
| | You must know how to determine if an electrical cord or equipment is serviceable. |
| | You must be able to read a measuring tape |
| Fire-watch Knowledge | Know how long to stay at your assigned site after cutting/welding has completed |
| | Know what to do if the Plant Alarm sounds. Ask your foreman if you are not clear on this. |
| | You must know how to monitor a confined space: entry/exit procedures and documentation |

# TOOL ROOM ATTENDANT EXPECTATIONS

The following is a list of expectations that are required of each employee that is working as a Tool Room Attendant for UPS Industrial Services. The importance of the tool room position is often underestimated. A good Tool Room Attendant can significantly affect loss prevention, productivity, and profitability of a project if you follow the following:

| | EXPECTATION |
|---|---|
| Safety | Wear appropriate safety equipment as required per tasks |
| | Follow the Safety Mitigation Process |
| | Follow the Safety$^2$ process |
| | Follow Stop Work Authority Process as necessary |
| Professional | Show up to work as scheduled on time every day |
| | Treat others as you expect to be treated (Golden Rule) |
| | Managing your time is key to your success |
| Leadership | Follow appropriate chain of command on site and in work area |
| | Own your actions good or bad (Extreme Ownership) |
| | Take pride in your work and that of your team |
| | No extra work should be performed without proper approval |
| Tool Room | You must keep your tool room organized free of any clutter. Dirty tool rooms are a negative reflection to our client and all others who see our tool rooms. |
| | Maintain adequate inventory of tools and consumables in stock |
| | Ensure you are communicating to field supervision on the status of missing tools |
| | Loss prevention is a major part of your daily routine and you must make every effort to recover missing tools throughout the day. |
| | All tools including rental tools should be stored in the tool room (with the exception of tools that are too large). Rental tools are treated as our own and should be signed in/out. |
| | It is your responsibility to conduct inspections of any UPSIS employee tool box entering and leaving the job site. |
| | It is your responsibility to ensure that UPSIS Employee's personal tool box do not contain unsafe or homemade tools onto the job site. |
| | It is your responsibility to inspect personal tool box of personnel that have been released from the job site ensuring that all UPSIS tools and equipment are not present. |

# TOOL ROOM ATTENDANT EXPECTATIONS

| | EXPECTATION |
|---|---|
| Tool Maintenance | Ensure that you conduct daily inspections on tools that enter and come back in to the tool room. |
| | Tag and remove tools that are not serviceable and document appropriately. |
| | Ensure you follow manufacturer's specific checks of the following: Electrical tools, rigging, fall protection, pneumatic tools, and certain hand tools. |
| | Ensure you maintain required color coding of tools, chords, and harnesses. |
| Job Close-out | Make sure all non-billables are replaced prior to returning the trailer to the shop. |
| | Prepare the Tool Room for return to the shop in the same or better shape than when you were assigned to the tool room. |

# TOWER CRAFT EXPECTATIONS

The following is a list of expectations that are required of each employee that is working as a Tower Craft for UPS Industrial Services.

| | EXPECTATION |
|---|---|
| Safety | Wear appropriate safety equipment as required per tasks |
| | Follow the Safety Mitigation Process |
| | Follow the Safety² process |
| | Follow Stop Work Authority Process as necessary |
| | Working in Confined Spaces adds another level of hazards to your work environment. You must keep in mind and apply all Confined Space Safety Practices |
| Professional | Show up to work as scheduled on time every day |
| | Take Pride in your work, do your job right the first time, when you leave your job site leave it better than you found it. |
| | Show up prepared with all your equipment/tools as expected |
| | Treat others as you expect to be treated (Golden Rule) |
| | Managing your time is key to your success |
| Leadership | Follow appropriate chain of command on site and in work area |
| | Own your actions good or bad (Extreme Ownership) |
| | Take pride in your work and that of your team |
| | No extra work should be performed without proper approval |
| Quality | Understand the meaning of "clean" and understand the meaning of "complete". |
| Work Knowledge | You must know how to read tray drawings. Ensure you get with your supervisor if you have any questions. |
| | You must know how to identify different tray parts. Ensure you ask your supervisor if have any questions prior to starting any work. |
| | You must know the different types of valves on a tray and what type to use on the project you are on. |
| | You must know the importance of down comer clearances and weir heights. |
| | You must know how to make adjustments on comer clearances and weir heights. |
| | You must know the difference between the different types of packing. You must know how to safely remove and replace all types of packing. If you have questions get with your supervisor before you begin. |
| | Know the proper way to remove and replace the different types of demister pads. |
| | Knowing how to fit up new rings and bars per the client's drawings will positively impact your career |

# TOWER CRAFT EXPECTATIONS

| | EXPECTATION |
|---|---|
| Work Knowledge | You must know the proper layout of a nozzle. This is critical to the operation and must be verified by inspection prior to cutting the hole or welding. |
| | When you are welding to the shell of a vessel you must know the hold points for each step of the processing |
| | You must know the alloy of the material you are supposed to have for each component. The material can change from one tray level to another. Always verify type first. |
| | When tightening a flange ensure you tighten appropriately so that no one has to come and retighten behind you. |
| | Flange joint/alignment should have an even gap all the way around, should have no high/low. |
| | Bolts should be uniform with bolts having at least 1 thread outside of nut (client requirements may vary on this ensure you verify prior to work). |

# PIPEFITTER EXPECTATIONS

The following is a list of expectations that are required of each employee that is working as a Pipefitter for UPS Industrial Services.

| | EXPECTATION |
|---|---|
| Safety | Wear appropriate safety equipment as required per tasks |
| | Follow the Safety Mitigation Process |
| | Follow the Safety² process |
| | Follow Stop Work Authority Process as necessary |
| Professional | Show up to work as scheduled on time every day |
| | Take Pride in your work, do your job right the first time, when you leave your job site leave it better than you found it. |
| | Show up prepared with all your equipment/tools as expected |
| | Treat others as you expect to be treated (Golden Rule) |
| | Managing your time is key to your success |
| Leadership | Follow appropriate chain of command on site and in work area |
| | Own your actions good or bad (Extreme Ownership) |
| | Take pride in your work and that of your team |
| | No extra work should be performed without proper approval |
| Quality | QC is part of your team for success. Involve them before any welding or testing is to start |
| | Fit up's IDs are to match with proper transitions & properly cleaned |
| | You must properly square and bevel pipe cuts |
| | Double check your own work prior to QC inspecting your work |
| | Ensure you measure twice cut once to save time and client money |
| | Make sure that all piping attaching to a pump is free floating aligned with no strain on the pump case |
| Work Knowledge | Must know how to read ISO's and & P&ID's, if you have any questions ask someone before you start your task |
| | Must know how to determine the type of material to determine the type of alloy per drawing and specs: Check the BOM to make sure we have all material |
| | Must pay attention to leveling pipe & supports |
| | All fits must be plum & square |
| | All Socket welds should have proper gaps |
| | Pipe inside fittings should be cut square |

# PIPEFITTER EXPECTATIONS

| | EXPECTATION |
|---|---|
| Flange Make-up | Tighten flanges to specifications without having someone come back and tighten loose bolts |
| | Joint alignment - should have even gap all around no high low |
| | Joint alignment - bolts should be uniform with bolts having at least 1 thread outside of nuts (site requirements may vary on this ensure you get clear expectation from your supervisor) |
| Flange Make-up | Joint alignment – nuts should have stamped side out |
| | Joint alignment – all bolts should be tight with no loose nuts |
| | If bolts have to be cut, always ensure to cut them from one end and leave stamped end for identification |
| | Spiral wound and metal gaskets have sharp edges and must be handled with **Kevlar gloves** |
| | Removing/Installing – Gaskets/Blinds – only 1 less than half of the bolts need to be removed from pipe flange |
| | Removing/Installing – Gaskets/Blinds – Inspect all gasket sealing surfaces for damage prior to making back up |
| | Anti- Seize – ensure that you follow client requirements on application specifications |

## SECTION 2:

# IMPORTANT SAFETY TIPS

# SAFETY² PROCESS

Safety² is the foundation of the UPS HSE Program. The Safety² process is a simple method for looking for hazards. The process begins with your mindset.

- **1: How can I be injured?**
  Identify the hazards of your activities and your surroundings. Ask the question throughout your day!

The second party of the Safety² process is all about actions:

- **2: What am I going to do about it?**
  Take actions needed to mitigate the hazards to prevent injury to yourself or others.

Mitigation of the hazards by either controlling or removing the hazard is the key to preventing injuries or damage.

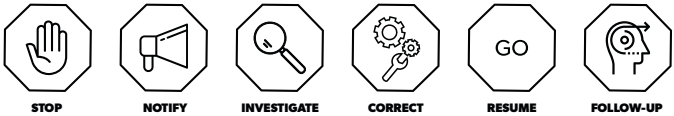
**TAKE ACTION — PREVENT THE INCIDENT**

Find the hazard before the hazard finds you!

Eliminate the hazard before the hazard eliminates you!

# STOP WORK AUTHORITY (SWA)

It is our duty and expectation to stop work when a new hazard is introduced, or you notice that the potential for someone to be injured or damage to equipment is about to occur.




**Prepare to resume—From a Stop Work Authority**

If it is determined and agreed that the stop work issue is valid, then every attempt will be made to resolve the issue to affected person's satisfaction prior to resuming work. Notify your Supervisor!

If the stop work issue cannot be resolved immediately work shall be suspended until proper resolution is achieved.

Persons with proper authority (e.g. next level of management, HSE Professional) who are not directly involved with the conflict should be identified to resolve such issues.

## INCIDENT REPORTING

Report all incidents to your supervision immediately. Incident must be reported to meet UPS expectations and client requirements. Conducting investigations into incident causes gives us a learning path.

# JOB SAFETY ANALYSIS (JSA)

The Job Safety Analysis (JSA) process is about thinking, not about the paperwork. JSA forms are a guide to help you go through the mental process of hazard recognition.

Resolving the hazard:

- Top priority — ELIMINATE the hazard.
- Second priority — MITIGATE the hazard, by taking steps to control the hazard and make tasks safe to complete.
- If the hazard cannot be eliminated or mitigated, then stop work and NOTIFY your supervisor.

Tips on how to conduct a great JSA:

- Focus on specific hazards in the work area and develop specific ways to resolve the hazards.
- Discuss the work jointly with your crew—work as a team. Make it fun—challenge the crew on how many hazards they can identify, play the "what if" game, or give recognition to the best comment.
- Always include every crew member. Make sure each person in the crew identifies at least one hazard.

# STANDING JSA

- The Approved Standing JSA addresses the hazards associated with the task. For example, the Standing JSA you are receiving must be reviewed by all crew members and followed. Changes or additions must be covered on the Standing JSA Acknowledgment Form. The expectation is that this form is reviewed with the entire crew and each item that pertains to the actual task is highlighted, underlined, or somehow identified as relevant.

## ELIMINATING OR CONTROLLING HAZARDS

**Plan A** Eliminate the hazard: Get rid of or remove the hazard

**Plan B** Control the hazard: Take action steps to control hazards that will make tasks safe to complete

**Plan C** If the hazard cannot be eliminated or controlled, then stop work and notify your supervisor

- Tasks that are not covered on the Standing JSA (or if there is no Standing JSA for the task) can be addressed on the Acknowledgment form.
- Hazards associated with the task, and elimination/control steps must be included.
- All members of the work crew must review the Standing JSA Acknowledgment form.
- The supervisor must review the Standing JSA and Acknowledgment and sign the JSA Acknowledgment form prior to the beginning of the task.

**Note: It is very important that the entire crew participates in identifying hazards and elimination or control steps!**

# UPS LIFE SAVING RULES

United Plant Services Life Saving Rules

I understand that the following Life Saving Rules are in place because failure to follow them could result in serious injury or death to me or someone working around me.

I understand that failure to follow these four lifesaving rules is grounds for disciplinary action, up to and including termination.

1. **Never Violate Work Permit Procedures.**

• No work without a valid permit on jobs requiring a permit.

• Do not receive a permit without conducting the required job-site verification.

• Do not enter a confined space without a valid permit or a required standby present.

• Do not receive a work permit without a required gas test being conducted.

2. **Always Follow Energy Isolation Lockout/Tagout Procedures.**

• Do not perform work on equipment without all energy isolated and controlled.

• No unauthorized removal or tampering with a lockout/tagout device.

• No opening process equipment without joint field verification that the equipment has

been properly cleaned, isolated and de-energized or without wearing proper PPE.

3. **Never bypass or defeat a safety device.**

4. **Never work without Fall Protection when required.**

# UPS 10 SAFE WORK COMMITMENTS

1. I believe that all incidents are preventable.

2. I will report all incidents, no matter how minor.

3. I am not authorized to perform work where uncontrolled hazards exist. I will eliminate them or control them!

4. I will perform Safety$^2$ throughout the day, every task, every time.

5. I will use Stop Work Authority to intervene and correct at risk behaviors and conditions.

6. I will conduct myself in a professional manner at all times – no horseplay, harassment or discrimination.

7. I will only perform tasks that I am qualified to perform, and, will only operate equipment that I am qualified to operate.

8. I will use the best tool for the job, as defined by the JSA or procedure.

9. I will always do the job right the first time; safety and quality go hand in hand. No shortcuts!

10. I will keep my work area clean, tools and materials organized, and travel paths clear at all times.

# FABRICATION STANDING JSA

This Standing JSA must be the approved version that is located in SharePoint. Changes must be approved by Safety and Supervisor.

| Task | Associated Hazards | Mitigation/Elimination Steps |
|---|---|---|
| 1. Stage Pipe, Iron, or plate using cribbing, jack-stands, shackles, chokers, and slings | A. Crushing hazards from moving or adjusting large bore pipe, structure, or plate<br>B. Rigging failure from damaged equipment<br>c. Pinch points, pipe shifting or rolling on cribbing or jack stand<br>D. Falling material due to improper jack stand use<br>E. Tripping hazards from lay-down material. | A. Use a tag-line to control load. Maintain communication with rigging department personnel and operator. Ensure NO personnel under load<br>B. Inspect all rigging prior to each use by a certified rigger and ensure proper color code is in place<br>D. Use a 4 leg jack stand for 8" or larger diameter pipe. Use jack stand(s) only on level solid ground when surface conditions are anything other than concrete. Level, sturdy, and rigid support material must be placed beneath the legs of the jack stands.<br>E. Protruding pipe material will be flagged. Lay-down areas will be barricaded and tagged with a gate for access. Material well be stored in a way that does not block access to any other material and will have clear access paths. |
| 2. Prep/cut Pipe, Iron or plate using electric 5" grinder, 7" grinder, die-grinder, bandsaw, Metabo grinder, drill, mag drill, center punch, and cutting torch | A. Electric shock from power tools<br>B. Burns or abrasions from improper tool use<br>C. Cut hazards from saw blades, drill bits or grinding discs<br>D. Trip hazards from electric cords<br>E. Fumes / Inhalation hazard from welding<br>F. Flying debris and sparks striking the workers(s)<br>G. Flammable material becoming ignited<br>H. Muscle Strains from lifting mag drill<br>I. Striking hazard while singing hammer<br>J. Wrist snap form drill binding twisting<br>K. Material or clothing getting caught in drill or grinder<br>L. Hot surfaces from fresh cuts | A. Inspect cords that are not normally turned in everyday before use and frequently throughout task to make sure no abrasions, cuts, or wear have occurred. Have GFCI at the power source<br>B. Unplug grinder to change disc or adjust guard. Hold tools with both hands on designated factory handles. Never use a grinder without a guard or without a handle.<br>C. Unplug tools to change blade, disc, or bit. Secure any material by device or mechanical means while cutting or grinding; do not attempt to hold material. Keep hands or body parts away from material that is being grinded drilled or cut. Unplug powered tools when not in use. Guard must be placed to protect hand on handle<br>D. Run cords overhead or not in a walkway so a 7'clearance can be maintained in the walkways. Flag cords if less than 7'<br>E. Refer to Addendum for Specific respiratory Protection for Welding<br>F. Anyone using or within 10' of a grinder or torch while in use will utilize same PPE sealed eye wear and a 787+face shield. Maximum speed of Grinder<br>G. Construct spark containment or hooch that is capable of preventing all sparks or slag from leaving the containment or falling below the work area if it is elevated. Remove all flammable or combustible material from the containment or falling below the work area if it is elevated. Remove all flammable or combustible material from the containment prior to task. Utilize a fire-watch with a horn and vest. Fire-watch will have a radio WHEN REQUIRED BY PERMIT. Fire-watch will stop the work if sparks or slag are flying out of or falling from the containment<br>H. Get help moving, lifting and setting mag-drill, and always pick up with legs (NOT-BACK) |

# FABRICATION STANDING JSA

| | | |
|---|---|---|
| | | I. Never hold any object with your hand, use channel lock or other tool holding device<br>J. Hold drill with both hands using a firm grip, step up drill size gradually, and use cutting lubricant to reduce binding<br>K. Keep loose clothing tucked in, and/or material secured away from, drill or grinder while in use. Have shirt sleeves buttoned<br>L. Always wear leather gloves when working with cutting torch and watch your hand placement |
| 3. Weld Pipe, Iron or plate using welding machine, welding leads, argon hose, electric 5" grinder, and argon cylinder | A. Eye burns from arc<br>B. Flammable material becoming ignited<br>C. Hot surfaces from fresh welds or cuts<br>D. Tripping hazards from leads and/or argon hoses<br>E. Fumes / Inhalation hazard when welding<br>F. flying debris while grinding<br>G. Cut hazards from grinding discs | A. Utilize welding helmet with #10 through #14 lens filter. Maintain a dry lens surface<br>B. Construct a welding enclosure or hooch that is capable of preventing all sparks or slag from leaving the containment or falling below the work area if it is elevated. Remove all flammable or combustible material from the containment prior to task. Utilize a fire-watch with a horn and vest. Fire watch will have a radio. (WHEN REQUIRED BY PERMIT) Fire-watch will stop the work if sparks or slag are flying out of or falling from containment.<br>C. Do not place hands or body parts on hot (fresh) welds /cuts<br>D. Run cords/hoses overhead so a 7' clearance can be maintained in the walkways. Flag hoses/cords if less than 7'<br>E. Refer to Addendum for Specific respiratory protection<br>F. Utilize sealed eyewear and a Z87+ face shield will be used. Maximum RPM rating of Grinding Disk must be greater than Maximum speed of Grinder<br>G. Unplug grinder to change disc. Secure any material by device or mechanical means while grinding; do not attempt to hole material. Keep hands or body parts away from material that is being grinded. Unplug powered tools when not in use. Guard must be placed to protect hand on handle |

_____
Safety Director/Date

_____
JSA Subject Matter Expert/Date

_____
JSA Policy Owner

# JSA ACKNOWLEDGMENT FORM STANDING JSA

- Tasks that are not covered on the Standing JSA (or if there is no Standing JSA for the task) can be addressed on the Acknowledgment form.
- Hazards associated with the task, and elimination/control steps must be included.
- All members of the work crew must review and sign the Standing JSA Acknowledgment.
- The supervisor must review the Standing JSA and Acknowledgment prior to the beginning of the job.

# JSA ACKNOWLEDGEMENT

| (Sic of Standing JSA(s): | |
|---|---|
| LOTO Box #: _____ Energy Isolation, zero energy verified by: _____ | |
| Use this form for any additional tasks or tools to be used for the task.<br>This form may also be used as your JSA if a Standing JSA does not exist for the task you are performing | |
| Task Hazards to Consider: | |
| • Tool Hazards:pinch, cuts, burns, strikes, etc.<br>• Sensitive Equipment in the area?<br>• Rigging? Type and Size Determined? Softeners?<br>• Leaks/Spills? Environmental protection Systems in Place?<br>• Electric Shock? LOTO in Place? Other Protection Systems in place? | • Use of Motorized Equipment? Spotters?<br>• Flying Debris, Sparks, Airborne Particles<br>• Inhalation – Fumes? Respiratory<br>• Heavy Lifting – Machine or Muscle?<br>• Fire/Hole/Hazard Watch Required? Understands Duties?<br>• Crane Loads? Path Cleared? Tag Lines in Place? Plan? Rigging? |

| LIST ANY ADDITIONAL TASKS OR TOOLS TO BE USED FOR TASK. | HOW CAN YOU BE INJURED? | WHAT ARE YOU GOING TO DO ABOUT IT? |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**Note: It is very important that the entire crew participates in identifying hazard elimination and / or control steps!**

I have READ and UNDERSTAND the Standing JSA, this Acknowledgement, and the Permit and agree to comply with all safety controls and procedures listed to complete my job safely.

ALL WORKERS MUST SIGN BEFORE STARTING WORK.

| | | |
|---|---|---|
| | | |
| | | |
| | | |

| | |
|---|---|
| Crew Leader / Foreman: Print Name | Crew Leader / Foreman: Signature |
| Audited / Reviewed by: Print Name | Audited / Reviewed by: Signature |

# EXAMPLE OF A JSA ACKNOWLEDGMENT

UNIVERSAL PLANT SERVICES

## JSA ACKNOWLEDGEMENT

Title of Standing JSA(s):

LOTO Box #: _____ Energy Isolation, zero energy verified by: _____

Use this form for any additional tasks or tools to be used for the task.
This form may also be used as your JSA if a Standing JSA does not exist for the task you are performing

Task Hazards to Consider:

- Tool Hazards pinch, cuts, burns, strikes, etc.
- Sensitive Equipment in the area?
- Rigging? Type and Size Determined? Softeners?
- Leaks/Spills? Environmental protection Systems in Place?
- Electric Shock? LO/TO in Place? Other Protection Systems in place?
- Use of Motorized Equipment? Spotters?
- Flying Debris, Sparks, Airborne Particles
- Inhalation – Fumes? Respiratory
- Heavy Lifting – Machine or Muscle?
- Fire/Wide/Hazard Watch Required? Understands Duties?
- Crane Loads? Path Cleared? Tag Lines in Place? Plan? Rigging?

| LIST ANY ADDITIONAL TASKS OR TOOLS TO BE USED FOR TASK. | HOW CAN YOU BE INJURED? | WHAT ARE YOU GOING TO DO ABOUT IT? |
|---|---|---|
| | | |
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| | | |

I have READ and UNDERSTAND the Standing JSA, this Acknowledgement, and the Permit and agree to comply with all safety controls and procedures listed to complete my job safely.

ALL WORKERS MUST SIGN BEFORE STARTING WORK.

_____ _____ _____

_____ _____ _____

_____ _____ _____

Crew Leader / Foreman: Print Name

Crew Leader / Foreman: Signature

Audited / Reviewed by: Print Name

Audited / Reviewed by: Signature

# THE PERSONAL HAZARD ASSESSMENT (PHA)

## COVER PAGE

- Fill out your name, company # and supervisor
- Read all instructions
- Check all that apply

**Important:** The PHA must always be filled out at the work location in order to effectively address hazards

# PHA

**Personal Hazard Assessment**

**Name** _____

**Company #** _____

**Supervisor** _____

**How can I be injured?**
**What am I going to do about it?**

## INSTRUCTIONS

**Remember: The PHA Card MUST always be filled out at your work area following the field visit.**

## Check All That Apply

- ❑ Walk out your work area – identify wind direction.
- ❑ Identify safety showers and evacuation routes/sites.
- ❑ Have you read and do you understand the Standing JSA?
- ❑ Review and note hazards on Jobsite Hazards List.
- ❑ If a new hazard is identified and not listed, write down the hazard in the **OTHER** section.
- ❑ Place each hazard number within the circle.
- ❑ Hazards identified in the circle **MUST** be eliminated or controlled. Circle the hazard # within the circle.
- ❑ **Hazards that you cannot immediately eliminate or control MUST be listed individually in the space provided, and in the circle. A discussion MUST occur with your Foreman, Crew Leader, Safety Contact, Permit Issuer, or facility contact to find a way to eliminate or control the hazard before work proceeds.**

**If the scope of work for your job changes or if you move to a different job then a new PHA must be filled out.**

UNIVERSAL PLANT SERVICES.

Complete your name, Co # & Supervisor's name

Read each item and Check All that Apply

| JOB-SITE HAZARDS | | |
|---|---|---|
| # | HOUSEKEEPING/ TRAVEL PATH HAZARDS | ✓ |
| H1 | Uneven ground conditions | ✓ |
| H2 | Slippery Surfaces (algae, ice, sand, water, pellets, etc.) | |
| H3 | Tripping Hazards (rigging, equipment, hoses, temp. piping) | |
| H4 | Clutter in Work Area (trash, job materials, tools, etc.) | |
| H5 | Potential Falling Objects | |
| H6 | Barricade not removed | |
| H7 | Debris that could become airborne (sandblast grit, insulation, etc.) | |
| # | FACILITY HAZARDS | ✓ |
| F1 | Cuts/Punctures/Sharps (metal insulation, wire, banding, etc.) | |
| F2 | Hot surfaces | |
| F3 | Head Knockers/Body Knockers (pipe, valve stems) | |
| F4 | Open-ended Flanges, Bleed Points, Double-block and Bleeds | |
| F5 | Lighting Inadequate | |
| F6 | Sensitive Equipment (tubing, flow meters, probes, PVC pipe etc.) | |
| # | JOB PLANNING/SET UP | ✓ |
| J1 | Platform or Scaffold not adequate for job | ✓ |
| J2 | Adjacent Work Crews (hazards they may cause in your area) | |
| J3 | Mobile Equipment/Traffic (roll over, crushed/struck by) | |
| J4 | Hot Work (Correct Set-up?) | |
| J5 | Overhead Loads/Work Crews (material dropping) | |
| J6 | Process lines not cleaned or cleared | |
| # | PROCEDURES | ✓ |
| P1 | Permit issues | |
| P2 | LOTO/Energy Isolation | |
| P3 | Confined space issues (ventilation, no hole watch, gas test) | |
| # | ENVIRONMENT | ✓ |
| E1 | Weather (windy, lightening, rain) | |
| E2 | Heat Stress or cold stress | |
| E3 | Excessive Noise | |
| E4 | Insects or animals | |
| # | TOOLS/EQUIPMENT | ✓ |
| T1 | Electrical Hazards (extension cords frayed, loose wiring) | |
| T2 | Defective tool/Not inspected | |
| T3 | Rigging condition, inspection | ✓ |
| T4 | Safety device missing | |
| T5 | Compressed Gas Cylinder storage and use | |
| | | |
| | | |
| | | |

Check each hazard that you have found in the area.

# HAZARD ASSESSMENT

Write the unit you will be working in and the current date / time. Please use black / blue ink.

Write a brief job scope in the lines provided. If you received a Work Permit for this job, then this job scope should be similar to the one on the permit.

Now (at the job site) begin assessing your hazards by looking around, observing, talking with co-workers, operations and using the HAZARD list. Write the corresponding number of the hazard in the circle.

In this example, there are three (3) hazards that MUST be eliminated or controlled.

As you eliminate or control the hazards circle the numbers.

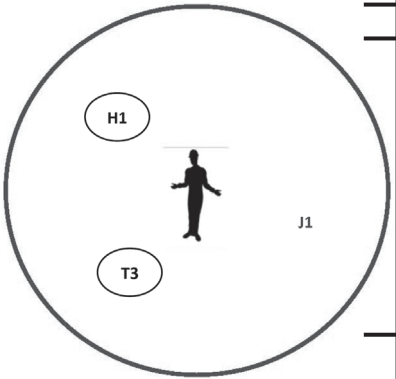
**Unit/Loc:** _____ **Date:** _____

**Time** _____ **Permit Reviewed? Y or N/A**

**Job 2 (brief job scope)** _____

_____

_____




**Discuss the HAZARDS not eliminated or controlled above and describe the path forward below.**

**Hazard #** J1 **How Controlled** Called Foreman at 7:10 AM; Foreman called scaffold crew at 7:30 AM

**Hazard #** _____ **How Controlled** _____

_____

**Hazard #** _____ **How Controlled** _____

_____

**DO IT SAFELY OR DON'T DO IT**

**Reviewed By:**

**Supervisor:** _____

**Safety:** _____

List the Unit/Location you are working in.

List the date/time of your job walk.

Did you review the permit for your task?

Provide a brief detailed description of the job scope or task you are performing.

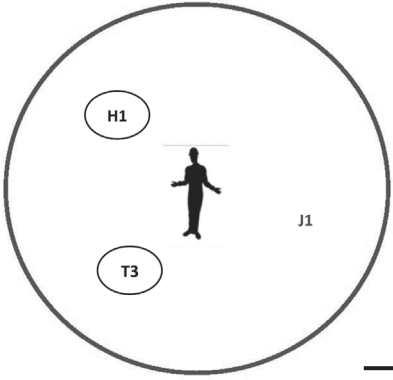
Inside the red circle list the hazards by # (from the Job Site Hazards list) you have found in your work area. Circle those hazards that you or the crew has mitigated; be prepared to answer audit questions about how you mitigated the hazards.

NOTE: If you have more than 5-6 hazards listed, housekeeping is a problem and the area needs to be cleaned or a Stop Work Authority needs to be issued so that the hazards can be eliminated.

**Unit/Loc:** _____ **Date:** _____

**Time** _____ **Permit Reviewed? Y or N/A**

**Job 2 (brief job scope)** _____




**Discuss the HAZARDS not eliminated or controlled above and describe the path forward below.**

**Hazard #** J1 **How Controlled** Called Foreman at 7:10 AM; Foreman called scaffold crew at 7:30 AM

**Hazard #** _____ **How Controlled** _____

**Hazard #** _____ **How Controlled** _____

**DO IT SAFELY OR DON'T DO IT**

**Reviewed By:**

**Supervisor:** _____

**Safety:** _____

If the hazard cannot be mitigated or properly controlled, then list item in this section.

Contact your Supervisor.

Do not proceed with the task or job until all hazards are controlled or eliminated.

Once hazard has been eliminated or controlled then return to the red circle and mark the hazard by circling the number.

A discussion about the hazards found and the mitigations must take place between crew members and Site Supervision or Safety Professional.

# FILLING OUT THE UPS HAZARD CARD

## JOBSITE HAZARDS ANALYSIS

Most hazards in the work area should be noted on the following jobsite hazards card.

Use the identified items on the card for your hazard assessment.

Your assessment should include any at risk behaviors as well.

## ADDITIONAL METHODS TO INPUT HAZARD OBSERVATIONS, STOP WORK AUTHORITY, NEAR MISSES AND AUDITS.

This is accomplished by the UPS Forms App on phones or iPads and on the Safety main page of the UPS SharePoint site.

All hazards observations, Stop Work Authority, Near Misses, Audits and Incidents must be entered into the Forms App or SharePoint site.

Each Supervisor level employee and HSE Professional must enter a Hazard Observation into the system per day per shift.

| UPS HAZARD CARD | |
|---|---|
| Observer Name: | |
| Date: | |
| Last 4 SSN: | |
| UPS Company #: | |
| Facility: | |
| Activity Observed: | |
| **AT RISK BEHAVIORS** | |
| **#** | **Check behaviors that you observed AND corrected.** ✓ |
| **LINE OF FIRE / PERSONAL INJURY RISK / PPE** | |
| L 1 | PPE-Basic (wrong or not using) |
| L 2 | PPE-Special (wrong or not using) |
| L 3 | Unsafe Body Position |
| L 4 | Unsafe Hand Position |
| L 5 | Walking/working under a load |
| L 6 | Muscle instead of machine (over 50 lbs) |
| L 7 | Not using 3 points of contact climbing/not using handrails |
| L 8 | Crossing barricade |
| L 9 | Climbing/standing on equip. (need scaffold, ladder or stool) |
| L 10 | Walking outside of walk paths |
| L 11 | Within 10' of a job without PPE required for that job |
| **WORK PRACTICES** | |
| W 1 | Worker not qualified on tool or equipment |
| W 2 | No/wrong barricade |
| W 3 | Wearing dark glasses in dark areas or past dusk |
| W 4 | Improper ladder use |
| W 5 | Poor or improper rigging practices |
| W 6 | Not using a spotter for moving equipment |
| W 7 | Swing path not cleared for crane load |
| W 8 | Not containing sparks |
| W 9 | Improper use of tool or equipment |
| W10 | Vehicle or mobile equipment operation |
| W11 | Improper use of harness/lanyard |
| W12 | Standby issues |
| W13 | JSA/Addendum/PHA issues (Wrong/incomplete) |
| W14 | Poor communication |
| W15 | Not followW ing procedure or no procedure for task |
| W16 | Safety$^2$ process not being used |
| **Describe Hazard** | |
| | |
| | |
| | |
| | |
| | |

| JOBSITE HAZARDS | | |
|---|---|---|
| # | Check jobsite hazards you observed And corrected | ✓ |
| | **HOUSEKEEPING/ TRAVEL PATH HAZARDS** | |
| H 1 | Uneven ground conditions (holes, rocks, etc.) | |
| H 2 | Slippery Surfaces (algae, ice, sand, water, pellets, etc.) | |
| H 3 | Tripping Hazards (rigging, equipment, hoses, temp.piping) | |
| H 4 | Clutter in Work Area (trash, job materials, tools, etc.) | |
| H 5 | Potential Falling Objects | |
| H 6 | Barricade not removed | |
| H 7 | Debris could become airborne (sandblast grit, insulation, etc.) | |
| | **FACILITY HAZARDS** | |
| F 1 | Cuts/Punctures/Sharps (metal insulation, wire, banding, etc.) | |
| F 2 | Hot surfaces | |
| F 3 | Head Knockers/Body Knockers (pipe, valve stems) | |
| F 4 | Open-ended Flanges, Bleed Points, Double-block and Bleeds | |
| F 5 | Lighting Inadequate | |
| F 6 | Sensitive Equipment (tubing, flow meters, probes, etc.) | |
| | **JOB PLANNING/SET UP** | |
| J 1 | Platform or Scaffold not adequate for job | |
| J 2 | Adjacent Work Crews (hazards may cause in your area) | |
| J 3 | Mobile Equipment/Traffic (roll over, crushed/struck by) | |
| J 4 | Hot Work (Correct Set-up?) | |
| J 5 | Overhead Loads/Work Crews (material dropping) | |
| J 6 | Process lines not cleaned or cleared | |
| | **PROCEDURES** | |
| P 1 | Permit issues | |
| P 2 | LOTO/Energy Isolation | |
| P 3 | Confined space issues (ventilation, no hole watch, gas test) | |
| | **ENVIRONMENT** | |
| E 1 | Weather (Windy, lightening, rain) | |
| E 2 | Heat Stress or cold stress | |
| E 3 | Excessive Noise not managed | |
| E 4 | Insects or animals | |
| | **TOOLS/EQUIPMENT** | |
| T 1 | Electrical Hazards (extension cords frayed, loose wiring) | |
| T 2 | Defective tool/Not inspected | |
| T 3 | Rigging condition, inspection | |
| T 4 | Safety device missing | |
| T 5 | Compressed gas cylinder storage and use | |
| | **Describe Hazard** | |
| | | |
| | | |
| | | |
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| | | |

# LOCKOUT / TAGOUT

## Universal Plant Services has an extensive policy regarding energy isolation to protect our coworkers.

Please refer to our policy # S-3310 and your project policies for energy isolation or lockout / tagout. Below are comments from the OSHA website that specifically address this topic. If you have any questions on energy isolation, please contact your site safety and supervisor prior to accepting a safe work permit on a potentially energized system.

Energy sources including electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other sources in machines and equipment can be hazardous to workers. During the servicing and maintenance of machines and equipment, the unexpected startup or release of stored energy can result in serious injury or death to workers.

- Proper lockout/tagout (LOTO) practices and procedures safeguard workers from the release of hazardous energy. The OSHA standard for The Control of Hazardous Energy (Lockout/Tagout) (29 CFR 1910.147 [link: http://tinyurl.com/pea65q2]) for general industry, outlines specific action and procedures for addressing and controlling hazardous energy during servicing and maintenance of machines and equipment. Employers are also required to train each worker to ensure that they know, understand, and are able to follow the applicable provisions of the hazardous energy control procedures. Workers must be trained in the purpose and function of the energy control program and have the knowledge and skills required for the safe application, usage and removal of the energy control devices.
- All employees who work in an area where energy control procedure(s) are utilized need to be instructed in the purpose and use of the energy control procedure(s), especially prohibition against attempting to restart or reenergize machines or other equipment that are locked or tagged out.
- All employees who are authorized to lockout machines or equipment and perform the service and maintenance operations need to be trained in recognition of applicable hazardous energy sources in the workplace, the type and magnitude of energy found in the workplace, and the means and methods of isolating and/or controlling the energy.
- Specific procedures and limitations relating to tagout systems where they are allowed.
- Retraining of all employees to maintain proficiency or introduce new or changed control methods.

# WORK PERMITS

**SCOPE OF WORK (SOW)** — Ensure you conduct a job walk with the client to review the SOW prior to permit issue. Ensure that the permit contains a clear description and scope of the work to be performed. Some jobs require multiple tasks to be performed. Each task may have different safety requirements such as inspection, cleaning, line preparation, blinding, etc. Detailing the safety requirements for each task covered in the work permit is important since the exposure and hazards may vary at each stage of the work.

Read and understand the SOW conditions. If the permit is not legible, requires safety precautions that seem too much or too little for the type of work you are doing, or if there is any information missing or confusing to you — DO NOT ACCEPT THE PERMIT. Get clarification, and have the initiator reissue the permit with the additional information.

Do not exceed the SOW that is indicated on the permit. Stop work if the work scope or job conditions change beyond what is specified on the original permit. Contact the permit issuer and get the permit updated in writing. If it is not in writing, DON'T DO IT! Verbal approval is not permitted!

Check the permit for the following:

- The date and time for which the permit is valid. Work must start within one hour after the permit is issued. (Some clients require work to start sooner)
- Unit, area, name and number of equipment and location are clearly identified.
- Equipment isolation (LOTO) and line preparation procedures are specific.
- Atmospheric testing data is complete, and the signature of the individual performing the testing is present.
- SDS is provided for the material that was previously in the line or vessel.
- Respirator selection – If respirators are indicated as required on the permit, the type of respirator and/or cartridge must be specified.
- Any special PPE provisions must satisfy the permit requirements, our company policies, and regulatory compliance.
- If the work involves interconnecting units or areas, make sure you have signatures from operators of all affected areas on the permit.

Walk the jobsite to visually inspect, determine equipment needs, coordinate work, and complete the JSA. When working with either a hot or cold work permit, ensure proper barricades are in place between permit areas. Ensure that a safe distance exists between conflicting types of work.

Remember, permit issuers are human and can make mistakes, so it is your responsibility to take your time, read, understand and ask questions. Keep asking questions until you get clarification and are satisfied that you and your crew thoroughly understand the scope, hazards, site conditions, and safety precautions necessary to complete the job safely

# WORK PERMITS

**STOP AND THINK** — A permit doesn't replace common sense.

- What is the most hazardous aspect of the job?
- If performing a procedure, have I talked to the affected people & supervisor prior to beginning?
- Are process safety hazards considered?
- Is Lockout/Tagout required?
- Is blinding point(s) and / or piping de-pressured and drained?
- Do I need a gas test?
- Am I downwind of any hazard?
- Is there adequate lighting?
- Is the scaffold adequate, inspected and tagged?
- Do I need a harness?
- Do I need a respirator?
- Do I need special gloves?
- Do I need to wear a face shield?
- Could my actions impact the environment?
- Could my actions impact other units?
  - If yes, have I contacted / discussed with affected personnel?
- Have I checked for:
  - Possible pinch points
  - Nearest fire extinguisher
  - Escape routes
  - Nearest safety shower
  - Appropriate PPE
  - Slipping hazards
  - Adequate and appropriate tools
  - Proper gasket type
  - Proper blind type
  - Exposed steam tracing

# PNEUMATIC TESTING

The pneumatic test may be used, with UPS Engineering approval, in lieu of standard hydrostatic pressure testing of piping systems, valves, vessels and other processing equipment if the system is so designed that:

- The item being tested cannot safely support the weight of water filling.
- The item cannot be adequately drained or dried after hydrostatic testing.
- Liquids would contaminate a process that would be hazardous, corrosive, or become inoperative in the presents of moisture.
- Liquids would cause damage internal components.

**Safety Precautions**

- **Before performing any pneumatic test always review the latest UPS Pneumatic Test Procedure.**
- **Any pneumatic test with pressures greater than 25 psi requires UPS engineering review and written QC manager approval.**
- Pneumatic testing involves the hazard of released energy stored in compressed gas. Particular care must be therefore be taken to minimize the chance of brittle fracture during a pneumatic leak test. Test temperature is important in this regard. If the temperature is or is expected to be below 50 deg. F and/ or the material wall thickness is greater than 1/2 inch thick, engineering must be consulted to determine if the conditions will fall below the minimum design metal temperature and create a brittle fracture hazard.
- Reinforcing plates and welds are tested using the threaded weep (telltale) hole in the plate, the test pressure shall not exceed 15 psi unless directed in writing by UPS Engineering.
- This test is not to be used on cast iron pipe, plastic pipe or pipe having soldered joints.
- Rope off the work area for a minimum of 25 feet, barricade with caution tape or signs.
- Compressed gas cylinders will be secured and stored in their upright position.
- All compressed gases will be introduced through a pressure regulator set to the test pressure.
- All pneumatic tests shall have a pressure relief device provided, having a set pressure not higher than the test pressure plus the lesser of 50 psi or 10% of the test pressure.
- Never leave the filling valve unattended while building pressure.
- Face shields and hearing protection will be worn by all personnel inside the pressure test barricade area. High pressure leaks, ruptures gaskets or system failures can result in debris injuries and sudden loud noises.
- A properly sized and calibrated test gauge will be located within view of the filling manifold.

# HYDROSTATIC TESTING

Hydrostatic testing is performed on existing, new equipment and pipelines to check for leaks after repair or maintenance. The main hazard during hydrostatic testing is losing control of the high-pressure water flow. A secondary hazard is over-pressurizing the system. Both hazards can damage property and endanger workers' safety. Never start the test if a problem is identified.

### HYDROSTATIC TESTING PREPARATION

Hydro-tests will be performed per the UPS Quality Manuals for the items being tested. Before hydro-testing, be sure to verify that:

- A safe work permit has been issued by authorized personnel.
- The test area is isolated and surrounded with safety line. Place appropriate safety signs near the area. If possible, perform the test in a remote area. No one other than workers involved with the hydro-testing shall be in the area.
- All workers are wearing proper personal protective equipment.
- There are specific work and communication plans among everyone involved in, or affected by, the test.
- Any equipment or pipes not included in the hydrostatic test have been isolated.
- Vents are available and installed at high points. Re-check the vent line immediately before testing to make sure it is not blocked.
- There is a drain valve at the low point in order to completely empty the system.
- All pipe and vessel supports are in good condition and have been inspected.
- Temporary supports which may be required for systems designed for vapor or gas during the hydrostatic test are approved by the client.
- Water temperature is higher than 60 F.
- All test equipment and tools have been inspected for wear or damage.
- Pressure gauges are installed at a location so that they can be easily read and do not create additional hazards by exposing personnel to leaking hydro-test fluid. The gauges are recommended to have 150% of the maximum allowable working pressure. Pressure gauges must have current calibration inspections.
- Hydro-testing of multi-chamber vessels or heat exchangers have been reviewed with the client to confirm the maximum differential pressure between the chambers or across the tube sheets. Ensure that at least two test gauges are used to monitor the differential pressure.
- All the temporary tools (such as valve, fitting, hoses, flanges, blind plate, etc.) are rated more than the maximum hydrostatic pressure.
- Someone is assigned to monitor the pump pressure during operation.
- Dispose of used hydro-test water only in the approved locations.

# CRITICAL LIFT PLAN

UPS Industrial Services procedure for critical lifting is as follows:

1. Engineering Dept. determines weight and center of gravity of component to be lifted.
2. The Competent rigging person sizes rigging hardware and its application, taking into consideration deductions for sling configuration, sling angle, shackle configuration, and the 1:1 ratio of cable choker to pin shackle (1" cable choker requires minimum 1"shackle pin diameter, ¾": ¾", etc.)
3. Competent rigging person sizes crane and determines crane configuration, taking into consideration all aspects of the lift, including: tip height, boom angle, boom and jib length and off-set, deductions for erected or stowed jib, deductions for traveling block and parts of line or falls, and deductions for rigging hardware. Remember to check for load and boom clearances, tail swing clearances, overhead power lines or obstructions, soil condition and compaction, matting requirements, underground lines, sewers, recent excavations or voids.
4. Measure to confirm actual lifting radius and elevation. Do not rely on crane's computer or other electronic devices.
5. If necessary, perform geotechnical survey to determine allowable ground bearing pressures and ensure crane owner provides maximum imposed ground bearing pressures. Engineering Dept. shall calculate appropriate matting arrangement.
6. Provide detailed engineer stamped sketch or CAD drawing (plan and elevation view) to client representative for approval.
7. Perform pre-lift meeting to establish responsibilities and to assure all parties are aware of the sequence of activities to take place.
8. Confirm that all inspections of crane, lift lugs / trunnions, and rigging hardware have been completed.
9. Confirm that lift and tail swing radius have been barricaded and all non-essential personnel have been notified and cleared from the lift site.
10. Attach the required number and length of tag lines to the load in order to maintain control at all times.
11. Be aware of imminent weather conditions and the dynamic effects wind can have on loads and crane components, or the effect that accumulations of snow and rain can have on the weight of items to be lifted.
12. Establish a sole crane signal person who is to remain in constant communication with the crane operator. Crane operator should be prepared to acknowledge a "stop signal" from anyone involved in the lift.

# GLOVE SELECTION

Employees shall use the proper hand protection when hazards exist from skin absorption of harmful substances, cuts or lacerations, abrasions, punctures, chemical burns, thermal burns and harmful temperature extremes. Hand protection shall be selected on the basis of the task to be performed, conditions present, duration of use and the hazards & potential hazards identified.

## PROPER GLOVE FIT

- Wear only gloves that fit your hands.
- Gloves that are too small can tire your hands.
- Gloves that are too large are awkward to work with.
- Wearing gloves around moving equipment shall be done with great caution. Gloves may get caught and pull your hand into the machinery.

## TYPES OF GLOVES

**Leather Gloves**

- Leather gloves protect against sparks, moderate heat, blows, chips and rough objects.
- Welders gloves (heavy duty) - used for handling moderately hot materials.
- Welders gloves (TIG) - Smooth finished with cuff.
- Leather gloves (long cuffed) - used by riggers and operators.
- Leather gloves (short cuffed) - used by various crafts.
- Driver's gloves - leather, smooth finish, good general-purpose glove.

**Neoprene Gloves**

These are black, elbow length gloves used for handling and cleaning with chemicals. Neoprene protects workers from burns, irritation, and dermatitis caused by contact with oils, greases, solvents, hydraulic fluids, gasoline, alcohol's, organic acids and alkalis.

**Nitrile Gloves**

This glove type should be used for handling Hexane and Hydrocarbons. Stands up to heavy use even after prolonged exposure that causes other gloves to deteriorate.

**Kevlar Blend Gloves**

Kevlar provides a unique combination of toughness, flexibility, cut resistance and exceptional thermal stability. Use these gloves when cutting or when exposed to mild heat. Cut resistance minimum cut level 3 or higher.

**Bead Blasting Gloves**

Are to be used for bead blasting machines ONLY.

**Latex Gloves**

- Reduce the risk of exposure to blood and other potentially infectious substances.
- Comfortable to wear and pliability, along with their protective qualities, make them a popular general purpose glove.
- Protects workers' hands from most water solutions of acids, alkalis, and salts.
- Hypoallergenic gloves, glove liners, and powder-less gloves are possible alternatives for those allergic to latex.

**Vinyl Gloves**

Should only be used for minor tasks such as trash pickup.

NOTE: GLOVES SHOULD NOT BE CONSIDERED TOTAL PROTECTION. ALWAYS BE AWARE OF HAND POSITIONING AND LINE OF FIRE.

## SECTION 3:

# TOOL USE AND INSPECTION

# INSPECTION COLOR CODES

| Quarterly Color Code |
| --- |
| Q1 – 1 JAN – 31 MAR – Yellow |
| Q2 – 1 APR – 30 JUN – Green |
| Q3 – 1 JUL – 30 SEP – Red |
| Q4 – 1 OCT – 31 DEC – Orange |
| **Defective Tool** |
| Brown |

# PERSONAL PROTECTIVE EQUIPMENT (PPE)

| EQUIPMENT | REQUIRED PPE | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Gloves | FRC's | Steel-Toe-Boots | Safety Glasses | Hearing Protection | Face Shield | Hard Hat | Respirator |
| **HAND TOOLS** | | | | | | | | |
| Combination Wrench |  |  |  |  |  |  |  | |
| Hammer Wrench |  |  |  |  |  |  |  | |
| Hand Torque Wrench |  |  |  |  |  |  |  | |
| Pipe Wrench |  |  |  |  |  | |  | |
| Hack Saw |  |  |  |  |  | |  | |
| Hand File |  |  |  |  |  | |  | |
| Hammer |  |  |  |  |  | |  | |
| Pry Bar |  |  |  |  |  | |  | |
| Bull Pin |  |  |  |  |  | |  | |
| Socket |  |  |  |  |  |  |  | |
| **ELECTRICAL TOOLS** | | | | | | | | |
| Grinders: Portable Grinders |  |  |  |  |  |  | | |
| Bench Grinders |  |  |  |  |  |  |  | |
| Saws: Port-A-Band Saw |  |  |  | |  |  |  | |
| Saws: Reciprocating Saw (Sawzall) |  |  |  |  |  |  |  | |
| Saws: Chop Saw |  |  |  |  |  |  |  | |
| Saws: Circular Saw |  |  |  |  |  |  |  | |

# PERSONAL PROTECTIVE EQUIPMENT (PPE)

| EQUIPMENT | REQUIRED PPE | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Gloves | FRC's | Steel-Toe-Boots | Safety Glasses | Hearing Protection | Face Shield | Hard Hat | Respirator |
| **ELECTRICAL TOOLS** | | | | | | | | |
| Hand Drill | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Magnetic Drill | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Pipe Threader | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| Welding Machine | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Impact Wrench | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| **PNEUMATIC AND HYDRAULIC TOOLS** | | | | | | | | |
| Air Torque Wrench | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Hydraulic Torque Wrench | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Air Chisel | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Air Mover | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| **OTHER TOOLS** | | | | | | | | |
| Jack Stand | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| Cutting Torch | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Beveling Machine | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Port-A-Power | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Come-A-Long And Chain Fall | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| Air Tugger | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |

## Hand Tools
# COMBINATION WRENCH

A combination wrench is a double-ended wrench where one end is an open-end wrench and the other a box-end wrench or ring spanner. Both ends generally fit the same size bolt. It is used to apply manual torque to turn objects.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do you have the correct size wrench that fits the job? |
| Do you have a good grip on the wrench to prevent slipping? |
| Have you inspected the wrench and nut for damages or wear that may cause slipping? |
| Have you checked for pinch points or hand injury points should the wrench slip? |
| Is the area where your are working clear of tripping hazards and well lit? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Always push, never pull any tool towards you.
- Remove your body and that of others from line of fire!
- Inspect the wrench for flaws, damage, or wear prior to use.
- Return any damaged wrench to tool room.
- Maintain correct balance and footing. Ensure the floor is not slippery and wear non-slip shoes.
- Clear area around wrench work to protect against injury if the wrench slips.
- Use the correct jaw to avoid slippage. Box wrenches are safer than open-end wrenches since they are less likely to slip.
- Use a split box wrench on flare nuts. Grip the wrench so it will not slip.

**DON'T:**

- Don't attempt to repair a wrench with rounded or damaged points on the box end or worn or spread jaws on the open end.
- Never use fractional wrenches on metric fasteners or vice versa.
- Don't use a shim to make a wrench fit.
- Never overload a wrench by using a pipe extension or cheater bar on the handle.
- Don't strike the handle with a hammer. This can weaken the metal of the wrench and cause the tool to break.
- Never use a wrench on moving machinery.
- Don't overreach. Keep proper footing and balance at all times.
- Don't double wrench.

## Hand Tools
# HAMMER WRENCH

A hammer wrench is a specialized, short, stocky wrench with a block end designed to be hit by a hammer. This tool is commonly used with large fasteners, especially a nut and stud which both have index marks. Typically, the nut is hand-tightened first, and then further tightened with the hammer wrench a specific number of index marks, thus giving precise torque (preload). Hammer wrenches also provide shock and high force for releasing large and / or stuck nuts and bolts including situations where there is not room for a large wrench.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do you have the correct size hammer wrench for the job? |
| Have you inspected the wrench and nut for flaws or wear that may cause it to slip? |
| Do you have enough clearance to hold the wrench and swing the hammer safely? |
| Do you have a good grip on the wrench to prevent slipping? |
| If you are working with a partner, do you have line of sight and a plan to prevent someone from being struck? |
| Is the area where your are working clear of tripping hazards and well lit? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Inspect the wrench for flaws, damage, or wear.
- Return any damaged wrench.
- Maintain correct balance and footing. Ensure the floor is not slippery and wear non-slip shoes.
- Clear area around wrench work to protect against injury if the wrench slips.
- Ensure you have room to swing hammer safely.
- Maintain line of sight and / or have a communication plan with co-workers to make sure no one is struck.
- Must use a holder to secure hammer wrench.
- It is preferred not to be used as a backup, but when you must utilize a tool holder.

**DON'T:**

- Don't hold it in your hands, while in use.
- Don't attempt to repair a wrench with worn or damaged points.
- Never use fractional wrenches on metric fasteners or vice versa.
- Don't use a shim to make a wrench fit.
- Never overload a wrench by using a pipe extension or cheater bar on the handle.
- Never use a wrench on moving machinery.
- Don't overreach. Keep proper footing and balance at all times.
- Never swing a hammer before ensuring adequate clearance and the location of co-workers.

## Hand Tools

# HAND TORQUE WRENCH

Hand Torque wrenches primarily are used to measure torque and to apply it on any type of fastener, such as nuts, socket head screws or bolts. Torque wrenches come in many shapes and sizes for use in different situations, but all operate essentially the same.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do you have the correct size wrench for the job? |
| Do you have the correct socket and have you verified that it fits properly on the nut or bolt being tightened? |
| Have you inspected the wrench and nut for flaws or wear that may cause slipping? |
| Is your balance and footing properly maintained? |
| Do you have sufficient space and correct body positioning to do the job? |
| Is the tool on the proper torque setting before use? |
| Is the grip handle held correctly and in the proper position? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Inspect the wrench for flaws, damage, or wear.
- Return any damaged wrench.
- Maintain correct balance and footing.
- Clear area around wrench work to protect against injury if the wrench slips.
- Verify that torque wrench has been serviced, calibrated, and maintained by a qualified technician.
- Clean and / or repair the threads that will be tightened. Damaged or dirty threads will result in a misleading torque reading.
- Store torque wrench inside a case in a clean and dry location.
- Use tool only within rated torque range.
- Inspect before every use.
- Use only sockets with the correct drive and that are rated to at least the torque that will be applied to it.

**DON'T:**

- Don't use tool if damaged or parts are loose. Return for repairs.
- Never immerse wrench in cleaning solution, as it damages the internal lubrication.
- Don't use a handle extension, hammer or pry bar to increase force.
- Never turn knurled handle below the lowest torque setting.
- Don't use torque wrench for loosening.
- Never use a wrench on moving machinery.
- Don't overreach. Keep proper footing and balance at all times.
- Push don't pull. Never pull towards your body.

## Hand Tools
# PIPE WRENCH


There are three basic types of pipe wrenches — the strap wrench, the chain wrench and the Stillson wrench. They are used to connect or break pipe joints, or to turn cylindrical parts. When using a pipe wrench of any size, maintain a small gap between the shank of the hook jaw and the pipe itself.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do you have the correct size and type of pipe wrench to do the job? |
| Have you inspected the pipe wrench for any excessive wear, cracks or damaged parts? |
| Is there enough clearance for the job to be performed? |
| Is the work piece secured or clamped to a stable platform? Is your footing properly maintained while using the wrench? |
| Is your area clean and clear of all possible hazards? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Inspect the wrench for flaws, damage, or wear.
- Return any damaged wrench.
- Maintain correct balance and footing.
- Clear area around wrench work to protect against injury if the wrench slips.
- Select a pipe wrench with sufficient capacity and leverage to do the job.
- Adjust the pipe wrench grip to maintain a gap between the back of the hook jaw and the pipe.
- Face wrench forward and turn wrench so pressure is against heel jaw.
- Pull, rather than push, on the pipe wrench handle.
- Inspect pipe wrenches periodically for worn or unsafe parts. Keep pipe wrench teeth clean and sharp.

**DON'T:**

- Don't use tool if damaged or parts are loose. Return for repairs.
- Never modify or alter a pipe wrench.
- Don't use in conjunction with a power drive, threading machine or any mechanical / hydraulic device to make or break fittings.
- Never use a handle extension, hammer or pry bar to increase force.
- Don't apply a side load to the handle.
- Never use a pipe wrench to bend, raise or lift a pipe.
- Don't overreach.
- Push don't pull. Never pull towards your body.

## Hand Tools
# HACK SAW

A hacksaw is comprised of a fine tooth blade under tension in a frame, used for cutting materials such as metal or plastics. Hacksaw blades are available with tooth counts ranging from 14 to 32 teeth per inch. Thin material requires more teeth per inch, while thicker material requires fewer teeth per inch.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do you have the correct saw blade for the material to be cut? Is the material to be cut secure in a vise or a holding device? |
| Is the blade correctly tensioned and teeth pointing forward? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Secure the material to be cut in a vise or other holding device to avoid vibration.
- Choose the correct blade for the material being cut.
- Insert the correct blade in the hacksaw frame and adjust wing nut for proper tension.
- Maintain correct balance and footing. Use a file to make a notch for guiding the first strokes of the saw.
- Steady the saw by holding the handle with the one hand and the frame with the other.
- Keep your hands and fingers away from the saw blade.
- Hold the blade perpendicular to the material being cut.
- Saw at a rate not to exceed 40 to 50 strokes per minute. Cut harder materials slower than softer materials.
- When done, place saw flat on a work bench or in a spot where teeth cannot be damaged between cuts. Keep saw blade clean, and use light machine oil on the blade to keep it from rusting, overheating and breaking.
- Protect saw blade teeth from coming in contact with metal or other material that may damage them.
- Replace damaged saw handles with new ones immediately when needed.

**DON'T:**

- Don't use tool if damaged or parts are loose. Return for repairs.
- Never modify or alter a saw.
- Don't carry a saw by the blade.
- Never force the saw if it binds. Use a wedge to spread the cut..
- Never cut material that isn't secure, and do not hold material you are cutting. Don't overreach.
- Never place your hand on or near the blade during use.

## Hand Tools
# HAND FILE

Metal hand files are used for shaping , cutting and finishing metal, and also for removing excess material or smoothing rough edges. Files come in a variety of materials, sizes, shapes, cuts, and tooth configurations.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do you have the proper file for the job? |
| Is your balance and footing properly maintained? |
| Do you have proper hand protection? |
| Is the material to be filed secured in a vice or other holding device? |
| Is your area clean and clear of all possible hazards? |
| Is the file handle fitted tightly? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Secure the material being filed in a vice or other holding device.
- Use an offset handle if available.
- Maintain correct balance and footing. Ensure the floor is clear and stable.
- Inspect file before every use.
- Grasp the file with one hand and guide the point of the file with the thumb and forefinger of the other hand. Always wear proper hand protection.
- Use the lightest amount of pressure to perform the desired job.
- Carry pointed tools with the point facing DOWN.
- Ensure proper handle is installed on the file.
- Ensure that the file is clean and serviceable before and after use.

**DON'T:**

- Don't use tool if damaged.
- Never use a file without a handle.
- Don't use a file to pry or hammer.
- Never hold the file rigid or stationary—keep stroking continually.
- Don't overreach. Keep proper footing and balance at all times.

# Hand Tools
# HAMMER

FIG. 1A

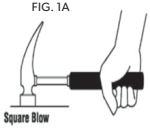
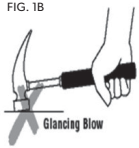



FIG. 1B




A hammer is a basic construction tool used to deliver an impact to an object. Common uses include driving nails, fitting parts, forging metal and breaking up objects. There are specific hammers designed for particular jobs.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do you have the proper weight and size hammer for the job? |
| Have you inspected the hammer for excessive wear, mushrooming, or cracks? |
| Is the head of the hammer firmly attached to the handle? |
| Is your balance and footing properly maintained? |
| Have you warned nearby personnel before using the hammer? |
| Do you have adequate clearance to swing the hammer safely? |
| Do you have all the PPE require for the job? |

**DO:**

- Wear appropriate PPE.
- Watch the object you are hitting.
- Keep striking face clear of oil and grease.
- Hold the hammer with your wrist straight and your hand firmly wrapped around the handle.
- Look behind and above you before swinging the hammer.
- Strike a hammer blow squarely with the striking face parallel to the surface being struck. See Fig. 1a
- Avoid glancing blows as well as over and under strikes. See Fig. 1b
- Protect wood handles from extremely wet and dry conditions.
- Inspect the wood handle prior to use.

**DON'T:**

- Don't use a hammer with dents, cracks, chips, mushrooming, or excessive wear to the head.
- Never redress, grind, weld or heat-treat a hammer head.
- Don't use a hammer for any purpose other than for which it was designed or intended.
- Don't strike with the side or cheek of the hammer.
- Don't overreach. Keep proper footing and balance at all times.

# Hand Tools
# PRY BAR


A Pry bar (or Crowbar) is commonly used for ripping out, separating or prying apart objects, It also can be used as a lever. Pry bars come in many different sizes and weights. Crow bars have an angled, forked end, typically used for removing nails.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do you have the proper size and type pry bar for the job? |
| Is your balance and footing properly maintained? |
| Do you have the proper hand protection? |
| Have you inspected the pry bar for wear or cracks? |
| Is your area clean and clear of all possible hazards? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Inspect the bar for burrs and cracks.
- Look behind you before using to make sure the area is clear.
- Be sure to secure the object you are demolishing.
- Have secure footing before applying pressure.
- Find a narrow crack and insert the pry bar into the crack and then apply force slowly.
- Carry pointed tools by your side with the points and heavy end DOWN.

**DON'T:**

- Don't use a bar that is cracked, bent or has excessive wear.
- Never use a pry bar for any purpose other than for which it was designed or intended.
- Don't strike a bar with another tool.
- Never apply force quickly to an object you are prying apart.
- Don't overreach. Keep proper footing and balance at all times.
- Push don't pull. Never pull towards your body.

# Hand Tools
# BULL PIN

A bull pin or drift pin is used as an aid in aligning bolt or rivet holes prior to inserting a fastener. They are often made from round steel stock. It is important to discard any drift pin that is not straight or has excessive wear.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Is your balance and footing properly maintained? |
| Do you have the proper hand and eye protection? |
| Have you inspected the bull pin for cracks, chips, mushrooming or excessive wear? |
| Do you have all the PPE required for the job? |

**DO:**

- Return any drift pin if it is bent or either end shows dents, cracks, chips, mushrooming or excessive wear.
- Look behind and above you before striking the bull pin.
- Maintain correct balance and footing. Ensure the floor is not slippery and wear non-slip shoes.
- Barricade the area, when possible.
- Watch the bull pin as you are striking it. Be careful for sudden release of stored energy of the pin.
- Strike the head squarely with a hammer.
- Use a tool holder, if possible.

**DON'T:**

- Don't use a bull pin with dents, cracks, chips, mushrooming, or excessive wear.
- Never use a bull pin for any purpose other than for which it was designed or intended.
- Don't hold the bull pin while someone else is striking the head with the hammer, and vice versa.
- Never use a drift pin as a punch.
- Don't ever weld to a bull pin.

## Hand Tools
# HAND SOCKET

A socket is a cup shaped fitting with a recess that grips the head of a bolt or nut. Sockets are attached to various types of socket wrenches, including hand held, powered and torque wrenches.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do you have the correct size and type of socket to do the job? |
| Is the socket secured with a socket retaining pin? |
| Have you inspected the socket for any cracks or damage? |
| Is your area clean and clear of all possible hazards? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Regularly inspect sockets and drive tools.
- Replace sockets if corners are worn or cracked.
- Select the correct size and type of socket for the job. Match the socket to the drive tool / wrench.
- Use an approved retaining pin to hold socket to drive tool.
- Use the shortest and simplest connection to the drive tool. Avoid extension bars and adapters if possible.
- Maintain correct balance and footing.

**DON'T:**

- Don't use damaged or worn sockets.
- Never use hand sockets on power or impact tools.
- Don't strike an impact socket with a hammer or other tool.
- Never hold a socket, universal joint, or any other attachment while the power tool is running.
- Don't continue to operate an impact tool once the fastener is tight.
- Never modify a socket to accomplish a task for which it was not intended.
- Don't use shims to get a socket to fit. Use the correct size socket.
- Don't ever attempt to repair a damaged socket (do not weld).

## Electrical Tools
# GRINDERS: PORTABLE GRINDERS

Hazards with the use of portable grinders include the disc either contacting the operator's body, or shattering and throwing off fragments at high speed. Operators must be trained in selecting, inspecting, fitting, maintaining, removing, and carefully using portable grinders. **Always check the max RPM of the grinder before mounting a wheel, to ensure that it doesn't exceed the maximum operating speed marked on the wheel.**

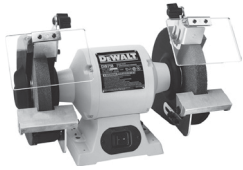
| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Is the guard present and firmly attached? |
| Is the wheel free from cracks, chips, gouges, or other damage? |
| **Is the rated wheel speed greater or equal to that of the grinder, and is the correct wheel size used?** |
| Are the flange nuts and flanges in good condition and appropriate for the wheel? |
| Have you inspected the new abrasive wheels before they are mounted? |
| Is the wheel being used correct for the application, and correctly mounted and tightened before use? |
| Is the electrical cord or air hose damaged or showing excessive wear? |
| Are there any worn or damaged mounting accessories? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Use clamps or other safe ways to secure and support the work piece to a stable platform.
- Be sure ON/OFF switch is non- locking type. And inspect for proper function.
- Remove adjusting keys or wrenches before turning on the tool.
- Disconnect the plug from the power source before making any adjustments, changing accessories, or storing the tool.
- Always use a side handle, in order to maintain control of the tool.
- Wear FRC clothing and proper gloves when grinding with the portable disc grinder to protect hands and forearms.
- Require same PPE for people within 10' of grinding activities.
- Always operate the grinder with two (2) hands.
- **Check the safe operating speed of grinding disks and rocks before use.**

**DON'T:**

- Never reach underneath the work. The guard cannot protect you below the work.
- Never overreach; keep proper footing and balance at all times.
- Don't use damaged cutting disc, wheel or rock.
- Never abuse the cord. Never use the cord to carry the tools or pull the plug from an outlet.
- Don't place the cord near heat, oil, sharp edges or moving parts. Remove damaged cords immediately.
- Never override the ON/OFF switch or secure it in the ON position.
- Don't work on unsecure materials.
- Don't sharpen tungsten with the grinder.




## Electrical Tools
# GRINDERS: BENCH GRINDERS

There are four basic safety elements to the bench grinder that serve as guards or shields. (1) The flange and spindle guard protect you from the spinning wheel. (2) The eye shield protects your eyes. (3) The adjustable tongue guard helps stop flying debris and sparks. It should be no more than 1/4-inch from the wheel. (4) The work rest is the point of operation and ensures safe operation if located properly. The rest should be 1/8-inch from the wheel. You should position the work piece on the rest so it touches the wheel from the front or edge.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do side guards cover the spindle, nut and flange and 75% of the wheel diameter? |
| Is the eye shield secure , clear and free of cracks? |
| Is the adjustable tongue guard on the top of the grinder within 1/4" of the wheel? |
| Is the work rest in place and adjusted to within 1/8" of the wheel? |
| Is the maximum RPM rating of each abrasive wheel compatible with the RPM rating of the grinder motor? |
| Before a new abrasive wheel is mounted, is it visually inspected and ring tested? Make sure the grinder is unplugged prior to removing / installing wheels. |
| Is the grinding surface completely square with no grooves? (if no, dress wheel prior to use) |
| Is the bench grinder securely mounted? |
| Is the grinder effectively grounded? |
| Does the grinder have an individual ON/OFF switch? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Dress wheel prior to use if disk surface is irregular in any way.
- Bring the object into contact with the grinding wheel slowly and smoothly, avoiding impact motions.
- Keep bystanders a safe distance away from the work area.
- Move object being ground back and forth across the face of the wheel to avoid forming grooves.
- Keep proper footing and balance at all times.

**DON'T:**

- Don't use a bench grinder if it is not firmly fastened to a work bench or rigid frame.
- Never grind on the side ; grind only on the face of the grinding wheel.
- Never use tool if switch does not turn it on or off. Any tool that cannot be controlled with the switch is dangerous and must be repaired.
- Don't force tool. Use the correct tool for your job.
- Never grind or sharpen anything that cannot be adequately supported by the tool rest.
- Don't stick an object into the wheel to slow or stop it, and always wait until the grinder stops completely before leaving.

## Electrical Tools

# SAWS: PORT-A-BAND SAW


Few tools can make a job of cutting metallic tubing or other stock easier than a bandsaw. On those occasions when the stock cannot be brought to the machine, portable bandsaws offer the option of taking the machine to the work.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Is the object being cut secured? |
| Are GFI's installed, labeled, and operating correctly? |
| Is the blade correct for the application and has it been correctly mounted and tightened before use? |
| Is the electrical cord damaged or showing signs of excessive wear? |
| Does the START / STOP control function properly? |
| Are there any worn or damaged mounting accessories? |
| Are stops in place and in good condition? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Use clamps or other safe ways to secure and support the work piece on a stable platform.
- Avoid accidental starting. Be sure the switch is OFF before plugging in.
- Make sure the portable band saw is clean before using.
- Remove adjusting keys or wrenches before turning the tool on.
- Wait until the motor has reached full speed before starting a cut.
- Support both pieces before cutting. Do not let large pieces free fall.
- Keep hands away from cutting area and blade.
- Check for misalignment or binding of moving parts, breakage of parts, or any other condition that may affect the tools operation.
- Utilize fence when cutting.
- Keep hands on handles during cutting operations.
- Disconnect plug from power source before making any adjustments, changing accessories, or storing the tool.
- Keep cord away from heat, oil, sharp edges or moving parts.
- Use an approved outdoor extension cord.
- Maintain tools with care. Keep cutting tools sharp and clean.
- Always operate the port-a-band saw with two (2) hands.

**DON'T:**

- Never remove the grounding prong or modify the plug in any way. Do not use any adapter plugs.
- Don't force tool. Use the correct tool for your job.
- Never expose electric power to rain or wet conditions.
- Don't abuse the cord. Never use the cord to carry the tool or pull the plug from an outlet.
- Never overreach. Keep proper footing and balance at all times.
- Don't use tool if START / STOP switch does not work.
- Never modify and/or use this tool for any application other than for which it was designed.
- Don't work on unsecured materials.

## Electrical Tools

# SAWS: RECIPROCATING SAW (SAWZALL)

A reciprocating saw is a type of saw in which the cutting action utilizes a push and pull reciprocating motion of the blade. Reciprocating saws are most useful for making quick, crude cuts.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Are guards present and firmly attached? |
| Is the saw housing in good condition? |
| Is the work area clean and are cords routed in a manner not to create tripping hazards? |
| Does the blade show signs of excessive wear or missing teeth? |
| Is the electrical cord damaged or showing signs of excessive wear? |
| Is the saw effectively grounded? |
| Are there any worn or damaged mounting accessories? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Use an approved outdoor extension cord.
- Avoid accidental starting. Be sure switch is OFF before plugging in.
- Use clamps or other safe ways to secure and support the work piece on a stable platform.
- Disconnect the plug from power source before making adjustments, changing accessories, or storing tool.
- Maintain tools with care. Keep cutting tools sharp and clean.
- Check for misalignment or binding of moving parts, breakage of parts, and any other condition that may affect the tool's operation.

**DON'T:**

- Don't remove the grounding prong or modify the plug in any way.
- Never force tool. Use the correct tool for your job.
- Don't expose power tools to rain or wet conditions.
- Never abuse the cord. Never use the cord to carry the tool or pull the plug from an outlet.
- Don't overreach. Keep proper footing and balance at all times.
- Never use tool if ON/OFF switch does not work properly.
- Don't operate this tool it if becomes too hot to touch with bare hand.

## Electrical Tools
# SAWS: CHOP SAW

A chop (or miter) saw is used to make accurate cross cuts in wood, plastic, and light metals. It has a fixed blade attached to a moving arm which spins over a small worktable. The operator lines up the piece to be cut and lowers the saw blade.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Are the guards in position and in good working condition before operating? |
| Does the swing arm and movable saw parts function properly? |
| Is work area clean and are cords routed in a manner not to create tripping hazards? |
| Is the cutting blade in good working order and properly aligned? |
| Is the electrical cord damaged, show signs of excessive wear or damage to prongs? |
| Do you have all the PPE required for the job? |

**DO:**

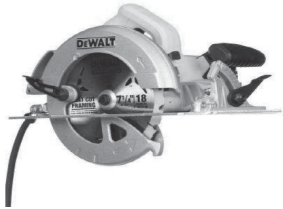
- Wear appropriate PPE.
- Use an approved outdoor extension cord.
- Avoid accidental starting. Be sure switch is OFF before plugging in.
- Use clamps or other safe ways to secure and support the work piece on a stable platform.
- Disconnect the plug from power source before making adjustments, changing accessories, or storing tool.
- Maintain tools with care. Keep cutting tools sharp and clean.
- Check for misalignment or binding of moving parts, breakage of parts, and any other condition that may affect the tool's operation.

**DON'T:**

- Don't remove the grounding prong or modify the plug in any way. Do not use any adapter plugs.
- Never force tool. Use the correct tool for your job.
- Don't expose power tools to rain or wet conditions.
- Never abuse the cord. Never use the cord to carry the tool or pull the plug from an outlet.
- Don't overreach. Keep proper footing and balance at all times.
- Never use tool if ON/OFF switch does not work properly.
- Don't reach into the cutting area until the blade comes to a full stop.
- Never reach underneath the work. The guard cannot protect you from the blade below the work.
- Don't use damaged blades.
- Never use circular saw blades or any other toothed blades with an abrasive cutoff saw.

(NOTE: THERE ARE METAL CUTTING SAWS THAT USE TOOTHED BLADES. THEY ARE PURPOSE BUILT AND MATCHED TO THEIR COMPONENTS. PLEASE VERIFY WITH APPROPRIATE PERSONNEL PRIOR TO USE IF UNSURE).

## Electrical Tools
# SAWS: CIRCULAR SAW




A circular saw is handheld electrical power saw with a rotating saw blade.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Is the retracting lower blade guard in good condition and moves freely? |
| Is the saw blade mounted for proper rotation? |
| Is the blade locked in at a depth so that the lowest tooth does not extend more than about 0.3 cm or 1/8" beneath the wood. |
| Are extension cords properly sized for electrical load? (15AMP) |
| Are all cords in good condition (no frays, splits or tears)? |
| Are work platforms stable, level and free from clutter? |
| Is there adequate ventilation in the work area? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Keep cord away from heat, oil, sharp edges, and moving parts.
- Use an approved outdoor extension cord.
- Avoid accidental starting. Be sure switch is OFF before plugging in.
- Use clamps or other safe ways to secure and support the work piece on a stable platform.
- Disconnect the plug from power source before making adjustments, changing accessories, or storing tool.
- Maintain tools with care. Keep cutting tools sharp and clean.
- Check for misalignment or binding of moving parts, breakage of parts, and any other condition that may affect the tool's operation.
- Check lower guard for proper closing before each use.
- Check operation and condition of the lower guard spring.
- Use blades with correct size and shape arbor holes (diamond vs. round).
- Use extra caution when making a "pocket cut" into existing walls or other blind areas.

**DON'T:**

- Don't remove the grounding prong or modify the plug in any way. Do not use any adapter plugs.
- Never force tool. Use the correct tool for your job.
- Don't expose power tools to rain or wet conditions.
- Never abuse the cord. Never use the cord to carry the tool or pull the plug from an outlet.
- Don't overreach. Keep proper footing and balance at all times.
- Never use tool if ON/OFF switch does not work properly.
- Don't operate saw if lower guard does not move freely and close instantly. Never clamp or tie the lower guard into the open position.
- Never use dull or damaged blades.
- Don't use damaged or incorrect blade washers or bolts.
- Never reach into the cutting area until the blade comes to a full stop.
- Don't reach underneath the work. The guard cannot protect you from the blade below the work.
- Never hold piece being cut in your hands or across your legs.

## Electrical Tools
# HAND DRILL

Hand drills are used for boring holes in wood, concrete, steel or other construction materials. Here are two types of hand drills: Manual and power drills (corded, pneumatic or battery powered).

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Is the drill housing in good condition? |
| Does the bit show signs of excessive wear? |
| Is the hand drill the right tool for the job? |
| Is the size and capacity of the tool adequate for the work being performed? |
| For pneumatic drills: Is air hose in good condition and properly secured? |
| Is the electrical cord damaged or showing signs of excessive wear? |
| Is each electrically operated hand drill effectively grounded? |
| Is the chuck in good working order? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Keep cord/ hose away from heat, oil, sharp edges, and moving parts.
- Use an approved outdoor extension cord.
- Use clamps or other safe ways to secure and support the work piece on a stable platform.
- Disconnect the plug / hose from power source before making adjustments, changing accessories, or storing tool.
- Maintain tools with care. Keep bits sharp and clean.
- Check for misalignment or binding of moving parts, breakage of parts, and any other condition that may affect the tool's operation.
- Remove adjusting / chuck key before turning the tool on.
- Be aware that drill bits can "grab" during the cut. Use body and hand positions that will prevent the drill from running into something. Always use the side handle.
- Keep handle dry, clean, and free from oil or grease to ensure control of the tool.
- Hold tool by insulated gripping surface to ensure personal safety.
- Be aware of the drill bit binding by maintaining a firm grip on the tool.
- Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tool from becoming accidentally disconnected.

**DON'T:**

- Don't remove the grounding prong or modify the plug in any way.
- Never force tool. Use the correct tool for your job.
- Don't expose power tools to rain or wet conditions.
- Never abuse the cord. Never use the cord to carry the tool or pull the plug from an outlet.
- Don't overreach. Keep proper footing and balance at all times.
- Never use tool if ON/OFF switch does not work properly.
- Don't operate drill if it becomes too hot to touch with bare hand.

## Electrical Tools
# MAGNETIC DRILL

Magnetic base drills are a specialized type of drill primarily for drilling metal. The magnetic base secures firmly to the metal to be cut, ensuring that the drill can accurately bore through the metal.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Are the guards in position and in good working condition before operating? |
| Is the drill base and hardware in good repair? |
| Is the work area clean and are cords routed in a manner not to create tripping hazards? |
| Is the drill bit size less than or equal to the rated capacity of the magnetic drill? |
| Is the magnetic drill set up as to avoid awkward operations and hand positions? |
| Is the size and capacity of the tool adequate for the work being performed? |
| Is the electrical cord damaged or showing signs of excessive wear? |
| Is each electrically operated magnetic drill effectively grounded? |
| Is there enough room around the machine to do the job safely? |
| Is the tool secured in the event of power loss and the power cord tagged or clearly identified? |

**DO:**

- Wear appropriate PPE.
- Keep cord away from heat, oil, sharp edges, and moving parts.
- Use an approved extension cord.
- Use clamps or other safe ways to secure and support the work piece on a stable platform.
- Place the unit on a surface that is clear of shavings, chips or dirt to allow for optimum magnetic hold.
- Be sure that the drill press is plugged into the correct voltage system and is grounded correctly and a safety chain is attached.
- Remove adjusting / chuck key before turning the tool on.
- Be aware that drill bits can "grab" during the cut.
- Disconnect the plug from power source before making adjustments, changing accessories, or storing tool.
- Check for misalignment or binding of moving parts, breakage of parts, and any other condition that may affect the tool's operation.
- Maintain tools with care. Keep bits sharp and clean.
- Use only accessories recommended by the manufacturer.
- Attach safety chain to magnetic drill when you are using them in elevation.

**DON'T:**

- Don't remove the grounding prong or modify the plug in any way.
- Never force tool. Use the correct tool for your job.
- Don't expose power tools to rain or wet conditions.
- Never abuse the cord. Never use the cord to carry the tool or pull the plug from an outlet.
- Don't overreach. Keep proper footing and balance at all times.
- Never use tool if ON/OFF switch does not work properly.

# Electrical Tools
# PIPE THREADER

Pipe Threading machines thread and cut pipe, as well as bar stock and power roll grooving equipment. Follow instructions on proper use of threading machines.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Is the foot switch present and does it turn the machine off when released? |
| Are all electrical connections dry and off the ground? |
| Is the work area clean and are cords routed in a manner not to create tripping hazards? |
| Are the cutting dies in good working order and properly installed? |
| Is the threading machine barricaded when material extends past the machine? |
| Is the size and capacity of the tool adequate for the work being performed? |
| Is the proper cutting oil or lubricant for the job available and being used? |
| Is the electrical cord damaged or worn excessively? |
| Are you familiar with the safe operation of the threading machine you are using? |
| Is there enough room around the machine to do the job safely? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Keep cord away from heat, oil, sharp edges, and moving parts.
- Replace damaged cords immediately.
- Secure machine to bench or stand.
- Keep floors dry and free of slippery materials such as oil.
- Guard or barricade the area when work piece extends beyond machine.
- Avoid accidental starting. Be sure switch is OFF before plugging in.
- Tighten chuck handwheel and engage rear centering device on the pipe before turning on the machine.
- Operate machine from side with REV/OFF/FOR switch.
- Use proper lubricating fluid to extend the life of the cutting dies.
- Keep hands away from rotating pipe and fittings.
- Stop the machine before wiping pipe threads or screwing on fittings. Allow the machine to stop completely before touching the pipe or machine chucks.
- Disconnect the plug from power source before making adjustments, changing accessories, or storing tool.
- Maintain tools with care. Keep cutting tools sharp and clean.
- Check for misalignment or binding of moving parts, breakage of parts, and any other condition that may affect the tool's operation.
- Lock foot switch when machine is not in use.
- Use only accessories that are approved for the specific machine you are using.

**DON'Ts:**

- Don't remove the grounding prong or modify the plug in any way.
- Never force tool. Use the correct tool for your job.
- Don't expose power tools to rain or wet conditions.
- Never abuse the cord. Never pull the plug from an outlet.
- Don't overreach. Keep proper footing and balance at all times.
- Never use tool if ON/OFF switch does not work properly.
- Don't operate the machine with covers removed. Exposure to moving parts may result in entanglement and serious injury.
- Never use this machine to make or break fittings.
- Don't use this machine if the foot switch is broken or missing.

## Electrical Tools
# WELDING MACHINE

Welding machines are the primary tool in fabrication, providing the source of electrical spark to create the arc between the gas, filler material and material being welded. Effective grounding of the machine is critical, as is properly securing the gas tanks and cylinders.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Are all the connections tight, including the earth ground? |
| Are the electrode holder and welding cable free of defects or repairs ? |
| Is the work area clean and are cords routed in a manner not to create tripping hazards? |
| Is the original enclosure and fan guarding in place? |
| Are the cables the right size for your job? Be sure any damaged cable insulation is replaced. |
| Are the leads spread out and run neatly to prevent overheating? |
| Is there enough dry insulation between your body and the work piece? |
| Is there adequate ventilation in your work area? |
| Is the work stable and easy to reach from where you are standing? |
| Are the work area conditions such that normal safety precautions can be observed? |
| Do you have all the PPE required for the job? |

CONTINUED ON PAGE 57

# Electrical Tools
# WELDING MACHINE

CONTINUED

**DO:**

- Wear appropriate PPE.
- Use only grounded or double insulated equipment.
- Verify that welding machine has functioning GFCI in place for power supply.
- Verify the supply ground. Connect equipment grounding terminal to a proper earth ground.
- Use only well maintained and properly operating equipment.
- Keep all doors, panels, covers, and guards closed and securely in place.
- Turn off or unplug all electrical equipment connected to generator power receptacles before starting or stopping the engine.
- Use protective screens or barriers to protect others from flash and glare; warn others not to watch the arc.
- Ensure gas tanks / cylinders are properly chained to the machine or on a tank cart.
- Verify that cables are not pinched under forklifts, hand trucks or other moving equipment.
- Keep away from moving parts such as fans, belts, and rotors.
- Follow hex chrome procedures when welding an alloy metal.
- Insulate yourself from work and ground using dry insulating mats or covers big enough to prevent any physical contact with the work or ground.
- Work in a confined space only if it is well ventilated, or while wearing an air-supplied respirator.
- Clamp work cable with good metal to metal contact to work piece or work table as near the weld as practical.
- Insulate work clamp when not connected to work piece to prevent contact with any metal object.
- Disconnect both welding cables to prevent live electrode from causing electric shock and fire hazards if using generator power only and not welding.
- Watch for fire, and keep a fire extinguisher nearby.
- Disconnect input power or stop engine before inspecting, servicing or reconnecting welding machine.
- Inspect electrical cables and power cables regularly for fraying or other problems. Replace cord immediately if damaged.
- Turn off all equipment when not in use.

**DON'T:**

- Don't operate the machine if the ON / OFF switch does not work properly.
- Never use worn, damaged, undersized, or poorly spliced cables.
- Don't connect to any electrical distribution system normally supplied by utility power unless a proper transfer switch and grounding procedure are employed.
- Never use AC output in damp areas, if movement is confined, or if there is a danger of falling.
- Don't drape cables over your body.
- Never touch electrode if you are in contact with the work, ground, or another electrode from a different machine.
- Don't touch live electrical parts.
- Never touch the torch or electrode clamp simultaneously with the earth clamp.
- Don't point gun (MIG) toward any part of your body, other people, or any metal when threading welding wire.
- Never add fuel near an open flame or welding arc or when the engine is running.
- Do not attempt to move a welding machine trailer from the side with a forklift.

## Electrical Tools
# IMPACT WRENCH

Impact wrenches are widely used in many industries where high torque output is needed, and are available in all sizes and several styles. Compressed air is the most common power source for impact wrenches, although electric and hydraulic power are also used. Even cordless electric devices are becoming increasingly popular.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Have you checked the hose for wear, and made sure that all connections are secure? |
| Is the work area clean and are hoses routed in a manner not to create tripping hazards? |
| Has the impact wrench been calibrated and inspected prior to use? |
| Is the size and capacity of the tool adequate for the work being performed? |
| Is the trigger in the "OFF" position before connecting to the air supply? |
| Is the retaining ring properly installed if required? |
| Is the impact socket specifically designed for the particular impact wrench? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Keep hoses away from heat, oil, sharp edges, and moving parts.
- Ensure wrench air valve (or trigger) is in the “off” position before connecting to the air supply.
- Disconnect tool from power source before making adjustments, changing accessories, or storing tool.
- Maintain tool with care.
- Check for misalignment or binding of moving parts, breakage of parts, and any other condition that may affect the tool’s operation.
- Maintain correct balance and footing.
- Check air hose for wear before use and ensure that all connections are secure.
- Check for correct air pressure.
- Drain the compressor air tank daily. Water in the air line will damage the wrench.
- Always use appropriate retaining rings if required.

**DON’T:**

- Never use tool if ON / OFF switch does not work properly.
- Don’t use wrench if damaged or thought to be faulty.
- Never use worn, or damaged sockets.
- Don’t use without an approved socket retainer; do not use improvised retainers.
- Never carry wrench with your hand on the trigger to prevent unintentional starting.
- Don’t carry the wrench by the air hose, or yank the hose from the air supply.
- Never overreach. Keep proper footing and balance at all times.
- Don’t direct air from the air hose at yourself or others.
- Don’t use an Impact Wrench as a hammer or hit it with a hammer.

# Pneumatic and Hydraulic Tools
# AIR TORQUE WRENCH


This high speed tool puts out more torque then a regular pneumatic impact wrench. Several size drives are common in our workplace, including ¾", 1" and 1 ½" drives. It is important to review the air pressure chart supplied by the manufacturer to ensure you have selected the correct tool for the job.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Have you checked the hose for wear, and made sure that all connections are secure? |
| Is the work area clean and are hoses routed in a manner not to create tripping hazards? |
| Has the wrench been calibrated and well maintained prior to used? |
| Is the size and capacity of the tool adequate for the work being performed? |
| Is the trigger in the "OFF" position before connecting to the air supply? |
| Is the socket designed for the specific wrench? |
| Have you verified the charts for the wrench to ensure proper pressure settings? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Keep hoses away from heat, oil, sharp edges, and moving parts.
- Ensure wrench air valve (or trigger) is in the "off" position before connecting to the air supply.
- Disconnect tool from power source before making adjustments, changing accessories, or storing tool.
- Maintain tool with care.
- Check for misalignment or binding of moving parts, breakage of parts, and any other condition that may affect the tool's operation.
- Maintain correct balance and footing. Ensure the floor is not slippery and wear non-slip shoes.
- Check air hose for wear before use and ensure that all connections are secure.
- Drain the compressor air tank daily. Water in the air line will damage the wrench.
- Make sure oil lubricator has correct oil levels before using tool.
- Make sure reaction arm is sitting properly against flange.
- Make sure wrench has pressure charts to set air pressure to proper torque.
- Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tool from becoming accidentally disconnected.
- Check calibration date prior to use.

**DON'T:**

- Never use tool if ON/OFF switch does not work properly.
- Don't use wrench if damaged or thought to be faulty.
- Never use worn, or damaged sockets.
- Don't use without an approved socket retainer; do not use improvised retainers.
- Never carry wrench with your hand on the trigger to prevent unintentional starting.
- Don't carry the wrench by the air hose, or yank the hose from the air supply.
- Never overreach. Keep proper footing and balance at all times.
- Don't direct air from the air hose at yourself or others.
- Never use if hoses are leaking air.
- Never use if direct torque cannot be regulated.
- Don't operate if tool doesn't have a place to rest reaction arm.

## Pneumatic and Hydraulic Tools

# HYDRAULIC TORQUE WRENCH

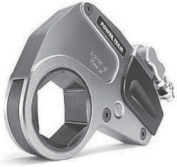
A hydraulic torque wrench uses hydraulics to exert torque on a fastener to achieve proper tightening or loosening of a connection. Hydraulic torque wrenches typically offer a high degree of accuracy and repeatability. A good and solid support is the first requirement for safe use.

| IS THIS NOTED IN YOUR JSA/PHA? |
| --- |
| Do you have all the proper tools for the job? |
| Have all users been trained in Torque Training? |
| Have you inspected all hydraulic hoses, quick connects, pump, impact sockets and accessories for damages prior to use? |
| Is the work area clean and are hoses routed in a manner not to create tripping hazards? |
| Is the proper size socket being used? |
| Is there enough clearance for the job to be performed? |
| Do you have all the PPE required for the job? |

CONTINUED ON PAGE 61

## Pneumatic and Hydraulic Tools

# HYDRAULIC TORQUE WRENCH



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**DO:**

- Wear appropriate PPE.
- Keep hoses away from heat, oil, sharp edges, and moving parts.
- Ensure trigger is in the "off" position before connecting to the pump.
- **Disconnect tool from power source before making adjustments, changing accessories, or storing tool.**
- Maintain tool with care.
- Check for misalignment or binding of moving parts, breakage of parts, and any other condition that may affect the tool's operation.
- Maintain correct balance and footing.
- Check hoses for wear before use and ensure that all connections are secure.
- Avoid sharp bends and kinks that will cause back-up pressure in hoses or lead to premature hose failure.
- Only use impact sockets designed for use with the specific wrench.
- Use proper mechanical support and correct reaction arm positioning to control forces.
- Keep hands away from the boot and reaction bar.
- Use the quick connect system to attach the hoses to the tool and pump.
- Use proper hand signals as your primary method of communication. If hand signals are not applicable, voice command should be "STROKE" to activate and "RETRACT" to deactivate.
- Inspect sight glass of pump to make sure oil levels are adequate.
- Use compressed air only — Never use combustible gases or steam as a power source.
- Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tool from becoming accidentally disconnected.

**DON'T:**

- Never use tool if ON / OFF switch does not work properly.
- Don't use wrench or sockets if damaged, worn, or thought to be faulty.
- Never carry the wrench by the hose, or yank the hose from the pump.
- Don't overreach. Keep proper footing and balance at all times.
- Never use damaged, frayed or deteriorated hoses and fittings.
- Don't place hands near reaction arm.
- Never position the reaction arm so that it tilts the tool off axis of the bolt.
- Never use the uni-swivel coupling as a reaction point.

## Pneumatic and Hydraulic Tools
# AIR CHISEL

An air chisel is a cutting and driving tool powered by compressed air that can be used to break or cut metal objects. It is also used for smoothing metal that has been roughed, shaped or formed.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Is the air supply clean and under 125 psi? |
| Is the trigger in the "OFF" position before connecting to the air supply? |
| Does the tool have an inline oiler? |
| Have you checked the hose for wear, and made sure that all connections are secure? |
| Is the work area clean and are hoses routed in a manner not to create tripping hazards? |
| Is the size and capacity of the tool adequate for the work being performed? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Keep hoses away from heat, oil, sharp edges, and moving parts.
- Ensure trigger is in the “off” position before connecting to the air supply.
- Disconnect tool from power source before making adjustments, changing accessories, or storing tool.
- Maintain tool with care.
- Check for misalignment or binding of moving parts, breakage of parts, and any other condition that may affect the tool’s operation.
- Maintain correct balance and footing.
- Check air hose for wear before use and ensure that all connections are secure.
- Check correct air pressure is maintained and not exceeded.
- Inspect air hose for wear before each use and ensure that all connections are secure.
- Keep the handle clean, dry, and free from oil and grease at all times.
- Be sure the trigger is not depressed when carrying the Air Chisel to avoid unintentional starting.
- Use compressed air only — Never use combustible gases or steam as a power source.
- Never use tool if ON / OFF switch does not work properly.
- Don’t use chisel if damaged or thought to be faulty.
- Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tool from becoming accidentally disconnected.

**DON’T:**

- Never carry chisel with your hand on the trigger to prevent unintentional starting.
- Don’t carry the chisel by the air hose, or yank the hose from the air supply.
- Never overreach. Keep proper footing and balance at all times.
- Don’t direct air from the air hose at yourself or others.
- Never use if hoses are leaking air.
- Don’t allow air chisel to free run as this will reduce bearing life.

## Pneumatic and Hydraulic Tools
# AIR MOVER

Air movers (or "blowers") are used to disperse hazardous fumes, move air into a confined space, cool individuals in high temperature conditions, and / or ventilate equipment and machinery.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Have you visually inspected the air mover for damaged, worn, or broken parts? |
| Have you checked the air hoses for wear, and made sure that all connections are secure? |
| Is the air supply clean and under 125 psi? |
| Is the work area clean and are hoses routed in a manner not to create tripping hazards? |
| Is the air blower properly mounted and secured? |
| Is the air flow in the proper direction? (out of the vessel) |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Keep hoses away from heat, oil, sharp edges, and moving parts.
- Keep the blower clean and properly serviced.
- Inspect the blower before use for damaged, worn, loose and / or broken parts.
- Check air hose for wear before use and ensure that all connections are secure.
- Check that the correct air pressure is maintained and not exceeded.
- Secure the device while in use.
- Use proper lifting techniques when moving or carrying blower.
- Use compressed air only — Never use combustible, inert gases or steam as a power source.
- Disconnect the blower from the air supply before attempting to service or move the blower.
- Disconnect blower from power source before making adjustments, changing accessories, or storing.

**DON'T:**

- Don't direct air from the air hose towards yourself or others.
- Never use if hoses are leaking air.
- Don't operate the blower without the inlet and outlet screens properly secured and in place.
- Don't stand directly in front of and / or face the blower outlet.
- Never hook Air Mover up to anything other than an air source.
- Don't use without proper grounding.

## Other Tools
# JACK STAND

Jack stands support material such as pipe. The standard unit has a steel V-head on a threaded shaft for fine adjustment. Special application heads include bar stick roller head, dual wheel roller head, or ball caster transfer head.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Are all of the components present and operating properly? |
| Is the jack stand set up on a flat, stable surface? |
| Is the jack stand rated for the load weight? |
| Is the jack stand head sufficient to safely hold the pipe's diameter? |
| Do you have a sufficient number of jack stands to support the load? |
| Is the height of the jack stand at the center of travel? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Inspect jack stand before use.
- Set up jack stand on flat, stable surface.
- Use plywood or planks to ensure a good working surface.
- Use T-Handle to raise and lower jack stand.
- Verify that the load washer and locking mechanism are in place and secure.
- Confirm the head is appropriate for the application.
- Verify the pipe load weight before setting on jack stand, and ensure there are enough stands to safely support the load.
- When using multiple stands, confirm that all are adjusted to the same height.
- Check your weight the 3 leg stands are rated for up to 2500#'s while the 4 leg can handle up to 6000#'s.

**DON'T:**

- Don't use a jack stand for any purpose other than for which it was designed.
- Never roll pipe on a jack stand unless jack stand has roller head.
- Don't stack multiple jack stands on top of each other.
- Never release a load with the locking washer; use the screw adjustment on the head.
- Don't overload your stands.
- Never modify a jackstand.
- Don't place pipe larger than 8" in diameter on the jack stand.
- Don't use a 4 leg jack stand for anything other than pipe.

## Other Tools
# CUTTING TORCH

The most common portable cutting torch uses a combination of oxygen and acetylene as fuel, and is used to cut metals such as steel. Propane cutting torches are used for cutting non-tempered metals such as aluminum, while plasma torches can cut the strongest metals, as they can reach temperatures up to five thousand degrees.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Are all users trained in the safe operation of the cutting torch? |
| Do you have all the proper tools for the job? |
| Do you have a fire extinguisher readily available? |
| Have you inspected the oxygen tank, the acetylene tank and the hoses for damage or wear? |
| Are the acetylene and oxygen bottles secure and stored in an upright position? |
| Have you secured the material to be cut to an adequate support at a comfortable working height? |
| Have you referred the torch tip chart and selected the proper tip for the material (page 138)? |
| Have you reviewed the torch tip chart for the proper gas pressures for the tip selected? |
| Are you wearing tinted torch goggles and/or a face shield? |
| Do you have the proper gloves? |
| Is your area clean and well lit? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Secure cylinders to a cart, wall, or post to prevent them from falling. All cylinders should be used and stored in an upright position.
- Ensure the torch is well maintained and serviced.
- Check for loose gas connections, hose leaks, damage, or any other condition that may impair the cutting torch operation.
- Use clamps or other safe ways to secure and support the work piece to a stable platform.
- Point the cutting tip away from yourself and others when lighting.
- Avoid exposure to fumes and gases, by keeping your head out of the fumes.
- Have a fire extinguisher of the proper size and type in the work area.

**DON'T:**

- Don't use a torch for any purpose other than for which it was designed.
- Never operate an acetylene cutting torch in explosive atmospheres, such as in the presence of flammable liquids, gases, or dust.
- Don't use the cutting torch if the tool or the hoses are worn, damaged or not properly functioning.
- Never touch the tip or weld until cool.
- Don't adjust acetylene pressure above 15 psi.
- Never use oil or grease on connections.
- Don't use a torch as a hammer.

## Other Tools
# BEVELING MACHINE

Beveling machines deliver accurate and swift pipe cutting and beveling, saving weld prep time compared to hand beveling. Made of hard-anodized aluminum, these machines are both lightweight and durable.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Are users trained in the safe operation of the beveling machine? |
| Do you have all the proper tools for the job? |
| Do you have the proper type and size fire extinguisher available in case of a fire? |
| Is the pipe to be cut secured to a table or pipe stand prior to starting? |
| Have you checked for loose gas connections, hose leaks, or any other condition that may affect the machine's operation? |
| Is your area clean and clear of all possible tripping hazards? |
| Do you have the proper hand protection to proceed with the job? |
| Do you have all the PPE required for the job? |

CONTINUED ON PAGE 67

## Other Tools
# BEVELING MACHINE
CONTINUED

**DO:**

- Wear appropriate PPE.
- Secure cylinders to a cart, wall, or post to prevent them from falling. All cylinders should be used and stored in an upright position.
- Ensure the torch is well maintained and serviced.
- Check for loose gas connections, hose leaks and damage, any other condition that may affect the beveling machine operation. If damaged, have it serviced before using.
- Use heat-resistant shields to protect nearby walls from sparks and hot material.
- Adequately ventilate area to prevent the concentration of dangerous fumes.
- Ensure pipe is firmly secured to a table, pipe stand, or other device prior to starting .
- Point the cutting tip away from yourself and others when lighting.
- Rotate Torch one full turn around the pipe to be sure torch tip will not contact the pipe.
- Avoid exposure to fumes and gases, by keeping your head out of the fumes.
- Keep hands and feet as far from the path of the beveling machine as possible.
- Inspect the general area for flame or smoldering materials when work has been completed.
- Have a fire extinguisher of the proper size and type in the work area.

**DON'T:**

- Don't use the machine for any purpose other than for which it was designed.
- Never operate a beveling machine in an explosive atmosphere, such as in the presence of flammable liquids, gases, or dust.
- Don't use the tool if it, or the hoses, are worn, damaged or not properly functioning.
- Never direct flame or debris associated with cutting process toward the oxygen or fuel gas cylinders.
- Don't lubricate the beveling machine or use oil or grease on connections.
- Never attempt to remove metal slag from cutting area while machine is in operation.

## Other Tools
# PORT-A-POWER

Port-a-Power tools provide hydraulic power in a portable format for situations where material needs in place modifications. They can be used to deliver hydraulic power in order to straighten, bend, lift, or modify metal material.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Is the hydraulic Port-a-Power set on a hard and level surface? |
| Have you inspected the Port-a-Power for damage before use? |
| Is the load centrally located to attachment or ram saddle, and secure? |
| Have you purged the air from the Port-a-Power by pumping the handle a few strokes before use? |
| Is the size and capacity of the tool adequate for the work being performed? |
| Is there enough clearance for the job to be performed? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Locate machine only on a hard, level surface capable of sustaining rated capacity loads.
- Keep ram clean at all times.
- Use only approved grade hydraulic oil.
- Use only approved accessories.
- Use shims, friction material or constraints to prevent slippage of the base or load.
- Ensure object is securely and safely located in ram saddle.
- Monitor pressure and load at all times.
- Avoid pinch points or crush points created by the load or parts of ram.
- Keep the piston(s) fully retracted when the ram is not is use.

**DON'T:**

- Don't use the machine for any purpose other than for which it was designed.
- Don't modify this device.
- Never use the tool, rams or hoses if they are worn, damaged or not properly functioning.
- Never attach an accessory not authorized by manufacturer.
- Don't exceed the rated capacity of the ram.
- Never use tool as a vehicle lifting device or vehicle support.
- Don't locate loads off-center on the ram.
- Never allow personnel to work on, under or around a load before it is properly supported by appropriate mechanical means.
- Don't allow the hose to kink, twist, curl, crush, cut or bend so that the fluid flow within the hose is blocked or reduced.
- Never place hands under suspended loads.
- Don't open oil filler screw unless ram is fully retracted.
- Never attempt to grasp a leaking pressurized hose with your hands.
- Don't disassemble a hydraulic cylinder.

## Other Tools

# COME-A-LONG AND CHAIN FALL

A Ratchet Lever Hoist or "Come- A-Long" is used for lifting or lowering a load by means of a drum or lift-wheel around which rope or chain wraps. A Chain fall is used for the same purpose, and consists of a lift chain, pinion, sheaves and hook.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Do you have all the proper tools for the job? |
| Is the Come-A-Long or hoist properly installed to a fixed point? |
| Is the fixed point rated for the load being lifted? |
| Have you inspected Come-A-Long or chain fall for any evidence of worn, corroded, cracked, or distorted parts such as suspension housing, chain attachments, yokes suspension bolts, shafts, gears, bearings, pins, rollers and locking and clamping devices? |
| Are the load slings or other approved single attachments properly sized, rigged, and seated in the hook saddle? |
| Have you checked that the fixed suspension point rests on the center of the hook's saddle and that the hook's latch is engaged? |
| Have you verified that the load chain is not twisted and tangled prior to operating the hoist. |
| Is the load clear of any obstruction? |
| Have you barricaded the area below the lift point and warned nearby personnel before lifting or moving a load? |
| Do you have all the PPE required for the job? |

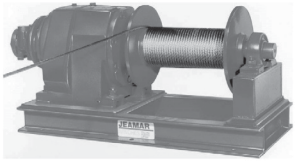
**DO:**

- Wear appropriate PPE.
- Inspect the come-a-long and area prior to use and return damaged or worn devices.
- Inspect chain falls regularly, paying particular attention to possible distortion and wear especially to the ratchet, pawl, chain and hook.
- If the secure latch and hook are not touching remove the come-a-long from service.
- Ensure adequate space to permit the operator and other persons to stand clear of the load and adjacent structures.
- Check the load before raising or pulling to see that it is held securely in the hook or sling.
- Be sure there are no twists in the load chain.
- Ensure everyone is clear of the chain when under a load.
- Keep constant communication during lift.
- Check for card inspection prior to use.

**DON'T:**

- Don't operate a hoist which has been modified or is damaged.
- Never operate hoist from an unsecured or off balance position.
- Don't lift more than rated load for the hoist or operate beyond the limits of the load chain travel.
- Never lengthen the load chain or repair a damaged load chain or hand chain.
- Don't use tool in a way that causes either hook to be side loaded, and never side load the hoist.
- Never apply the load to the tip of the hook or to the hook latch.
- Don't wrap the load chain around a load. Use a sling.
- Never use hoist if hook latch is missing or malfunctioning.
- Don't use a handle extender (cheater bar).
- Never swing the load or hook.
- Don't use the hoist to lift, support, or transport people.
- Never lift loads over people.
- Don't leave load supported by the hoist unattended unless specific precautions have been taken.
- Don't use hook for anything other than rigging.

## Other Tools
# AIR TUGGER




Air tuggers are used primarily for moving and lifting heavy objects. It essentially is a portable winch in a lighter weight compact configuration.

| IS THIS NOTED IN YOUR JSA/PHA? |
|---|
| Have you inspected the cable and air hoses? |
| Have you inspected the snatch block? |
| Have you made sure the in line oiler has oil and is at proper level? |
| Is the tugger located on a level, stable surface? |
| Do you have all the PPE required for the job? |

**DO:**

- Wear appropriate PPE.
- Position machine only on a hard, level surface capable of sustaining rated capacity loads.
- Securely attach the machine with anchor bolts or rigging
- Make sure the load is properly secured.
- Ensure everyone is clear of the cable when under a load.
- Keep constant communication between air tugger operator and rigging attendant.
- Always barricade the area and communicate with all affected employees in the area.

**DON'T:**

- Don't use the machine for any purpose other than for which it was designed. Don't modify this device.
- Never use the tool, or hoses, if they are worn, damaged or not properly functioning.
- Never attach an accessory not authorized by manufacturer.
- Don't exceed the rated capacity of the tugger.
- Never use tugger as a vehicle lifting device or vehicle support.
- Don't use for overhead lifting.
- Never hold the cable within 10 ft. of the drum.

UNIVERSAL PLANT SERVICES®
INDUSTRIAL SERVICES

# SECTION 4:
# QUALITY

# QA/QC Guidelines

One of the major causes of poor work quality in the shop and field is poor communication and planning between inspection and supervision/management. What you say, how you say it, and your attitude have a tremendous effect on you and the people you encounter.

An "Us versus Them" environment will not serve the interest of either departments or the company owners, and it has proven to be the downfall of many turnarounds and projects. We are all working towards the same goal.

All of UPS's procedures and quality systems depend entirely on good communication between all office and field personnel. If they know where they're going, it can take a lot of unnecessary running around out of the daily activities.

UPS's Supervision, Inspection, and Safety should be in Lock-Step with each other to develop and promote Team Work.

The following steps are what we've found to be the best method of planning, communicating and meeting the QA/QC requirements for most jobs. While all of these steps may not apply to every job, they are items that need to be considered for every job.

**Before Leaving For Job Site**

- Call the project Manager and request a date for you to be on site, and then relay that information to the Quality Manager.
- Establish what training is required to gain site access and complete training before departure as required.
- Discuss the project with your Quality Manager, Get contact phone numbers for the Project Manager, Lead Piping Inspector, and Field Accountant.
- Establish the need for Laptop/Air Card/ Printer/Cell Phone for yourself and if you will need identical items for a mechanical lead (if applicable)
- Ensure required programs (C-spec, Weld Log, Flange Log) and all required forms are loaded onto laptop(s)
- Ensure inspectors coming onto the field have ASNT Level II, Flange Assembly, Flange Torquing certifications are up to date.

CONTINUED

# QA/QC Guidelines

**Arriving at Job Site**

- If you are the lead inspector make contact with the Project Manager.
- If you are a Project inspector make contact with the Lead Piping Inspector and request to meet the Project Manager.
- Sit down and discuss the project variables and the role you will play.
- Ask questions, take notes, clarify any topics you may not completely understand.
- Ask for a copy of the job scope/ project plan and any additional information you may need to set-up your job packages.
- Obtain copy of plant pipe specifications and engineering requirements.
- Make sure you completely understand how the above individuals want the job set- up and your responsibilities.
- ASK, If you're not sure, then you don't know.
- Determine which WPS's / PQR's will be used on this project and obtain copies from SharePoint. Contact the Quality Manager for assistance if new WPS's and PQR's are needed. **Note:** Be sure to inform the client and project manager of any associated cost.
- Get plant approval on proposed WPS's and PQR's
- Ensure you have copies of each welder's WPQ, and that welder continuity is up to date. Maintain the tip of the filler rod within the gas shroud during welding to avoid contamination.

**Meet With Plant Inspection Group**

- Find out who will be our contacts in plant inspection group and who will be the third party contact if applicable.
- Determine Package turnover and document control procedures/ requirements.
- Identify Code work and determine if a UPS Code stamp will be required.
- Contact the AI, if required or find out who is the plant or subcontracted API 510.
- Find out if a subcontractor or combination will be used for API 510
- Find out who is performing NDE, (self- performed, subcontractor or combination)
- Find out who will contact NDE company
- Get a list of approved subcontractors if required.
- Ask for team effort in developing a plan to sell final packages, document and distribute to all concerned parties to ensure agreement.
- Ask for this plan to be distributed to all day and night shifts for review and document agreement.
- Document the above information and ensure project manager has a copy, and is completely aware of plant requirements AI, NDE, and selling final packages.

CONTINUED

# QA/QC Guidelines

**Contact Plant Designated Contact for CODE Work**

- Get approval for repair/scope plan and establish Hold Points, this includes contacting the AI for approval of repair/ scope plan prior to starting work.
- Establish NDE requirements per CODE package
- Discuss the project inspection Manpower needs with the Project Manager.
- Don't let them overload your group, request the manpower you need
- Make sure that you have copies of the certifications for inspectors (PT, VT, Vision exams)

**Requesting Inspectors to the Job Site**

After studying the scope of work with the Project Manager, determine the quantity of Piping and Mechanical inspectors you will need for the project.

NOTE: The solicitation of any inspectors to job sites by any site personnel or Project Manager is prohibited. You may make a request to the Area Quality Systems Managers that certain individuals be sent to your job site. But this is a request only. Quality Managers will dispatch all inspectors to job sites, no exceptions are allowed. This policy is strictly enforced.

Contact Quality Manager by phone and e-mail and request inspection manpower, be sure to include arrival dates, safety council training requirements, laptop/ air card /cell phone needs.

**Additional Duties and Activities**

- Divide inspection work and assign inspectors to foremen whenever possible. This keeps supervision and inspection working hand-in-hand or try to assign an inspector to an area.
- Lead inspector are to meet with supervision and document the meeting on the daily log.
- All inspectors are to meet with their assigned foremen at the beginning of each shift and stay in contact throughout the shift while developing a turnover report for their area.
- Turnover reports must be given to the lead inspector and updated (twice daily at a minimum) or as schedule requires. Individual inspector turnover reports are to be reviewed by the lead inspector each shift.
- Lead inspector must audit his own people daily.
- Build punch list from your inspectors turnover reports and distribute to operations.
- Communicate daily to operations QA/ QC priorities and document operations priorities to area inspectors.
- Stay in close contact with the Quality Manager; check in at least once every week.
- Let the Quality Manager know as soon as possible if additional inspectors are required on site.
- Maintaining contact will keep everyone informed of the project status and prevent inspection from falling behind.

# QA/QC

| NDT TECHNIQUE | MATERIALS APPLICABLE | DETECTION CAPABILITY | DEPTH SIZING | ORIENTATION EVALUATION | ACCESS PROBLEM | REMOTE DETECTION | AUTOMATED DETECTION |
|---|---|---|---|---|---|---|---|
| Liquid penetrant | All | Surface | No | No | Yes | No | No |
| Ultrasonic | All | Volumetric | Yes | Yes | Limited | Yes | Yes |
| Radio-graphy | All | Volumetric | Yes | Yes | Yes | No | Yes |
| Magnetic Particle | Magnetic | Surface, near-surface | No | No | Yes | No | No |
| Magnetic Flux-leakage | Magnetic | Surface, near-surface | Yes | Yes | No | Yes | Yes |
| Eddy current | Conducting | Surface, near-surface | Yes | Yes | Yes | Yes | Yes |
| Acoustic Emission | All | Volumetric | Yes | No | No | Yes | Yes |
| Thermo-graphy | All | Surface, near-surface | No | Yes | No | Yes | Yes |
| Visual | All | Surface | No | No | Limited | Yes | Yes |
| XRD | Conducting | Surface Stresses | Yes | No | Yes | No | No |
| Potential drop | Conducting | Surface | Yes | No | Yes | No | Yes |

# QA/QC
## Engineering and Construction Codes and Standards

ASME IX - American Society of Mechanical Engineers

ASME IX - B 31.3 PROCESS PIPING

ASME IX - B 31.1 POWER PIPING

Material (P numbers) will assist the Welding Engineer to complete the Welding Procedure Specification prior to the mechanical testing of the Procedure Qualification Report.

| P-Numbers | Material Composition |
|---|---|
| 1 | Carbon Steel |
| 3 | Carbon, 1/2 Mo |
| 4 | 1.25 Cr. |
| 5A | 2.25 Cr |
| 5B | 5 Cr. & 9Cr. |
| 6 | Martensitic Stainless Steel, (410) |
| 7 | Ferritic Stainless Steel (410SS) |
| 8 | Austenitic Stainless Steel |
| 10H | Duplex Stainless Steel |
| 11 | Low Alloy Steel, Quenched and Tempered to 95ksi+ |
| 15E | P91, 9Cr.-1Mo-V |
| 21 | 1.2% Mg or Mn alloy Aluminum |
| 22 | 1.2% Mn, 2.5% Mg, 0.25% Cu Aluminum |
| 23 | 1.3% Mg, 0.7% Si, 0.25% Cr Aluminum |
| 25 | 1.5% Mg, 0.8% Mn, 0.15 Cr Aluminum |
| 31 | Copper |
| 32 | Admirally, Naval, Aluminum Brass, Muntz Metals |
| 33 | Cu-Si Alloys |
| 34 | Cu-Ni Alloys |
| 41 | Nickel |
| 42 | Monel (400) |
| 43 | Inconel 600 series, Hastelloy 276 |
| 44 | Hastelloy |
| 45 | Inconel 800 Series |
| 51 | Titanium |
| 61 | Zirconium |

# QA/QC

**Approvals required prior to the commencement of welding operations.**

- Welding Procedure Specifications.
- Procedure Qualification Reports. Welder Certification Certificates. Welding Consumables.
- NDT Company.
- NDT Operators.
- NDT Procedures.
- Radiation Safety.
- Post Weld Heat Treatment Company. Post Weld Heat Treatment Procedure.
- Welding Inspection Personnel.
- Welding Repair Procedure.

| Welding Defects Defined | |
|---|---|
| DEFECT | CAUSE |
| Pipe off set mismatch | Pipe misalignment |
| Lack of root penetration | Welding technique |
| Insufficient root fill | Welding technique |
| Excessive penetration | Welding technique |
| External undercut | Excessive amps/volts |
| Internal undercut | Excessive amps/volts |
| Internal concavity | Welding technique |
| Root burn through | Welding technique |
| Lack of root penetration | Weld joint set up |
| Interpass slag inclusions | Weld technique, grinding, cleaning |
| Elongated slag inclusions | Weld technique, grinding, cleaning |
| Lack of side wall fusion | Weld technique, amps/volts to low |
| Interpass cold lap | Weld technique |
| Scattered porosity | Weld technique |
| Cluster porosity | Weld technique, insufficient wind cover |
| Root pass aligned porosity | Weld technique, insufficient wind cover |
| Transverse crack | Insufficient wind cover, lack of pre-heating & post weld heat treatment of weld joint. Material problem. |
| Longitudinal crack | Insufficient wind cover, lack of pre-heating & post weld heat treatment of weld joint. Material problem. |
| Longitudinal root crack | Insufficient wind cover, lack of pre-heating & post weld heat treatment of weld joint. Material problem. |
| Tungsten inclusions | Weld technique |

# QA/QC
## Welding Process Metrology

Welding Procedures to avoid hydrogen induced cracking.

To control cracking when completing the welding procedure the following factors must be considered.

| | |
|---|---|
| • Combined thickness of the material to be welded<br>• Carbon equivalent values | • Hydrogen scales<br>• Welding arc energy |

Codes and Standards That are most Commonly Used on Construction Projects

Codes and Standards That are most Commonly Used on Construction Projects

| ASME Boiler and Pressure Vessel Code | |
|---|---|
| **Clause** | **Section** |
| Clause Power boilers | I |
| Pressure vessels | VIII, DIVISION 1 |
| Pressure vessels | VIII, DIVISION 2 |
| Heating Boilers | IV |
| Nondestructive Ex | V |
| Welding & brazing qualifications | IX |

| American Pipeline Institute | | |
|---|---|---|
| API | 1104 | Welding Pipelines & related facilities |
| API | 650 | Welded Steel Tanks for Oil Storage |
| AWS | D1.1 | American Welding Society |
| ANSI | | American National Standards Institute |

| | |
|---|---|
| B31.1 Power Piping<br>B31.2 Industrial Gas & Air Piping<br>B31.3 Petroleum Refinery Piping<br>B31.4 Oil Transportation Piping | B31.5 Refrigeration Piping<br>B31.6 Chemical Industrial Piping<br>B31.7 Nuclear Power Piping<br>B31.8 Gas Transmission & Distribution Piping Systems |

# BEVEL DETAILS

Square

Closed Square

Single-bevel

Single J

Double-bevel

Double-J

Single-V

Single-U

Double-V

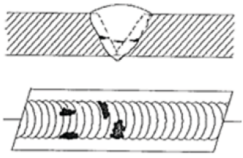
Double-U

Flange

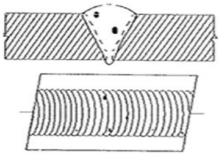
Tee

Flare

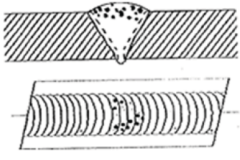
# WELDING DEFECTS



**Cold Lap** is a condition where the weld filler metal does not properly fuse with the base metal or the previous weld pass material (interpass cold lap). The arc does not melt the base metal sufficiently and causes the slightly molten puddle to flow into the base material without bonding.

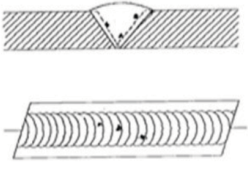


**Porosity** is the result of "gas entrapment" in the solidifying metal. Porosity can take many shapes on a radiograph but often appears as dark round or irregular spots or specks appearing singularly, in clusters, or in rows. Sometimes, porosity is elongated and may appear to have a tail. This is the result of gas attempting to escape while the metal is still in a liquid state and is called "wormhole porosity" All porosity is a void in the material and it will have a higher radiographic



density than the surrounding area.

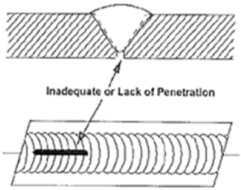
**Cluster Porosity** is caused when flux coated electrodes are contaminated with moisture. The moisture turns into gas when heated and be-comes trapped in the weld during the welding process. Cluster porosity appears just like regular



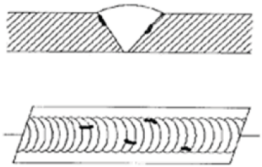
porosity in the radiograph but the indications will be grouped close together.

**Slag inclusions** are non metallic solid material entrapped in weld metal or between weld and base metal. In a radiograph, dark, jagged asymmetrical shapes within the weld or along the weld joints areas are indicative of slag inclusions.

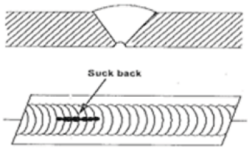
# WELDING DEFECTS




**Incomplete Penetration (IP)** or lack of penetration (LOP) occurs when the weld metal fails to penetrate the joint. It is one of the most objectionable weld discontinuities. Lack of penetration allows a natural stress riser from which a crack may propagate. The appearance on a radiograph is a dark area with well defined, straight edges that follows the land or root face down the center of the weldment.

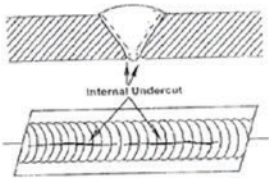


**Incomplete fusion** is a condition where the weld filler metal does not properly fuse with the base metal. Appearance on radiograph is usually appears as a dark line or lines oriented in the direction of the weld seam along the weld preparation or joining area.

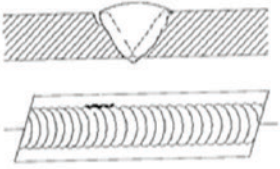



**Internal concavity or suck back** is a condition where the weld metal has contracted as it cools and has been drawn up into the root of the weld. On a radiograph it looks similar to a lack of penetration but the line has irregular edges and it is often quite wide in the center of the weld image.

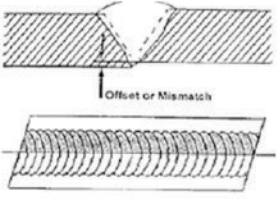
# WELDING DEFECTS




**Internal or Root Undercut** is an erosion of the base metal next to the root of the weld. In the radiographic image it appears as a dark irregular line offset from the centerline of ht weldment. Undercutting is not as straight edged as LOP because it does not follow a ground edge.

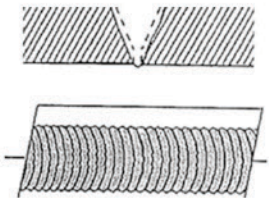


**External or Crown Undercut** is an erosion of the base metal next to the crown on the weld. In the radiograph, it appears as a dark irregular line along the outside edge of the weld area.

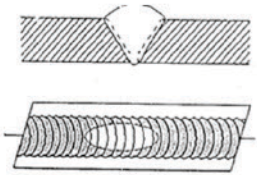



**Offset or Mismatch** are terms associated with a condition where two pieces being welded together are not properly aligned. The radiographic image shows a noticeable difference in density between the two pieces. The difference in density is caused by the difference in material thickness. The dark, straight line is caused by the failure of the weld metal to fuse with the land area.

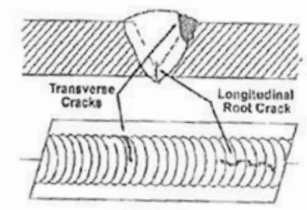
# WELDING DEFECTS



**Inadequate Weld Reinforcement** is an area of a weld where the thickness of weld metal deposited is less than the thickness of the base metal. It is very easy to determine by radiograph if the weld has inadequate reinforcement, because the image density in the area of suspected inadequacy will be higher (darker) than the image density of the surrounding base material.

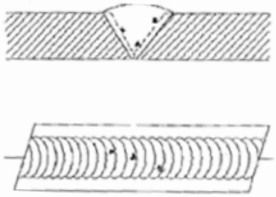


**Excess Weld Reinforcement** is an area of a weld that has a weld metal added in excess of that specified by engineering drawings and codes. The appearance on a radiograph is a localized, lighter area in the weld. A visual inspection will easily determine if the weld reinforcement is in excess of that specified by the engineering requirements.

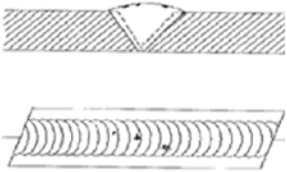



**Cracks** can be detected in a radiograph only when they are propagating in a direction that produces a change in thickness that is parallel to the x-ray beam. Cracks can appear as jagged and often very faint irregular lines. Cracks can sometimes appear as "tails" on inclusions or porosity.

# WELDING DEFECTS



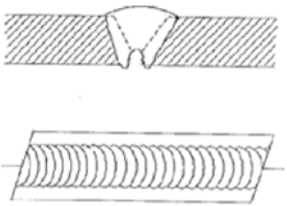
**Tungsten inclusion:** Tungsten is a brittle and inherently dense material used in the electrode in tungsten inert gas welding. If improper welding procedures are used, tungsten may be entrapped in the weld. Radiographically, tungsten is more dense than aluminum or steel, therefore it shows up as a lighter area with a distinct outline on the radiograph.



**Oxide Inclusions** are usually visible on the surface of material being welded (especially aluminum). Oxide inclusions are less dense than the surrounding material, and, therefore appear as dark irregularly shaped discontinuities in the radiograph.

**Discontinuities in TIG Welds**

Whiskers are short lengths of weld electrode wire, visible on the top or bottom surface of the weld or contained within the weld. On a radiograph they appear as light, "wire like" indications.



**Burn Through** results when too much heat causes excessive weld metal to penetrate the weld zone. Often lumps of metal sag through the weld, creating a thick globular condition on the back of the weld. These globs of metal are referred to as icicles. On the radiograph, burn through appears as dark sports, which are often surrounded by light globular areas (icicles).

# WELDER CLASSIFICATIONS AND WELDING PARAMETERS

## PIPE TESTS

**UPS-GT-1**
GTAW process using ER70S-2 filler metal, SA106 Gr. B Pipe 2.875" O.D. x .625" T (Magnum Coupon), 6G position.

**UPS-GT/SM-1**
GTAW & SMAW Process using ER70S-2, E7018 Filler Metal, SA106 Gr. B pipe 2.750" O.D. X .625" (Magnum Coupon) 6G position (.125" GTAW & .500 SMAW).

**UPS-GT-1/45**
GTAW process using ERNiCr-3 (Inco-82) filler metal, SA 106 Gr. B pipe 2.375 O.D. x .436" (XXH), 6G position.

## TOWER TESTS

**UPS-SM-1**
SMAW process using E7018, SA 106 Gr. B pipe 6.625" O.D. x .432" (S80)

6G position with backing ring.

**UPS-SM-8**
SMAW process using E309 filler metal, SA 106 Gr. B pipe 6.625" O.D. X .432" (S80),6G position with backing ring.

# WELD PROCEDURE (WPS) IDENTIFICATION

[UPS]-[SM]-[8]

**First section** ⇢ company name [UPS].

**Second section** ⇢ welding process,

GT = GTAW (Gas Tungsten Arc Welding) or tig

SM = SMAW or stick,

GM = GMAW (Gas Metal Arc Welding),

FC = FCAW (Flux Core Arc Welding)

SA= SAW (Sub Arc Welding

**Third section** ⇢ Type of base metal, 1 = carbon, 8 = stainless &, or filler metal.

## SECTION 5:

# CHARTS AND WEIGHT REFERENCES

# DECIMAL EQUIVALENCY CHART

**Decimal Equivalent Chart**

| 32nd | 16th | 8th | 4th | Decimal | Millimeters |
|---|---|---|---|---|---|
| 1/32" | | | | 0.03125 | 0.79375 |
| 2/32" | 1/16" | | | 0.0625 | 1.5875 |
| 3/32" | | | | 0.09375 | 2.38125 |
| 4/32" | 2/16" | 1/8" | | 0.125 | 3.175 |
| 5/32" | | | | 0.15625 | 3.96875 |
| 6/32" | 3/16" | | | 0.1875 | 4.7625 |
| 7/32" | | | | 0.21875 | 5.55625 |
| 8/32" | 4/16" | 2/8" | 1/4" | 0.25 | 6.35 |
| 9/32" | | | | 0.28125 | 7.14375 |
| 10/32" | 5/16" | | | 0.3125 | 7.9375 |
| 11/32" | | | | 0.34375 | 8.73125 |
| 12/32" | 6/16" | 3/8" | | 0.375 | 9.525 |
| 13/32" | | | | 0.40625 | 10.31875 |
| 14/32" | 7/16" | | | 0.4375 | 11.1125 |
| 15/32" | | | | 0.46875 | 11.90625 |
| 16/32" | 8/16" | 4/8" | 1/2" | 0.5 | 12.7 |
| 17/32" | | | | 0.53125 | 13.49375 |
| 18/32" | 9/16" | | | 0.5625 | 14.2875 |
| 19/32" | | | | 0.59375 | 15.08125 |
| 20/32" | 10/16" | 5/8" | | 0.625 | 15.875 |
| 21/32" | | | | 0.65625 | 16.66875 |
| 22/32" | 11/16" | | | 0.6875 | 17.4625 |
| 23/32" | | | | 0.71875 | 18.25625 |
| 24/32" | 12/16" | 6/8" | 3/4" | 0.75 | 19.05 |
| 25/32" | | | | 0.78125 | 19.84375 |
| 26/32" | 13/16" | | | 0.8125 | 20.6375 |
| 27/32" | | | | 0.84375 | 21.43125 |
| 28/32" | 14/16" | 7/8" | | 0.875 | 22.225 |
| 29/32" | | | | 0.90625 | 23.01875 |
| 30/32" | 15/16" | | | 0.9375 | 23.8125 |
| 31/32" | | | | 0.96875 | 24.60625 |
| 32/32" | | | | 1 | 25.4 |

To convert Millimeters to Inches divide by 25.4 Ex. 19mm / 25.4 = 0.748031 inches

To convert Inches to Millimeters multiply by 25.4 Ex. .75 Inches / 25.4 = 19.05mm

# DECIMAL EQUIVALENCY CHART

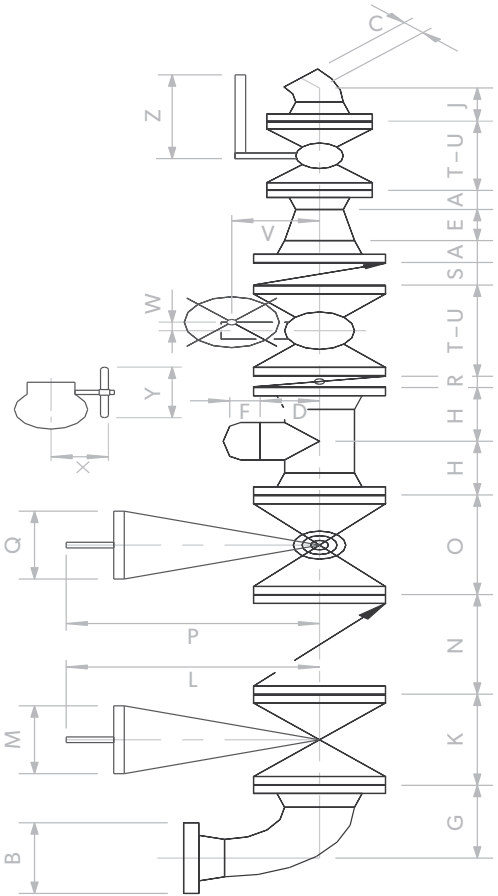
### Drill Sizes for Bolt Taps

| Size of Tap | Threads per Inch | Diameter of Drill |
|---|---|---|
| 1/4" | 20 | 7 |
| 5/16" | 18 | F |
| 3/8" | 16 | 5/16" |
| 7/16" | 14 | U |
| 1/2" | 13 | 27/64" |
| 5/8" | 11 | 17/32" |
| 3/4" | 10 | 21/32" |
| 7/8" | 9 | 49/64" |
| 1" | 8 | 7/8" |
| 1 1/8" | 7 | 63/64" |
| 1 1/4" | 7 | 1 7/64" |
| 1 3/8" | 6 | 1 13/64" |
| 1 1/2" | 6 | 1 11/32" |
| 1 3/4" | 5 | 1 11/16" |
| 2" | 4 1/2 | 1 25/32" |

### Drill Sizes for Pipe Taps and Thread Length

| Pipe Size | Threads per Inch | Diameter of Drill | Male Thread Length | Depth Screwed into Joint |
|---|---|---|---|---|
| 1/8" | 27 | 11/32" | 7/16" | 5/16" |
| 1/4" | 18 | 7/16" | 5/8" | 7/16" |
| 3/8" | 18 | 37/64" | 5/8" | 7/16" |
| 1/2" | 14 | 23/32" | 13/16" | 9/16" |
| 3/4" | 14 | 59/64" | 13/16" | 9/16" |
| 1" | 11 1/2 | 1 5/32" | 1" | 11/16" |
| 1 1/4" | 11 1/2 | 1 1/2" | 1" | 11/16" |
| 1 1/2" | 11 1/2 | 1 49/64" | 1 1/32" | 11/16" |
| 2" | 8 | 2 3/16" | 1 1/16" | 3/4" |
| 2 1/2" | 8 | 2 9/16" | 1 9/16" | 1 1/16" |
| 3" | 8 | 3 3/16" | 1 5/8" | 1 1/8" |
| 3 1/2" | 8 | 3 11/16" | 1 5/8" | 1 1/8" |
| 4" | 8 | 4 3/16" | 1 3/4" | 2 3/16" |

# VALVE AND FITTING DIMENSIONS



## 150 # RF Piping Dimensions

| SIZE | PIPE O.D. | WN FLG | OD FLG | 45 ELL | TEE | RE-DUCER | CAP | LR ELL & WN FLG | TEE & WN FLG | 45 ELL & WN FLG | GATE VALVE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | J | K | L | M |
| 1" | 1 5/16 | 2 3/16 | 4 1/4 | 7/8 | 1 1/2 | 2 | 1 1/2 | 3 11/16 | 3 11/16 | 3 1/16 | | | |
| 1 1/2" | 1 7/8 | 2 7/16 | 5 | 1 1/8 | 2 1/4 | 2 1/2 | 1 1/2 | 4 11/16 | 4 11/16 | 3 9/16 | | | |
| 2" | 2 3/8 | 2 1/2 | 6 | 1 3/8 | 2 1/2 | 3 | 1 1/2 | 5 1/2 | 5 | 3 7/8 | 7 | 15 3/4 | 8 |
| 2 1/2" | 2 7/8 | 2 3/4 | 7 | 1 3/4 | 3 | 3 1/2 | 1 1/2 | 6 1/2 | 5 3/4 | 4 1/2 | 7 1/2 | 16 1/2 | 8 |
| 3" | 3 1/2 | 2 3/4 | 7 1/2 | 2 | 3 3/8 | 3 1/2 | 2 | 7 1/4 | 6 1/8 | 4 3/4 | 8 | 20 3/4 | 9 |
| 4" | 4 1/2 | 3 | 9 | 2 1/2 | 4 1/8 | 4 | 2 1/2 | 9 | 7 1/8 | 5 1/2 | 9 | 25 3/4 | 10 |
| 6" | 6 5/8 | 3 1/2 | 11 | 3 3/4 | 5 5/8 | 5 1/2 | 3 1/2 | 12 1/2 | 9 1/8 | 7 1/4 | 10 1/2 | 35 1/4 | 14 |
| 8" | 8 5/8 | 4 | 13 1/2 | 5 | 7 | 6 | 4 | 16 | 11 | 9 | 11 1/2 | 44 | 16 |
| 10" | 10 3/4 | 4 | 16 | 6 1/4 | 8 1/2 | 7 | 5 | 19 | 12 1/2 | 10 1/4 | 13 | 52 1/2 | 18 |
| 12" | 12 3/4 | 4 1/2 | 19 | 7 1/2 | 10 | 8 | 6 | 22 1/2 | 14 1/2 | 12 | 14 | 60 1/2 | 18 |
| 14" | 14 | 5 | 21 | 8 3/4 | 11 | 13 | 6 1/2 | 26 | 16 | 13 3/4 | 15 | 70 1/4 | 22 |
| 16" | 16 | 5 | 23 1/2 | 10 | 12 | 14 | 7 | 29 | 17 | 15 | 16 | 79 3/4 | 24 |
| 18" | 18 | 5 1/2 | 25 | 11 1/4 | 13 1/2 | 15 | 8 | 32 1/2 | 19 | 16 3/4 | 17 | 89 | 27 |
| 20" | 20 | 5 11/16 | 27 1/2 | 12 1/2 | 15 | 20 | 9 | 35 11/16 | 20 11/16 | 18 3/16 | 18 | 97 1/4 | 30 |
| 24" | 24 | 6 | 32 | 15 | 17 | 20 | 10 1/2 | 42 | 23 | 21 | 20 | 112 3/4 | 30 |
| 26" | 26 | 4 3/4 | 34 1/4 | 16 | 19 1/2 | 24 | 10 1/2 | 43 3/4 | 24 1/4 | 20 3/4 | | | |
| 28" | 28 | 4 15/16 | 36 1/2 | 17 1/4 | 20 1/2 | 24 | 10 1/2 | 46 15/16 | 25 7/16 | 22 3/16 | | | |
| 30" | 30 | 5 3/8 | 38 3/4 | 18 1/2 | 22 | 24 | 10 1/2 | 50 3/8 | 27 3/8 | 23 7/8 | | | |
| 36" | 36 | 6 3/16 | 46 | 22 1/4 | 26 1/2 | 24 | 10 1/2 | 60 3/16 | 32 11/16 | 28 7/16 | | | |
| 42" | 42 | 6 3/4 | 53 | 26 | 30 | 24 | 12 | 69 3/4 | 36 3/4 | 32 3/4 | | | |

| CALC. BOX |
|---|
| |

(1) POSI-SEAL BUTTERFLY VALVES
(2) CRANE DUO-CHEK II
(3) TK BALL VALVES
(4) LENGTH DOES NOT INCLUDE CROWNS

# VALVE AND FITTING DIMENSIONS

## 150 # RF Piping Dimensions

| CHECK VALVE | GLOBE VALVE | | | BUTTERFLY VALVE (1) | WAFER CHECK VALVE (2) | BALL VALVE (3) | | | | | | | SIZE | NO. BOLTS | STUD BOLT SIZE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FULL PORT | RED. PORT | VALVE TO HW (FB) | HW OFF-SET (FB) | HW PROJ (FB) | HW OD (FB) | LEVER LEN-GTH (FB) | | | DIAME-TER | LENGTH (4) |
| N | O | P | Q | R | S | T | U | V | W | X | Y | Z | | | | |
| | | | | | | 5 | | | | | | 9 | 1" | 4 | 1/2 | 2 3/4 |
| | | | | | | 6 1/2 | | | | | | 15 | 1 1/2" | 4 | 1/2 | 3 |
| 8 | 8 | 13 3/4 | 8 | | 2 3/8 | 7 | 7 | 4 3/4 | | | | 23 | 2" | 4 | 5/8 | 3 1/4 |
| 8 1/2 | 8 1/2 | 14 1/2 | 8 | | 2 5/8 | | | | | | | | 2 1/2" | 4 | 5/8 | 3 1/2 |
| 9 1/2 | 9 1/2 | 16 1/2 | 9 | 1 7/8 | 2 7/8 | 8 | 8 | 7 1/16 | 3 1/8 | 10 1/16 | 17 1/8 | 33 | 3" | 4 | 5/8 | 3 3/4 |
| 11 1/2 | 11 1/2 | 19 3/4 | 10 | 2 1/8 | 2 7/8 | 9 | 9 | 8 | 3 1/8 | 10 1/16 | 17 1/8 | 44 | 4" | 8 | 5/8 | 3 3/4 |
| 14 | 16 | 24 1/2 | 12 | 2 1/4 | 3 7/8 | 15 1/2 | 10 1/2 | 10 13/16 | 5 | 11 1/2 | 24 | | 6" | 8 | 3/4 | 4 |
| 19 1/2 | 19 1/2 | 26 | 16 | 2 1/2 | 5 | 18 | 18 | 12 5/8 | 5 | 11 1/2 | 24 | | 8" | 8 | 3/4 | 4 1/4 |
| 24 1/2 | | | | 2 13/16 | 5 3/4 | 21 | 21 | 15 5/8 | 3 11/16 | 18 15/16 | 30 1/4 | | 10" | 12 | 7/8 | 4 3/4 |
| 27 1/2 | | | | 3 3/16 | 7 1/8 | 24 | 24 | 17 3/8 | 3 11/16 | 18 15/16 | 30 1/4 | | 12" | 12 | 7/8 | 4 3/4 |
| 35 | | | | 3 5/8 | 7 1/4 | 27 | 27 | 18 7/16 | 3 11/16 | 18 15/16 | 30 1/4 | | 14" | 12 | 1 | 5 1/4 |
| 39 | | | | 4 | 7 1/2 | 30 | 30 | 20 1/8 | 3 11/16 | 18 15/16 | 39 | | 16" | 16 | 1 | 5 1/2 |
| | | | | 4 1/2 | 8 | 34 | | 24 13/16 | 4 7/8 | 21 1/2 | 30 1/4 | | 18" | 16 | 1 1/8 | 6 |
| | | | | 5 | 8 5/8 | 36 | 36 | 25 3/8 | 4 7/8 | 21 1/2 | 39 | | 20" | 20 | 1 1/8 | 6 1/4 |
| | | | | 6 1/16 | 8 3/4 | 42 | 42 | 30 3/8 | 4 7/8 | 21 1/2 | 39 | | 24" | 20 | 1 1/4 | 7 |
| | | | | | 14 | 45 | | 34 1/4 | 5 3/4 | 31 3/8 | 30 1/4 | | 26" | 24 | 1 1/4 | 7 1/4 |
| | | | | | 12 | 49 | | 35 1/8 | 5 3/4 | 31 3/8 | 30 1/4 | | 28" | 28 | 1 1/4 | 7 1/4 |
| | | | | 6 1/4 | 12 | 51 | | 37 1/8 | 5 3/4 | 31 3/8 | 30 1/4 | | 30" | 28 | 1 1/4 | 7 1/2 |
| | | | | 7 | 14 1/2 | 60 | | 42 7/8 | 16 | 37 1/4 | 30 1/4 | | 36" | 32 | 1 1/2 | 8 1/2 |
| | | | | 9 | 17 | | | | | | | | 42" | 36 | 1 1/2 | 9 |

## 300 # RF Piping Dimensions

| SIZE | PIPE O.D. | WN FLG | OD FLG | 45 ELL | TEE | RE-DUCER | CAP | LR ELL & WN FLG | TEE & WN FLG | 45 ELL & WN FLG | GATE VALVE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | J | K | L | M |
| 1" | 1 5/16 | 2 7/16 | 4 7/8 | 7/8 | 1 1/2 | 2 | 1 1/2 | 3 15/16 | 3 15/16 | 3 5/16 | | | |
| 1 1/2" | 1 7/8 | 2 11/16 | 6 1/8 | 1 1/8 | 2 1/4 | 2 1/2 | 1 1/2 | 4 15/16 | 4 15/16 | 3 13/16 | 7 1/2 | 16 3/4 | 8 |
| 2" | 2 3/8 | 2 3/4 | 6 1/2 | 1 3/8 | 2 1/2 | 3 | 1 1/2 | 5 3/4 | 5 1/4 | 4 1/8 | 8 1/2 | 18 | 8 |
| 2 1/2" | 2 7/8 | 3 | 7 1/2 | 1 3/4 | 3 | 3 1/2 | 1 1/2 | 6 3/4 | 6 | 4 3/4 | 9 1/2 | 19 | 8 |
| 3" | 3 1/2 | 3 1/8 | 8 1/4 | 2 | 3 3/8 | 3 1/2 | 2 | 7 5/8 | 6 1/2 | 5 1/8 | 11 1/8 | 23 1/4 | 9 |
| 4" | 4 1/2 | 3 3/8 | 10 | 2 1/2 | 4 1/8 | 4 | 2 1/2 | 9 3/8 | 7 1/2 | 5 7/8 | 12 | 28 1/4 | 10 |
| 6" | 6 5/8 | 3 7/8 | 12 1/2 | 3 3/4 | 5 5/8 | 5 1/2 | 3 1/2 | 12 7/8 | 9 1/2 | 7 5/8 | 15 7/8 | 38 1/2 | 14 |
| 8" | 8 5/8 | 4 3/8 | 15 | 5 | 7 | 6 | 4 | 16 3/8 | 11 3/8 | 9 3/8 | 16 1/2 | 47 | 16 |
| 10" | 10 3/4 | 4 5/8 | 17 1/2 | 6 1/4 | 8 1/2 | 7 | 5 | 19 5/8 | 13 1/8 | 10 7/8 | 18 | 56 1/2 | 20 |
| 12" | 12 3/4 | 5 1/8 | 20 1/2 | 7 1/2 | 10 | 8 | 6 | 23 1/8 | 15 1/8 | 12 5/8 | 19 3/4 | 64 1/4 | 20 |
| 14" | 14 | 5 5/8 | 23 | 8 3/4 | 11 | 13 | 6 1/2 | 26 5/8 | 16 5/8 | 14 3/8 | 30 | 75 1/4 | 27 |
| 16" | 16 | 5 3/4 | 25 1/2 | 10 | 12 | 14 | 7 | 29 3/4 | 17 3/4 | 15 3/4 | 33 | 81 | 27 |
| 18" | 18 | 6 1/4 | 28 | 11 1/4 | 13 1/2 | 15 | 8 | 33 1/4 | 19 3/4 | 17 1/2 | 36 | 91 1/2 | 30 |
| 20" | 20 | 6 3/8 | 30 1/2 | 12 1/2 | 15 | 20 | 9 | 36 3/8 | 21 3/8 | 18 7/8 | 39 | 99 3/4 | 36 |
| 24" | 24 | 6 5/8 | 36 | 15 | 17 | 20 | 10 1/2 | 42 5/8 | 23 5/8 | 21 5/8 | 45 | 120 1/2 | 36 |
| 26" | 26 | 7 1/4 | 38 1/4 | 16 | 19 1/2 | 24 | 10 1/2 | 46 1/4 | 26 3/4 | 23 1/4 | | | |
| 28" | 28 | 7 3/4 | 40 3/4 | 17 1/4 | 20 1/2 | 24 | 10 1/2 | 49 3/4 | 28 1/4 | 25 | | | |
| 30" | 30 | 8 1/4 | 43 | 18 1/2 | 22 | 24 | 10 1/2 | 53 1/4 | 30 1/4 | 26 3/4 | | | |
| 36" | 36 | 9 1/2 | 50 | 22 1/4 | 26 1/2 | 24 | 10 1/2 | 63 1/2 | 36 | 31 3/4 | | | |
| 42" | 42 | 7 7/8 | 50 3/4 | 26 | 30 | 24 | 12 | 70 7/8 | 37 7/8 | 33 7/8 | | | |

| CALC. BOX |
|---|
| |

(1) POSI-SEAL BUTTERFLY VALVES
(2) CRANE DUO-CHEK II
(3) TK BALL VALVES
(4) LENGTH DOES NOT INCLUDE CROWNS

# VALVE AND FITTING DIMENSIONS

**300 # RF Piping Dimensions**

| CHECK VALVE | GLOBE VALVE | | | | BUTTERFLY VALVE (1) | WAFER CHECK VALVE (2) | BALL VALVE (3) | | | | | | | SIZE | NO. BOLTS | STUD BOLT SIZE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | FULL PORT | RED. PORT | VALVE TO HW (FB) | HWOFF-SET (FB) | HW PROJ (FB) | HW OD (FB) | LEVER LEN-GTH (FB) | | | DIA-METER | LENGTH (4) |
| N | O | P | Q | R | S | T | U | V | W | X | Y | Z | | | | |
| | | | | | | 6 1/2 | | | | | | | 1" | 4 | 5/8 | 3 1/4 |
| | | | | | | 7 1/2 | | | | | | | 1 1/2" | 4 | 3/4 | 3 3/4 |
| 10 1/2 | 10 1/2 | 17 3/4 | 9 | | 2 3/8 | 8 1/2 | 8 1/2 | 4 1/16 | | | | 23 | 2" | 8 | 5/8 | 3 1/2 |
| 11 1/2 | 11 1/2 | 19 | 10 | | 2 5/8 | | | | | | | | 2 1/2" | 8 | 3/4 | 4 |
| 12 1/2 | 12 1/2 | 20 1/2 | 10 | 1 7/8 | 2 7/8 | 11 1/8 | 11 1/8 | 7 1/16 | 3 1/8 | 10 1/16 | 17 1/8 | 33 | 3" | 8 | 3/4 | 4 1/4 |
| 14 | 14 | 24 3/4 | 14 | 2 1/8 | 2 7/8 | 12 | 12 | 8 | 3 1/8 | 10 | 17 1/8 | 44 | 4" | 8 | 3/4 | 4 1/2 |
| 17 1/2 | 17 1/2 | 29 3/4 | 18 | 2 5/16 | 3 7/8 | 15 7/8 | 15 7/8 | 10 13/16 | 5 | 11 1/2 | 24 | | 6" | 12 | 3/4 | 5 |
| 21 | 22 | 36 1/2 | 24 | 2 7/8 | 5 | 19 3/4 | 19 3/4 | 12 1/2 | 5 | 11 1/2 | 24 | | 8" | 12 | 7/8 | 5 1/2 |
| 24 1/2 | | | | 3 5/16 | 5 3/4 | 22 3/8 | 22 3/8 | 15 5/8 | 3 11/16 | 18 15/16 | 30 1/4 | | 10" | 16 | 1 | 6 1/4 |
| 28 | | | | 3 5/8 | 7 1/8 | 25 1/2 | 25 1/2 | 16 13/16 | 3 11/16 | 18 15/16 | 30 1/4 | | 12" | 16 | 1 1/8 | 6 3/4 |
| | | | | 4 5/8 | 8 3/4 | 30 | 30 | 18 7/16 | 3 11/16 | 18 15/16 | 30 1/4 | | 14" | 20 | 1 1/8 | 7 |
| | | | | 5 1/4 | 9 1/8 | 33 | 33 | 20 1/8 | 3 11/16 | 18 15/16 | 39 | | 16" | 20 | 1 1/4 | 7 1/2 |
| | | | | 5 7/8 | 10 3/8 | 36 | | 24 13/16 | 4 7/8 | 21 1/2 | 39 | | 18" | 24 | 1 1/4 | 7 3/4 |
| | | | | 6 1/4 | 11 1/2 | 39 | 39 | 16 1/2 | 4 7/8 | 21 1/2 | 39 | | 20" | 24 | 1 1/4 | 8 1/4 |
| | | | | 7 | 12 1/2 | 45 | 45 | 29 5/16 | 4 7/8 | 21 1/2 | 39 | | 24" | 24 | 1 1/2 | 9 1/4 |
| | | | | | 14 | 49 | | 34 1/4 | 5 3/4 | 31 3/8 | 30 1/4 | | 26" | 28 | 1 5/8 | 10 1/4 |
| | | | | | | 53 | | 35 1/8 | 5 3/4 | 31 3/8 | 30 1/4 | | 28" | 28 | 1 5/8 | 10 3/4 |
| | | | | 9 1/2 | 14 1/2 | 55 | | 37 1/8 | 5 3/4 | 31 3/8 | 30 1/4 | | 30" | 28 | 1 3/4 | 11 1/2 |
| | | | | 10 3/4 | 19 | 68 | | 40 7/8 | 16 | 37 1/4 | 30 1/4 | | 36" | 32 | 2 | 13 |
| | | | | | 22 3/8 | | | | | | | | 42" | 36 | 2 | 14 |

## 600 # RF Piping Dimensions

| SIZE | PIPE O.D. | WN FLG | OD FLG | 45 ELL | TEE | RE-DUCER | CAP | LR ELL & WN FLG | TEE & WN FLG | 45 ELL & WN FLG | GATE VALVE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | J | K | L | M |
| 1" | 1 5/16 | 2 11/16 | 4 7/8 | 7/8 | 1 1/2 | 2 | 1 1/2 | 4 3/16 | 4 3/16 | 3 9/16 | | | |
| 1 1/2" | 1 7/8 | 3 | 6 1/8 | 1 1/8 | 2 1/4 | 2 1/2 | 1 1/2 | 5 1/4 | 5 1/4 | 4 1/8 | | | |
| 2" | 2 3/8 | 3 1/8 | 6 1/2 | 1 3/8 | 2 1/2 | 3 | 1 1/2 | 6 1/8 | 5 5/8 | 4 1/2 | 11 1/2 | 18 1/4 | 8 |
| 2 1/2" | 2 7/8 | 3 3/8 | 7 1/2 | 1 3/4 | 3 | 3 1/2 | 1 1/2 | 7 1/8 | 6 3/8 | 5 1/8 | 13 | 22 1/4 | 9 |
| 3" | 3 1/2 | 3 1/2 | 8 1/4 | 2 | 3 3/8 | 3 1/2 | 2 | 8 | 6 7/8 | 5 1/2 | 14 | 25 3/4 | 10 |
| 4" | 4 1/2 | 4 1/4 | 10 3/4 | 2 1/2 | 4 1/8 | 4 | 2 1/2 | 10 1/4 | 8 3/8 | 6 3/4 | 17 | 31 1/2 | 14 |
| 6" | 6 5/8 | 4 7/8 | 14 | 3 3/4 | 5 5/8 | 5 1/2 | 3 1/2 | 13 7/8 | 10 1/2 | 8 5/8 | 22 | 42 3/4 | 20 |
| 8" | 8 5/8 | 5 1/2 | 16 1/2 | 5 | 7 | 6 | 4 | 17 1/2 | 12 1/2 | 10 1/2 | 26 | 52 1/4 | 24 |
| 10" | 10 3/4 | 6 1/4 | 20 | 6 1/4 | 8 1/2 | 7 | 5 | 21 1/4 | 14 3/4 | 12 1/2 | 31 | 62 1/4 | 27 |
| 12" | 12 3/4 | 6 3/8 | 22 | 7 1/2 | 10 | 8 | 6 | 24 3/8 | 16 3/8 | 13 7/8 | 33 | 70 | 27 |
| 14" | 14 | 6 3/4 | 23 3/4 | 8 3/4 | 11 | 13 | 6 1/2 | 27 3/4 | 17 3/4 | 15 1/2 | 35 | 77 1/4 | 30 |
| 16" | 16 | 7 1/4 | 27 | 10 | 12 | 14 | 7 | 31 1/4 | 19 1/4 | 17 1/4 | 39 | 83 3/4 | 30 |
| 18" | 18 | 7 1/2 | 29 1/4 | 11 1/4 | 13 1/2 | 15 | 8 | 34 1/2 | 21 | 18 3/4 | 43 | 93 3/4 | 36 |
| 20" | 20 | 7 3/4 | 32 | 12 1/2 | 15 | 20 | 9 | 37 3/4 | 22 3/4 | 20 1/4 | 47 | 104 1/2 | 36 |
| 24" | 24 | 8 1/4 | 37 | 15 | 17 | 20 | 10 1/2 | 44 1/4 | 25 1/4 | 23 1/4 | 55 | 126 | 42 |

| CALC. BOX |
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(1) POSI-SEAL BUTTERFLY VALVES
(2) CRANE DUO-CHEK II
(3) TK BALL VALVES
(4) LENGTH DOES NOT INCLUDE CROWNS

# VALVE AND FITTING DIMENSIONS

**600 # RF Piping Dimensions**

| CHECK VALVE | GLOBE VALVE | | | BUTTERFLY VALVE (1) | WAFER CHECK VALVE (2) | BALL VALVE (3) | | | | | | SIZE | NO. BOLTS | STUD BOLT SIZE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FULL PORT | RED. PORT | VALVE TO HW (FB) | HW OFF-SET (FB) | HW PROJ (FB) | HW OD (FB) | LEVER LENGTH (FB) | | | DIAMETER | LENGTH (4) |
| N | O | P | Q | R | S | T | U | V | W | X | Y | Z | | | | |
| | | | | | | 8 1/2 | | 3 1/8 | | | | 9 | 1" | 4 | 5/8 | 3 3/4 |
| 9 1/2 | | | | | | 9 1/2 | | 4 3/4 | | | | 15 | 1 1/2" | 4 | 3/4 | 4 1/4 |
| 11 1/2 | 11 1/2 | 19 | 10 | | 2 3/8 | 11 1/2 | 11 1/2 | 5 13/16 | | | | 23 | 2" | 8 | 5/8 | 4 1/4 |
| 13 | 13 | 21 1/4 | 12 | | 2 5/8 | | | | | | | | 2 1/2" | 8 | 3/4 | 4 3/4 |
| 14 | 14 | 23 1/2 | 12 | 1 13/16 | 2 7/8 | 14 | 14 | 7 1/16 | 3 1/8 | 10 1/16 | 17 1/8 | 33 | 3" | 8 | 3/4 | 5 |
| 17 | 17 | 27 1/2 | 18 | 2 3/8 | 3 1/8 | 17 | 17 | 8 | 3 1/8 | 10 5/8 | 17 1/8 | 44 | 4" | 8 | 7/8 | 5 3/4 |
| 22 | 22 | 35 | 24 | 2 7/8 | 5 3/8 | 22 | 22 | 10 13/16 | 5 | 11 1/2 | 24 | | 6" | 12 | 1 | 6 3/4 |
| 26 | | | | 3 1/2 | 6 1/2 | 26 | 26 | 14 | 3 11/16 | 18 15/16 | 30 1/4 | | 8" | 12 | 1 1/8 | 7 3/4 |
| 31 | | | | 4 1/2 | 8 3/8 | 31 | 31 | 15 1/2 | 3 11/16 | 18 15/16 | 30 1/4 | | 10" | 16 | 1 1/4 | 8 1/2 |
| 33 | | | | 5 1/2 | 9 | 33 | 33 | 17 7/16 | 3 11/16 | 18 15/16 | 30 1/4 | | 12" | 20 | 1 1/4 | 8 3/4 |
| | | | | 6 1/4 | 10 3/4 | 35 | 35 | 21 1/2 | 4 7/8 | 21 1/2 | 39 | | 14" | 20 | 1 3/8 | 9 1/4 |
| | | | | 7 | 12 | 39 | 39 | 20 1/16 | 4 7/8 | 21 1/2 | 39 | | 16" | 20 | 1 1/2 | 10 |
| | | | | 7 3/4 | 14 1/4 | 43 | 43 | 25 5/8 | 7 3/4 | 28 | 30 1/4 | | 18" | 20 | 1 5/8 | 10 3/4 |
| | | | | 9 | 14 1/2 | 47 | 47 | 27 3/8 | 7 3/4 | 28 | 30 1/4 | | 20" | 24 | 1 5/8 | 11 1/2 |
| | | | | 9 | 17 1/4 | 55 | 55 | 31 3/8 | 9 3/4 | 30 | 30 1/4 | | 24" | 24 | 1 7/8 | 13 |

## 900 # RF Piping Dimensions

| SIZE | PIPE O.D. | WN FLG | OD FLG | 45 ELL | TEE | RE-DUCER | CAP | LR ELL & WN FLG | TEE & WN FLG | 45 ELL & WN FLG | GATE VALVE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | J | K | L | M |
| 1" | 1 5/16 | 3 1/8 | 5 7/8 | 7/8 | 1 1/2 | 2 | 1 1/2 | 4 5/8 | 4 5/8 | 4 | | | |
| 1 1/2" | 1 7/8 | 3 1/2 | 7 | 1 1/8 | 2 1/4 | 2 1/2 | 1 1/2 | 5 3/4 | 5 3/4 | 4 5/8 | | | |
| 2" | 2 3/8 | 4 1/4 | 8 1/2 | 1 3/8 | 2 1/2 | 3 | 1 1/2 | 7 1/4 | 6 3/4 | 5 5/8 | | | |
| 2 1/2" | 2 7/8 | 4 3/8 | 9 5/8 | 1 3/4 | 3 | 3 1/2 | 1 1/2 | 8 1/8 | 7 3/8 | 6 1/8 | | | |
| 3" | 3 1/2 | 4 1/4 | 9 1/2 | 2 | 3 3/8 | 3 1/2 | 2 | 8 3/4 | 7 5/8 | 6 1/4 | 15 | 27 1/4 | 12 |
| 4" | 4 1/2 | 4 3/4 | 11 1/2 | 2 1/2 | 4 1/8 | 4 | 2 1/2 | 10 3/4 | 8 7/8 | 7 1/4 | 18 | 31 1/2 | 14 |
| 6" | 6 5/8 | 5 3/4 | 15 | 3 3/4 | 5 5/8 | 5 1/2 | 3 1/2 | 14 3/4 | 11 3/8 | 9 1/2 | 24 | 42 3/4 | 20 |
| 8" | 8 5/8 | 6 5/8 | 18 1/2 | 5 | 7 | 6 | 4 | 18 5/8 | 13 5/8 | 11 5/8 | 29 | 52 1/2 | 24 |
| 10" | 10 3/4 | 7 1/2 | 21 1/2 | 6 1/4 | 8 1/2 | 7 | 5 | 22 1/2 | 16 | 13 3/4 | 33 | 62 1/4 | 27 |
| 12" | 12 3/4 | 8 1/8 | 24 | 7 1/2 | 10 | 8 | 6 | 26 1/8 | 18 1/8 | 15 5/8 | 38 | 73 1/2 | 30 |
| 14" | 14 | 8 5/8 | 25 1/4 | 8 3/4 | 11 | 13 | 6 1/2 | 29 5/8 | 19 5/8 | 17 3/8 | 40 1/2 | 77 1/4 | 30 |
| 16" | 16 | 8 3/4 | 27 3/4 | 10 | 12 | 14 | 7 | 32 3/4 | 20 3/4 | 18 3/4 | 44 1/2 | 85 3/4 | 36 |
| 18" | 18 | 9 1/4 | 31 | 11 1/4 | 13 1/2 | 15 | 8 | 36 1/4 | 22 3/4 | 20 1/2 | | | |
| 20" | 20 | 10 | 33 3/4 | 12 1/2 | 15 | 20 | 9 | 40 | 25 | 22 1/2 | | | |
| 24" | 24 | 11 3/4 | 41 | 15 | 17 | 20 | 10 1/2 | 47 3/4 | 28 3/4 | 26 3/4 | | | |

| CALC. BOX |
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(1) POSI-SEAL BUTTERFLY VALVES
(2) CRANE DUO-CHEK II
(3) TK BALL VALVES
(4) LENGTH DOES NOT INCLUDE CROWNS

# VALVE AND FITTING DIMENSIONS

## 900 # RF Piping Dimensions

| CHECK VALVE | GLOBE VALVE | | | BUTTERFLY VALVE (1) | WAFER CHECK VALVE (2) | BALL VALVE (3) | | | | | | | SIZE | NO. BOLTS | STUD BOLT SIZE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FULL PORT | RED. PORT | VALVE TO HW (FB) | HW OFF-SET (FB) | HW PROJ (FB) | HW OD (FB) | LEVER LEN-GTH (FB) | | | DIA-METER | LENGTH (4) |
| N | O | P | Q | R | S | T | U | V | W | X | Y | Z | | | | |
| | | | | | | 10 | | | | | | 9 | 1″ | 4 | 7/8 | 5 |
| | | | | | | 12 | | | | | | 15 | 1 1/2″ | 4 | 1 | 5 1/2 |
| | | | | 2 3/4 | 2 3/4 | 14 1/2 | 14 1/2 | | | | | 33 | 2″ | 8 | 7/8 | 5 3/4 |
| | | | | 3 1/4 | 3 1/4 | | | | | | | | 2 1/2″ | 8 | 1 | 6 1/4 |
| 15 | 15 | 24 | 12 | 3 1/4 | 3 1/4 | 15 | 15 | 7 1/16 | 3 1/8 | 10 1/16 | 17 1/8 | 33 | 3″ | 8 | 7/8 | 5 3/4 |
| 18 | 18 | 29 1/2 | 20 | 4 | 4 | 18 | 18 | 9 9/16 | 5 | 11 1/2 | 24 | 44 | 4″ | 8 | 1 1/8 | 6 3/4 |
| 24 | 24 | 37 3/4 | 27 | 6 1/4 | 6 1/4 | 24 | 24 | 10 13/16 | 5 | 11 1/2 | 24 | | 6″ | 12 | 1 1/8 | 7 3/4 |
| 29 | | | | 8 1/8 | 8 1/8 | 29 | 29 | 16 | 3 11/16 | 18 15/16 | 30 1/4 | | 8″ | 12 | 1 3/8 | 8 3/4 |
| | | | | 9 1/2 | 9 1/2 | 33 | 33 | 15 5/8 | 3 11/16 | 18 15/16 | 30 1/4 | | 10″ | 16 | 1 3/8 | 9 1/4 |
| | | | | 11 1/2 | 11 1/2 | 38 | 38 | 18 3/8 | 3 11/16 | 18 15/16 | 30 1/4 | | 12″ | 20 | 1 3/8 | 10 |
| | | | | 14 | 14 | 40 1/2 | 40 1/2 | 21 1/2 | 4 7/8 | 21 1/2 | 39 | | 14″ | 20 | 1 1/2 | 10 3/4 |
| | | | | 15 1/8 | 15 1/8 | 44 1/2 | 44 1/2 | 20 1/16 | 4 7/8 | 21 1/2 | 39 | | 16″ | 20 | 1 5/8 | 11 1/4 |
| | | | | 17 3/4 | 17 3/4 | 48 | | 25 13/16 | 9 3/4 | 29 | 30 1/4 | | 18″ | 20 | 1 7/8 | 12 3/4 |
| | | | | 17 3/4 | 17 3/4 | 52 | 52 | 28 7/8 | 5 3/4 | 31 3/8 | 30 1/4 | | 20″ | 20 | 2 | 13 1/2 |
| | | | | 19 1/2 | 19 1/2 | 61 | 61 | 30 15/16 | 5 3/4 | 31 3/8 | 30 1/4 | | 24″ | 20 | 2 1/2 | 17 1/4 |

## 1500 # RF Piping Dimensions

| SIZE | PIPE O.D. | WN FLG | OD FLG | 45 ELL | TEE | RE-DUCER | CAP | LR ELL & WN FLG | TEE & WN FLG | 45 ELL & WN FLG | GATE VALVE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | J | K | L | M |
| 1" | 1 5/16 | 3 1/8 | 5 7/8 | 7/8 | 1 1/2 | 2 | 1 1/2 | 4 5/8 | 4 5/8 | 4 | 10 | 16 | 8 |
| 1 1/2" | 1 7/8 | 3 1/2 | 7 | 1 1/8 | 2 1/4 | 2 1/2 | 1 1/2 | 5 3/4 | 5 3/4 | 4 5/8 | 12 | 20 | 9 |
| 2" | 2 3/8 | 4 1/4 | 8 1/2 | 1 3/8 | 2 1/2 | 3 | 1 1/2 | 7 1/4 | 6 3/4 | 5 5/8 | 14 1/2 | 22 1/8 | 10 |
| 2 1/2" | 2 7/8 | 4 3/8 | 9 5/8 | 1 3/4 | 3 | 3 1/2 | 1 1/2 | 8 1/8 | 7 3/8 | 6 1/8 | 16 1/2 | 26 3/8 | 12 |
| 3" | 3 1/2 | 4 7/8 | 10 1/2 | 2 | 3 3/8 | 3 1/2 | 2 | 9 3/8 | 8 1/4 | 6 7/8 | 18 1/2 | 28 | 14 |
| 4" | 4 1/2 | 5 1/8 | 12 1/4 | 2 1/2 | 4 1/8 | 4 | 2 1/2 | 11 1/8 | 9 1/4 | 7 5/8 | 21 1/2 | 33 | 16 |
| 6" | 6 5/8 | 7 | 15 1/2 | 3 3/4 | 5 5/8 | 5 1/2 | 3 1/2 | 16 | 12 5/8 | 10 3/4 | 27 3/4 | 47 | 24 |
| 8" | 8 5/8 | 8 5/8 | 19 | 5 | 7 | 6 | 4 | 20 5/8 | 15 5/8 | 13 5/8 | 32 /34 | 55 | 27 |
| 10" | 10 3/4 | 10 1/4 | 23 | 6 1/4 | 8 1/2 | 7 | 5 | 25 1/4 | 18 3/4 | 16 1/2 | | | |
| 12" | 12 3/4 | 11 3/8 | 26 1/2 | 7 1/2 | 10 | 8 | 6 | 29 3/8 | 21 3/8 | 18 7/8 | | | |
| 14" | 14 | 12 | 29 1/2 | 8 3/4 | 11 | 13 | 6 1/2 | 33 | 23 | 20 3/4 | | | |
| 16" | 16 | 12 1/2 | 32 1/2 | 10 | 12 | 14 | 7 | 36 1/2 | 24 1/2 | 22 1/2 | | | |
| 18" | 18 | 13 1/8 | 36 | 11 1/4 | 13 1/2 | 15 | 8 | 40 1/8 | 26 5/8 | 24 3/8 | | | |
| 20" | 20 | 14 1/4 | 38 3/4 | 12 1/2 | 15 | 20 | 9 | 44 1/4 | 29 1/4 | 26 3/4 | | | |
| 24" | 24 | 16 1/4 | 46 | 15 | 17 | 20 | 10 1/2 | 52 1/4 | 33 1/4 | 31 1/4 | | | |
| | | | | CALC. BOX | | | | | | | | | |
| | | | | | | | | | | | | | |

(1)
(2) CRANE DUO-CHEK II
(3) TK BALL VALVES
(4) LENGTH DOES NOT INCLUDE CROWNS

# VALVE AND FITTING DIMENSIONS

**1500 # RF Piping Dimensions**

| CHECK VALVE | GLOBE VALVE | | | BUTTERFLY VALVE (1) | WAFER CHECK VALVE (2) | BALL VALVE (3) | | | | | | SIZE | NO. BOLTS | STUD BOLT SIZE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FULL PORT | RED. PORT | VALVE TO HW (FB) | HW OFF-SET (FB) | HW PROJ (FB) | HW OD (FB) | LEVER LEN-GTH (FB) | | | DIA-METER | LENGTH (4) |
| N | O | P | Q | R | S | T | U | V | W | X | Y | Z | | | | |
| | | | | | | 10 | | 3 1/8 | | | | 9 | 1" | 4 | 7/8 | 5 |
| | | | | | | 12 | | 5 13/32 | | | | 15 | 1 1/2" | 4 | 1 | 5 1/2 |
| 14 1/2 | 14 1/2 | 25 1/8 | 14 | | 2 3/4 | 14 1/2 | 14 1/2 | 6 1/2 | | | | 33 | 2" | 8 | 7/8 | 5 3/4 |
| 16 1/2 | 16 1/2 | 28 1/8 | 18 | | 3 1/4 | | | | | | | | 2 1/2" | 8 | 1 | 6 1/4 |
| 18 1/2 | 18 1/2 | 33 1/2 | 24 | | 3 1/4 | 18 1/2 | 18 1/2 | 7 3/8 | 3 1/8 | 10 1/4 | 17 1/8 | 33 | 3" | 8 | 1 1/8 | 7 |
| 21 1/2 | | | | | 4 | 21 1/2 | 21 1/2 | 9 9/16 | 5 | 11 1/2 | 24 | 44 | 4" | 8 | 1 1/4 | 7 3/4 |
| 27 3/4 | | | | | 6 1/4 | 27 3/4 | 27 3/4 | 12 9/16 | 5 | 18 15/16 | 30 1/4 | | 6" | 12 | 1 3/8 | 10 1/4 |
| 32 3/4 | | | | | 8 1/8 | 32 3/4 | 32 3/4 | 14 1/2 | 3 11/16 | 18 15/16 | 30 1/4 | | 8" | 12 | 1 5/8 | 11 1/2 |
| | | | | | 9 3/4 | 39 | 39 | 18 7/8 | 4 7/8 | 21 1/2 | 39 | | 10" | 12 | 1 7/8 | 13 1/4 |
| | | | | | 12 | 44 1/2 | 44 1/2 | 21 11/16 | 4 7/8 | 21 1/2 | 39 | | 12" | 16 | 2 | 14 3/4 |
| | | | | | 14 | 49 1/2 | 49 1/2 | 23 3/4 | 9 3/4 | 29 | 39 | | 14" | 16 | 2 1/4 | 16 |
| | | | | | 15 1/8 | 54 1/2 | 54 1/2 | 25 3/4 | 9 3/4 | 29 | 30 1/4 | | 16" | 16 | 2 1/2 | 17 1/2 |
| | | | | | 18 7/16 | 60 1/2 | | 30 1/2 | 5 3/4 | 31 3/8 | 30 1/4 | | 18" | 16 | 2 3/4 | 19 1/2 |
| | | | | | 21 | 65 1/2 | 65 1/2 | 31 1/4 | 5 3/4 | 31 3/8 | 30 1/4 | | 20" | 16 | 3 | 21 1/2 |
| | | | | | 22 | 76 1/2 | 76 1/2 | 37 7/8 | 16 | 37 1/4 | 30 1/4 | | 24" | 16 | 3 1/2 | 24 1/2 |

# VALVE AND FITTING DIMENSIONS

## 900 # RJT Piping Dimensions

| SIZE | PIPE O.D. | WN FLG | OD FLG | 45 ELL | TEE | RE-DUCER | CAP | LR ELL & WN FLG | TEE & WN FLG | 45 ELL & WN FLG | GATE VALVE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | J | K | L | M |
| 1" | 1 5/16 | 3 1/8 | 5 7/8 | 7/8 | 1 1/2 | 2 | 1 1/2 | 4 5/8 | 4 5/8 | 4 | | | |
| 1 1/2" | 1 7/8 | 3 1/2 | 7 | 1 1/8 | 2 1/4 | 2 1/2 | 1 1/2 | 5 3/4 | 5 3/4 | 4 5/8 | | | |
| 2" | 2 3/8 | 4 5/16 | 8 1/2 | 1 3/8 | 2 1/2 | 3 | 1 1/2 | 7 5/16 | 6 13/16 | 5 11/16 | | | |
| 2 1/2" | 2 7/8 | 4 7/16 | 9 5/8 | 1 3/4 | 3 | 3 1/2 | 1 1/2 | 8 3/16 | 7 7/16 | 6 3/16 | | | |
| 3" | 3 1/2 | 4 5/16 | 9 1/2 | 2 | 3 3/8 | 3 1/2 | 2 | 8 13/16 | 7 11/16 | 6 5/16 | 15 1/8 | 27 1/4 | 12 |
| 4" | 4 1/2 | 4 13/16 | 11 1/2 | 2 1/2 | 4 1/8 | 4 | 2 1/2 | 10 13/16 | 8 15/16 | 7 5/16 | 18 1/8 | 31 1/2 | 14 |
| 6" | 6 5/8 | 5 13/16 | 15 | 3 3/4 | 5 5/8 | 5 1/2 | 3 1/2 | 14 13/16 | 11 7/16 | 9 9/16 | 24 1/8 | 42 3/4 | 20 |
| 8" | 8 5/8 | 6 11/16 | 18 1/2 | 5 | 7 | 6 | 4 | 18 11/16 | 13 11/16 | 11 11/16 | 29 1/8 | 52 1/2 | 24 |
| 10" | 10 3/4 | 7 9/16 | 21 1/2 | 6 1/4 | 8 1/2 | 7 | 5 | 22 9/16 | 16 1/16 | 13 13/16 | 33 1/8 | 62 1/4 | 27 |
| 12" | 12 3/4 | 8 3/16 | 24 | 7 1/2 | 10 | 8 | 6 | 26 3/16 | 18 3/16 | 15 11/16 | 38 1/8 | 73 1/2 | 30 |
| 14" | 14 | 8 13/16 | 25 1/4 | 8 3/4 | 11 | 13 | 6 1/2 | 29 13/16 | 19 13/16 | 17 9/16 | 40 5/8 | 77 1/4 | 30 |
| 16" | 16 | 8 15/16 | 27 3/4 | 10 | 12 | 14 | 7 | 32 15/16 | 20 15/16 | 18 15/16 | 44 5/8 | 85 3/4 | 36 |
| 18" | 18 | | | 11 1/4 | 13 1/2 | 15 | 8 | 36 1/2 | 23 | 20 3/4 | | | |
| 20" | 20 | 10 1/4 | 33 3/4 | 12 1/2 | 15 | 20 | 9 | 40 1/4 | 25 1/4 | 22 3/4 | | | |
| 24" | 24 | 12 1/8 | 41 | 15 | 17 | 20 | 10 1/2 | 48 1/8 | 29 1/8 | 27 1/8 | | | |

CALC. BOX

(1)
(2)
(3) TK BALL VALVES
(4) LENGTH DOES NOT INCLUDE CROWNS

# VALVE AND FITTING DIMENSIONS

## 900 # RJT Piping Dimensions

| CHECK VALVE | GLOBE VALVE | | | BALL VALVE (3) | | | | | | | SIZE | NO. BOLTS | STUD BOLT SIZE | | RING INFO. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | FULL PORT | RED. PORT | VALVE TO HW (FB) | HW OFF-SET (FB) | HW PROJ (FB) | HW OD (FB) | LEVER LEN-GTH (FB) | | | DIA-METER | LENGTH (4) | RING NO. | GAP |
| N | O | P | Q | T | U | V | W | X | Y | Z | | | | | | |
| | | | | 10 | | | | | | 9 | 1" | 4 | 7/8 | 5 | R-16 | 5/32 |
| | | | | 12 | | | | | | 15 | 1 1/2" | 4 | 1 | 5 1/2 | R-20 | 5/32 |
| 14 5/8 | 14 1/2 | 23 | 13 3/4 | 14 5/8 | 14 5/8 | | | | | 33 | 2" | 8 | 7/8 | 5 3/4 | R-24 | 1/8 |
| 16 5/8 | 16 1/2 | 24 1/2 | 15 1/2 | | | | | | | | 2 1/2" | 8 | 1 | 6 1/4 | R-27 | 1/8 |
| 15 1/8 | 15 1/8 | 24 | 12 | 15 1/8 | 15 1/8 | 7 1/16 | 3 1/8 | 10 1/16 | 17 1/8 | 33 | 3" | 8 | 7/8 | 6 | R-31 | 5/32 |
| 18 1/8 | 18 1/8 | 29 1/2 | 20 | 18 1/8 | 18 1/8 | 9 9/16 | 5 | 11 1/2 | 24 | 44 | 4" | 8 | 1 1/8 | 7 | R-37 | 5/32 |
| 24 1/8 | 24 1/8 | 37 3/4 | 27 | 24 1/8 | 24 1/8 | 10 13/16 | 5 | 11 1/2 | 24 | | 6" | 12 | 1 1/8 | 7 3/4 | R-45 | 5/32 |
| 29 1/8 | | | | 29 1/8 | 29 1/8 | 16 | 3 11/16 | 18 15/16 | 30 1/4 | | 8" | 12 | 1 3/8 | 9 | R-49 | 5/32 |
| | | | | 33 1/8 | 33 1/8 | 15 5/8 | 3 11/16 | 18 15/16 | 30 1/4 | | 10" | 16 | 1 3/8 | 9 1/2 | R-53 | 5/32 |
| | | | | 38 1/8 | 38 1/8 | 18 3/8 | 3 11/16 | 18 15/16 | 30 1/4 | | 12" | 20 | 1 3/8 | 10 1/4 | R-57 | 5/32 |
| | | | | 40 7/8 | 40 7/8 | 21 1/2 | 4 7/8 | 21 1/2 | 39 | | 14" | 20 | 1 1/2 | 11 1/4 | R-62 | 5/32 |
| | | | | 44 1/2 | 44 1/2 | 20 1/16 | 4 7/8 | 21 1/2 | 39 | | 16" | 20 | 1 5/8 | 11 3/4 | R-66 | 5/32 |
| | | | | 48 1/2 | | 25 13/16 | 9 3/4 | 29 | 30 1/4 | | 18" | 20 | 1 7/8 | 13 1/2 | R-70 | 3/16 |
| | | | | 52 1/2 | 52 1/2 | 28 7/8 | 5 3/4 | 31 3/8 | 30 1/4 | | 20" | 20 | 2 | 14 1/4 | R-74 | 3/16 |
| | | | | 61 3/4 | 61 3/4 | 30 15/16 | 5 3/4 | 31 3/8 | 30 1/4 | | 24" | 20 | 2 1/2 | 17 3/4 | R-78 | 7/32 |

## 1500 # RJT Piping Dimensions

| SIZE | PIPE O.D. | WN FLG | OD FLG | 45 ELL | TEE | RE-DUCER | CAP | LR ELL & WN FLG | TEE & WN FLG | 45 ELL & WN FLG | GATE VALVE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | J | K | L | M |
| 1" | 1 5/16 | 3 1/8 | 5 7/8 | 7/8 | 1 1/2 | 2 | 1 1/2 | 4 5/8 | 4 5/8 | 4 | 10 1/8 | 16 | 8 |
| 1 1/2" | 1 7/8 | 3 1/2 | 7 | 1 1/8 | 2 1/4 | 2 1/2 | 1 1/2 | 5 3/4 | 5 3/4 | 4 5/8 | 12 1/8 | 20 | 9 |
| 2" | 2 3/8 | 4 5/16 | 8 1/2 | 1 3/8 | 2 1/2 | 3 | 1 1/2 | 7 5/16 | 6 13/16 | 5 11/16 | 14 5/8 | 22 1/8 | 10 |
| 2 1/2" | 2 7/8 | 4 7/16 | 9 5/8 | 1 3/4 | 3 | 3 1/2 | 1 1/2 | 8 3/16 | 7 7/16 | 6 3/16 | 16 5/8 | 26 3/8 | 12 |
| 3" | 3 1/2 | 4 15/16 | 10 1/2 | 2 | 3 3/8 | 3 1/2 | 2 | 9 7/16 | 8 5/16 | 6 15/16 | 18 5/8 | 28 | 14 |
| 4" | 4 1/2 | 5 3/16 | 12 1/4 | 2 1/2 | 4 1/8 | 4 | 2 1/2 | 11 3/16 | 9 5/16 | 7 11/16 | 21 5/8 | 33 | 16 |
| 6" | 6 5/8 | 7 1/8 | 15 1/2 | 3 3/4 | 5 5/8 | 5 1/2 | 3 1/2 | 16 1/8 | 12 3/4 | 10 7/8 | 27 7/8 | 47 | 24 |
| 8" | 8 5/8 | 8 13/16 | 19 | 5 | 7 | 6 | 4 | 20 13/16 | 15 13/16 | 13 13/16 | 32 7/8 | 55 | 27 |
| 10" | 10 3/4 | 10 7/16 | 23 | 6 1/4 | 8 1/2 | 7 | 5 | 25 7/16 | 18 15/16 | 16 11/16 | | | |
| 12" | 12 3/4 | 11 11/16 | 26 1/2 | 7 1/2 | 10 | 8 | 6 | 29 11/16 | 21 11/16 | 19 3/16 | | | |
| 14" | 14 | 12 3/8 | 29 1/2 | 8 3/4 | 11 | 13 | 6 1/2 | 33 3/8 | 23 3/8 | 21 1/8 | | | |
| 16" | 16 | 12 15/16 | 32 1/2 | 10 | 12 | 14 | 7 | 36 15/16 | 24 15/16 | 22 15/16 | | | |
| 18" | 18 | 13 9/16 | 36 | 11 1/4 | 13 1/2 | 15 | 18 | 40 9/16 | 27 1/16 | 24 13/16 | | | |
| 20" | 20 | 14 11/16 | 38 3/4 | 12 1/2 | 15 | 20 | 9 | 44 11/16 | 29 11/16 | 27 3/16 | | | |
| 24" | 24 | 16 13/16 | 46 | 15 | 17 | 20 | 10 1/2 | 52 13/16 | 33 13/16 | 31 13/16 | | | |

| CALC. BOX |
|---|
| |

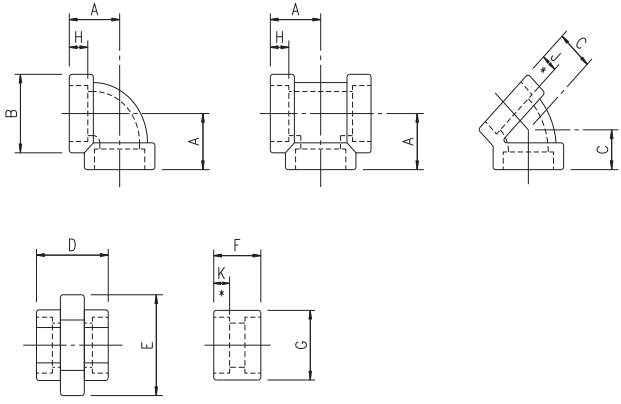
(1)
(2) CRANE DUO-CHEK II
(3) TK BALL VALVES
(4) LENGTH DOES NOT INCLUDE CROWNS

# VALVE AND FITTING DIMENSIONS

**1500 # RJT Piping Dimensions**

| CHECK VALVE | GLOBE VALVE | | | BALL VALVE (3) | | | | | | SIZE | NO. BOLTS | STUD BOLT SIZE | | RING INFO. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | FULL PORT | RED. PORT | VALVE TO HW (FB) | HW OFF-SET (FB) | HW PROJ (FB) | HW OD (FB) | LEVER LEN-GTH (FB) | | DIA-METER | LENGTH (4) | RING NO. | GAP |
| N | O | P | Q | T | U | V | W | X | Y | Z | | | | | |
| | | | | 10 | | 3 1/8 | | | | 9 | 1″ | 4 | 7/8 | 5 | R-16 | 5/32 |
| 12 | | | | 12 | | 5 13/32 | | | | 15 | 1 1/2″ | 4 | 1 | 5 1/2 | R-20 | 5/32 |
| 14 5/8 | 14 1/2 | 25 1/8 | 14 | 14 5/8 | 14 5/8 | 6 1/2 | | | | 33 | 2″ | 8 | 7/8 | 5 3/4 | R-24 | 1/8 |
| 16 5/8 | 16 1/2 | 28 1/8 | 18 | | | | | | | | 2 1/2″ | 8 | 1 | 6 1/4 | R-27 | 1/8 |
| 18 5/8 | 18 1/2 | 33 1/2 | 24 | 18 5/8 | 18 5/8 | 7 3/8 | 3 1/8 | 10 1/4 | 17 1/8 | 33 | 3″ | 8 | 1 1/8 | 7 | R-35 | 1/8 |
| 21 5/8 | | | | | 21 5/8 | 9 9/16 | 5 | 11 1/2 | 24 | 44 | 4″ | 8 | 1 1/4 | 7 3/4 | R-39 | 1/8 |
| 28 | | | | 28 | 28 | 12 9/16 | 5 | 18 15/16 | 30 1/4 | | 6″ | 12 | 1 3/8 | 10 1/2 | R-46 | 1/8 |
| 32 7/8 | | | | 33 1/8 | 33 1/8 | 14 1/2 | 3 11/16 | 18 15/16 | 30 1/4 | | 8″ | 12 | 1 5/8 | 12 | R-50 | 5/32 |
| | | | | 39 3/8 | 39 3/8 | 18 7/8 | 4 7/8 | 21 1/2 | 39 | | 10″ | 12 | 1 7/8 | 13 3/4 | R-54 | 5/32 |
| | | | | 45 1/8 | 45 1/8 | 21 11/16 | 4 7/8 | 21 1/2 | 39 | | 12″ | 16 | 2 | 15 1/2 | R-58 | 3/16 |
| | | | | 50 1/4 | 50 1/4 | 23 3/4 | 9 3/4 | 29 | 39 | | 14″ | 16 | 2 1/4 | 17 | R-63 | 7/32 |
| | | | | 55 3/8 | 55 3/8 | 25 3/4 | 9 3/4 | 29 | 30 1/4 | | 16″ | 16 | 2 1/2 | 18 1/2 | R-67 | 5/16 |
| | | | | 61 3/8 | | 30 1/2 | 5 3/4 | 31 3/8 | 30 1/4 | | 18″ | 16 | 2 3/4 | 20 1/2 | R-71 | 5/16 |
| | | | | 66 3/8 | 66 3/8 | 31 1/4 | 5 3/4 | 31 3/8 | 30 1/4 | | 20″ | 16 | 3 | 22 1/2 | R-75 | 3/8 |
| | | | | 77 5/8 | 77 5/8 | 37 7/8 | 16 | 37 1/4 | 30 1/4 | | 24″ | 16 | 3 1/2 | 25 3/4 | R-79 | 7/16 |

# SCREWED FITTINGS




| 3000# | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SIZE | A | B | C | D | E | F | G | H* | J* | K* |
| 1/2 | 1 5/16 | 1 1/2 | 1 | 2 1/8 | 2 3/16 | 1 7/8 | 1 1/8 | 1/2 | 1/2 | 1/2 |
| 3/4 | 1 1/2 | 1 13/16 | 1 1/8 | 2 5/16 | 2 9/16 | 2 | 1 3/8 | 9/16 | 9/16 | 9/16 |
| 1 | 1 3/4 | 2 3/16 | 1 5/16 | 2 1/2 | 2 15/16 | 2 3/8 | 1 3/4 | 11/16 | 11/16 | 11/16 |
| 1 1/2 | 2 3/8 | 3 | 1 11/16 | 3 1/8 | 3 11/16 | 3 1/8 | 2 1/2 | 11/16 | 11/16 | 11/16 |
| 2 | 2 1/2 | 3 5/16 | 1 3/4 | 3 1/2 | 4 9/16 | 3 3/8 | 3 | 3/4 | 3/4 | 3/4 |
| 2 1/2 | 3 1/4 | 4 | 2 1/16 | 4 5/8 | 5 1/4 | 3 5/8 | 3 5/8 | 15/16 | 15/16 | 15/16 |

| 6000# | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SIZE | A | B | C | D | E | F | G | H* | J* | K* |
| 1/2 | 1 1/2 | 1 13/16 | 1 1/8 | 2 7/8 | 2 13/16 | 1 7/8 | 1 1/2 | 1/2 | 1/2 | 1/2 |
| 3/4 | 1 3/4 | 2 3/16 | 1 5/16 | 3 3/8 | 3 1/8 | 2 | 1 3/4 | 9/16 | 9/16 | 9/16 |
| 1 | 2 | 2 7/16 | 1 3/8 | 3 5/8 | 3 13/16 | 2 3/8 | 2 1/4 | 11/16 | 11/16 | 11/16 |
| 1 1/2 | 2 1/2 | 3 5/16 | 1 3/4 | 4 3/16 | 4 3/4 | 3 1/8 | 3 | 11/16 | 11/16 | 11/16 |
| 2 | 3 1/4 | 4 | 2 1/16 | 4 5/8 | 5 1/4 | 3 3/8 | 3 5/8 | 3/4 | 3/4 | 3/4 |
| 2 1/2 | 3 3/4 | 4 3/4 | 2 1/2 | — | — | 3 5/8 | 4 1/4 | 15/16 | 15/16 | 15/16 |

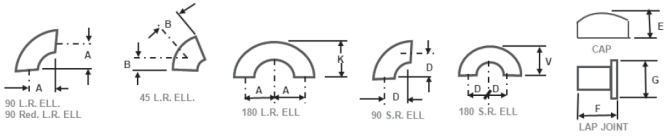
# ELL'S




**English Units**

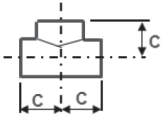
| NOM. PIPE SIZE | WALL THICKNESS **INCHES** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PIPE O.D. | LIGHT WALL | SCH. 20 | SCH. 30 | SCH. STD. | SCH. 40 | SCH. 60 | SCH. XSTG. | SCH. 80 | SCH. 100 | SCH. 120 | SCH. 140 | SCH. 160 | SCH. 180 |
| 1/2 | 0.840 | 0.083 | | | 0.109 | 0.109 | | 0.147 | 0.147 | | | | 0.188 | 0.294 |
| 3/4 | 1.050 | 0.083 | | | 0.113 | 0.113 | | 0.154 | 0.154 | | | | 0.219 | 0.308 |
| 1 | 1.315 | 0.109 | | | 0.133 | 0.133 | | 0.179 | 0.179 | | | | 0.250 | 0.358 |
| 1 1/4 | 1.660 | 0.109 | | | 0.140 | 0.140 | | 0.191 | 0.191 | | | | 0.250 | 0.382 |
| 1 1/2 | 1.900 | 0.109 | | | 0.145 | 0.145 | | 0.200 | 0.200 | | | | 0.281 | 0.400 |
| 2 | 2.375 | 0.109 | | | 0.154 | 0.154 | | 0.218 | 0.218 | | | | 0.344 | 0.436 |
| 2 1/2 | 2.875 | 0.120 | | | 0.203 | 0.203 | | 0.276 | 0.276 | | | | 0.375 | 0.552 |
| 3 | 3.500 | | | | 0.216 | 0.216 | | 0.300 | 0.300 | | | | 0.438 | 0.600 |
| 3 1/2 | 4.000 | | | | 0.226 | 0.226 | | 0.318 | 0.318 | | | | | 0.636 |
| 4 | 4.500 | | | | 0.237 | 0.237 | | 0.337 | 0.337 | | 0.438 | | 0.531 | 0.674 |
| 5 | 5.563 | | | | 0.258 | 0.258 | | 0.375 | 0.375 | | 0.500 | | 0.625 | 0.750 |
| 6 | 6.625 | | | | 0.280 | 0.280 | | 0.432 | 0.432 | | 0.562 | | 0.719 | 0.864 |
| 8 | 8.625 | | 0.250 | 0.277 | 0.322 | 0.322 | 0.406 | 0.500 | 0.500 | 0.594 | 0.719 | 0.812 | 0.906 | 0.875 |
| 10 | 10.750 | | 0.250 | 0.307 | 0.365 | 0.365 | 0.500 | 0.500 | 0.594 | 0.719 | 0.844 | 1.000 | 1.125 | 1.000 |
| 12 | 12.750 | | 0.250 | 0.330 | 0.375 | 0.406 | 0.562 | 0.500 | 0.688 | 0.844 | 1.000 | 1.125 | 1.312 | 1.000 |
| 14 | 14.000 | | 0.312 | 0.375 | 0.375 | 0.438 | 0.594 | 0.500 | 0.750 | 0.938 | 1.094 | 1.250 | 1.406 | |
| 16 | 16.000 | | 0.312 | 0.375 | 0.375 | 0.500 | 0.656 | 0.500 | 0.844 | 1.031 | 1.219 | 1.438 | 1.594 | |
| 18 | 18.000 | | 0.312 | 0.438 | 0.375 | 0.562 | 0.750 | 0.500 | 0.938 | 1.156 | 1.375 | 1.562 | 1.781 | |
| 20 | 20.000 | | 0.375 | 0.500 | 0.375 | 0.594 | 0.812 | 0.500 | 1.031 | 1.281 | 1.500 | 1.750 | 1.969 | |
| 24 | 24.000 | | 0.375 | 0.562 | 0.375 | 0.688 | 0.969 | 0.500 | 1.219 | 1.531 | 1.812 | 2.062 | 2.344 | |
| 30 | 30.000 | | 0.500 | 0.625 | 0.375 | | | 0.500 | | | | | | |
| 36 | 36.000 | | 0.500 | 0.625 | 0.375 | 0.750 | | 0.500 | | | | | | |
| 42 | 42.000 | | | | 0.375 | | | 0.500 | | | | | | |
| 48 | 48.000 | | | | 0.375 | | | 0.500 | | | | | | |

# ELL'S

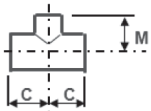



| NOM. PIPE SIZE | A IN | B IN | K IN | D IN | V IN | E IN | F INCHES | | G IN |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ASA | MSS | |
| 1/2 | 1 1/2 | 5/8 | 1 7/8 | | | 1 | 3 | 2 | 1 3/8 |
| 3/4 | 1 1/8 | 7/16 | 1 11/16 | | | 1 | 3 | 2 | 1 11/16 |
| 1 | 1 1/2 | 7/8 | 2 3/16 | 1 | 1 5/8 | 1 1/2 | 4 | 2 | 2 |
| 1 1/4 | 1 7/8 | 1 | 2 3/4 | 1 1/4 | 2 1/16 | 1 1/2 | 4 | 2 | 2 1/2 |
| 1 1/2 | 2 1/4 | 1 1/8 | 3 1/4 | 1 1/2 | 2 7/16 | 1 1/2 | 4 | 2 | 2 7/8 |
| 2 | 3 | 1 3/8 | 4 3/16 | 2 | 3 3/16 | 1 1/2 | 6 | 2 1/2 | 3 5/8 |
| 2 1/2 | 3 3/4 | 1 3/4 | 5 3/16 | 2 1/2 | 3 15/16 | 1 1/2 | 6 | 2 1/2 | 4 1/8 |
| 3 | 4 1/2 | 2 | 6 1/4 | 3 | 4 3/4 | 2 | 6 | 2 1/2 | 5 |
| 3 1/2 | 5 1/4 | 2 1/4 | 7 1/4 | 3 1/2 | 5 1/2 | 2 1/2 | 6 | 3 | 5 1/2 |
| 4 | 6 | 2 1/2 | 8 1/4 | 4 | 6 1/4 | 2 1/2 | 6 | 3 | 6 3/16 |
| 5 | 7 1/2 | 3 1/8 | 10 5/16 | 5 | 7 3/4 | 3 | 8 | 3 | 7 5/16 |
| 6 | 9 | 3 3/4 | 12 5/16 | 6 | 9 5/16 | 3 1/2 | 8 | 3 1/2 | 8 1/2 |
| 8 | 12 | 5 | 16 5/16 | 8 | 12 5/16 | 4 | 8 | 4 | 10 5/8 |
| 10 | 15 | 6 1/4 | 20 3/8 | 10 | 15 3/8 | 5 | 10 | 5 | 12 3/4 |
| 12 | 18 | 7 1/2 | 24 3/8 | 12 | 18 3/8 | 6 | 10 | 6 | 15 |
| 14 | 21 | 8 3/4 | 28 | 14 | 21 | 6 1/2 | 12 | | 16 1/4 |
| 16 | 24 | 10 | 32 | 16 | 24 | 7 | 12 | | 18 1/2 |
| 18 | 27 | 11 1/4 | 36 | 18 | 27 | 8 | 12 | | 21 |
| 20 | 30 | 12 1/2 | 40 | 20 | 30 | 9 | 12 | | 23 |
| 24 | 36 | 15 | 48 | 24 | 36 | 10 1/2 | 12 | | 27 1/4 |
| 30 | 45 | 18 1/2 | 60 | 30 | 45 | 10 1/2 | | | |
| 36 | 54 | 22 1/4 | | 36 | 54 | 10 1/2 | | | |
| 42 | 63 | 26 | | 42 | | 12 | | | |
| 48 | 72 | 29 3/4 | | 48 | | 13 1/2 | | | |

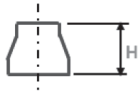
# TEE'S AND REDUCERS



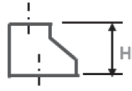
Straight Tee



Reducing Tee



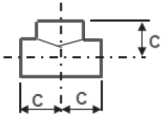
Conc. Reducer



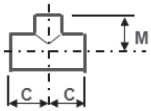
Eccentric Reducer

| NOM. PIPE | OUTLET IN | C IN | M IN | H IN |
|---|---|---|---|---|
| 3/4 | 3/4 | 1 1/8 | | |
| 3/4 | 1/2 | 1 1/8 | 1 1/8 | 1 1/2 |
| 1 | 1 | 1 1/2 | | |
| 1 | 3/4 | 1 1/2 | 1 1/2 | 2 |
| 1 | 1/2 | 1 1/2 | 1 1/2 | 2 |
| 1 1/4 | 1 1/4 | 1 7/8 | | |
| \| | 1 | 1 7/8 | 1 7/8 | 2 |
| \| | 3/4 | 1 7/8 | 1 7/8 | 2 |
| 1 1/4 | 1/2 | 1 7/8 | 1 7/8 | 2 |
| 1 1/2 | 1 1/2 | 2 1/4 | | |
| \| | 1 1/4 | 2 1/4 | 2 1/4 | 2 1/2 |
| \| | 1 | 2 1/4 | 2 1/4 | 2 1/2 |
| \| | 3/4 | 2 1/4 | 2 1/4 | 2 1/2 |
| 1 1/2 | 1/2 | 2 1/4 | 2 1/4 | 2 1/2 |
| 2 | 2 | 2 1/2 | | |
| \| | 1 1/2 | 2 1/2 | 2 3/8 | 3 |
| \| | 1 1/4 | 2 1/2 | 2 1/4 | 3 |
| \| | 1 | 2 1/2 | 2 | 3 |
| 2 | 3/4 | 2 1/2 | 1 3/4 | 3 |
| 2 1/2 | 2 1/2 | 3 | | |
| \| | 2 | 3 | 2 3/4 | 3 1/2 |
| \| | 1 1/2 | 3 | 2 5/8 | 3 1/2 |
| \| | 1 1/4 | 3 | 2 1/2 | 3 1/2 |
| 2 1/2 | 1 | 3 | 2 1/4 | 3 1/2 |
| 3 | 3 | 3 3/8 | | |
| \| | 2 1/2 | 3 3/8 | 3 1/4 | 3 1/2 |
| \| | 2 | 3 3/8 | 3 | 3 1/2 |
| \| | 1 1/2 | 3 3/8 | 2 7/8 | 3 1/2 |
| 3 | 1 1/4 | 3 3/8 | 2 3/4 | 3 1/2 |

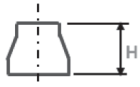
# TEE'S AND REDUCERS



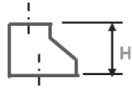
Straight Tee



Reducing Tee



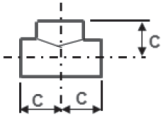
Conc. Reducer



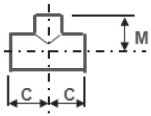
Eccentric Reducer

| NOM. PIPE | OUTLET IN | C IN | M IN | H IN |
|---|---|---|---|---|
| 3 1/2 | 3 1/2 | 3 3/4 | | |
| \| | 3 | 3 3/4 | 3 5/8 | 4 |
| \| | 2 1/2 | 3 3/4 | 3 1/2 | 4 |
| \| | 2 | 3 3/4 | 3 1/4 | 4 |
| 3 1/2 | 1 1/2 | 3 3/4 | 3 1/8 | 4 |
| 4 | 4 | 4 1/8 | | |
| \| | 3 1/2 | 4 1/8 | 4 | 4 |
| \| | 3 | 4 1/8 | 3 7/8 | 4 |
| \| | 2 1/2 | 4 1/8 | 3 3/4 | 4 |
| \| | 2 | 4 1/8 | 3 1/2 | 4 |
| 4 | 1 1/2 | 4 1/8 | 3 3/8 | 4 |
| 5 | 5 | 4 7/8 | | |
| \| | 4 | 4 7/8 | 4 5/8 | 5 |
| \| | 3 1/2 | 4 7/8 | 4 1/2 | 5 |
| \| | 3 | 4 7/8 | 4 3/8 | 5 |
| \| | 2 1/2 | 4 7/8 | 4 1/4 | 5 |
| 5 | 2 | 4 7/8 | 4 1/8 | 5 |
| 6 | 6 | 5 5/8 | | |
| \| | 5 | 5 5/8 | 5 3/8 | 5 1/2 |
| \| | 4 | 5 5/8 | 5 1/8 | 5 1/2 |
| \| | 3 1/2 | 5 5/8 | 5 | 5 1/2 |
| \| | 3 | 5 5/8 | 4 7/8 | 5 1/2 |
| 6 | 2 1/2 | 5 5/8 | 4 3/4 | 5 1/2 |
| 8 | 8 | 7 | | |
| \| | 6 | 7 | 6 5/8 | 6 |
| \| | 5 | 7 | 6 3/8 | 6 |
| \| | 4 | 7 | 6 1/8 | 6 |
| 8 | 3 1/2 | 7 | 6 | 6 |

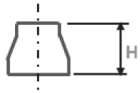
# TEE'S AND REDUCERS



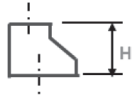
Straight Tee



Reducing Tee



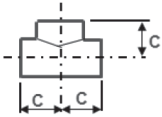
Conc. Reducer



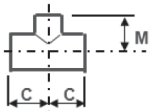
Eccentric Reducer

| NOM. PIPE | OUTLET IN | C IN | M IN | H IN |
|---|---|---|---|---|
| 10 | 10 | 8 1/2 | | |
| \| | 8 | 8 1/2 | 8 | 7 |
| \| | 6 | 8 1/2 | 7 5/8 | 7 |
| \| | 5 | 8 1/2 | 7 1/2 | 7 |
| 10 | 4 | 8 1/2 | 7 1/4 | 7 |
| 12 | 12 | 10 | | |
| \| | 10 | 10 | 9 1/2 | 8 |
| \| | 8 | 10 | 9 | 8 |
| \| | 6 | 10 | 8 5/8 | 8 |
| 12 | 5 | 10 | 8 1/2 | 8 |
| 14 | 14 | 11 | | |
| \| | 12 | 11 | 10 5/8 | 13 |
| \| | 10 | 11 | 10 1/8 | 13 |
| \| | 8 | 11 | 9 3/4 | 13 |
| 14 | 6 | 11 | 9 3/8 | 13 |
| 16 | 16 | 12 | | |
| \| | 14 | 12 | 12 | 14 |
| \| | 12 | 12 | 11 5/8 | 14 |
| \| | 10 | 12 | 11 1/8 | 14 |
| \| | 8 | 12 | 10 3/4 | 14 |
| 16 | 6 | 12 | 10 3/8 | 14 |
| 18 | 18 | 13 1/2 | | |
| \| | 16 | 13 1/2 | 13 | 15 |
| \| | 14 | 13 1/2 | 13 | 15 |
| \| | 12 | 13 1/2 | 12 5/8 | 15 |
| \| | 10 | 13 1/2 | 12 1/8 | 15 |
| 18 | 8 | 13 1/2 | 11 3/4 | 15 |

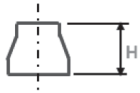
# TEE'S AND REDUCERS



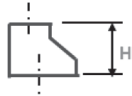
Straight Tee



Reducing Tee



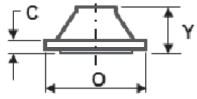
Conc. Reducer



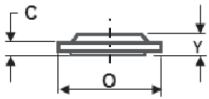
Eccentric Reducer

| NOM. PIPE | OUTLET IN | C IN | M IN | H IN |
|---|---|---|---|---|
| 20 | 20 | 15 | | |
| \| | 18 | 15 | 14 1/2 | 20 |
| \| | 16 | 15 | 14 | 20 |
| \| | 14 | 15 | 14 | 20 |
| \| | 12 | 15 | 13 5/8 | 20 |
| \| | 10 | 15 | 13 1/8 | 20 |
| 20 | 8 | 15 | 12 3/4 | 20 |
| 24 | 24 | 17 | | |
| \| | 20 | 17 | 17 | 20 |
| \| | 18 | 17 | 16 1/2 | 20 |
| \| | 16 | 17 | 16 | 20 |
| \| | 14 | 17 | 16 | 20 |
| \| | 12 | 17 | 15 5/8 | 20 |
| 24 | 10 | 17 | 15 1/8 | 20 |
| 30 | 30 | 22 | | |
| \| | 24 | 22 | 21 | 24 |
| \| | 20 | 22 | 20 | 24 |
| \| | 18 | 22 | 19 1/2 | 24 |
| \| | 16 | 22 | 19 | 24 |
| 30 | 14 | 22 | 19 | 24 |
| 36 | 36 | 26 1/2 | | |
| \| | 30 | 26 1/2 | 25 | 24 |
| \| | 24 | 26 1/2 | 24 | 24 |
| \| | 20 | 26 1/2 | 23 | 24 |
| \| | 18 | 26 1/2 | 22 1/2 | 24 |
| 36 | 16 | 26 1/2 | 22 | 24 |
| 42 | 42 | 30 | 28 | |
| \| | 36 | 30 | 28 | 24 |
| \| | 30 | 30 | 28 | 24 |
| \| | 24 | 30 | 26 | 24 |
| 42 | 20 | 30 | 26 | 24 |
| 48 | 48 | 35 | 33 | |
| \| | 42 | 35 | 32 | 28 |
| \| | 36 | 35 | 31 | 28 |
| 48 | 30 | 35 | 30 | 28 |

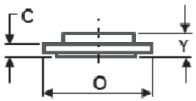
# FLANGE CHARTS



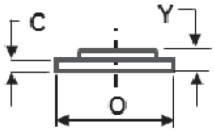

Weld Neck Flange



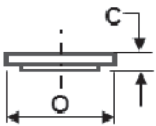

Slip-On Flange




Threaded Flange



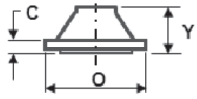

Lap Joint Flange



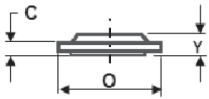

Blind Flange

| | 150 LB. FLANGES - INCHES | | | | | | |
|---|---|---|---|---|---|---|---|
| NOM. PIPE SIZE | O INCHES | C INCHES | Y | | | | NO. & SIZE OF HOLES |
| | | | WELD NECK | SLIP ON THRD. | LAP JOINT | BOLT CIRCLE | |
| 1/2 | 3 1/2 | 7/16 | 1 7/8 | 5/8 | 5/8 | 2 3/8 | 4 - 5/8 |
| 3/4 | 3 7/8 | 1/2 | 2 1/16 | 5/8 | 5/8 | 2 3/4 | 4 - 5/8 |
| 1 | 4 1/4 | 9/16 | 2 3/16 | 11/16 | 11/16 | 3 1/8 | 4 - 5/8 |
| 1 1/4 | 4 5/8 | 5/8 | 2 1/4 | 13/16 | 13/16 | 3 1/2 | 4 - 5/8 |
| 1 1/2 | 5 | 11/16 | 2 7/16 | 7/8 | 7/8 | 3 7/8 | 4 - 5/8 |
| 2 | 6 | 3/4 | 2 1/2 | 1 | 1 | 4 3/4 | 4 3/4 |
| 2 1/2 | 7 | 7/8 | 2 3/4 | 1 1/8 | 1 1/8 | 5 1/2 | 4-3/4 |
| 3 | 7 1/2 | 15/16 | 2 3/4 | 1 3/16 | 1 3/16 | 6 | 4-3/4 |
| 3 1/2 | 8 1/2 | 15/16 | 2 13/16 | 1 1/4 | 1 1/4 | 7 | 8-3/4 |
| 4 | 9 | 15/16 | 3 | 1 5/16 | 1 5/16 | 7 1/2 | 8-3/4 |
| 5 | 10 | 15/16 | 3 1/2 | 1 7/16 | 1 7/16 | 8 1/2 | 8-7/8 |
| 6 | 11 | 1 | 3 1/2 | 1 9/16 | 1 9/16 | 9 1/2 | 8-7/8 |
| 8 | 13 1/2 | 1 1/8 | 4 | 1 3/4 | 1 3/4 | 11 3/4 | 8-7/8 |
| 10 | 16 | 1 3/16 | 4 | 1 15/16 | 1 15/16 | 14 1/4 | 12-1 |
| 12 | 19 | 1 1/4 | 4 1/2 | 2 3/16 | 2 3/16 | 17 | 12-1 |
| 14 | 21 | 1 3/8 | 5 | 2 1/4 | 3 1/8 | 18 3/4 | 12-1 1/8 |
| 16 | 23 1/2 | 1 7/16 | 5 | 2 1/2 | 3 7/16 | 21 1/4 | 16-1 1/8 |
| 18 | 25 | 1 9/16 | 5 1/2 | 2 11/16 | 3 13/16 | 22 3/4 | 16-1 1/4 |
| 20 | 27 1/2 | 1 11/16 | 5 11/16 | 2 7/8 | 4 1/16 | 25 | 20-1 1/4 |
| 24 | 32 | 1 7/8 | 6 | 3 1/4 | 4 3/8 | 29 1/2 | 20-1 3/8 |

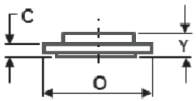
# FLANGE CHARTS



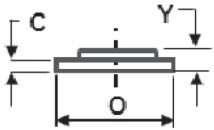

Weld Neck Flange



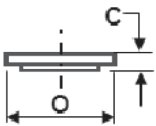

Slip-On Flange




Threaded Flange



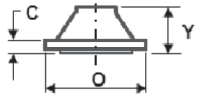

Lap Joint Flange



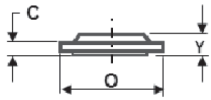

Blind Flange

| | 300 LB. FLANGES - INCHES | | | | | | |
|---|---|---|---|---|---|---|---|
| NOM. PIPE SIZE | O INCHES | C INCHES | Y | | | | NO. & SIZE OF HOLES |
| | | | WELD NECK | SLIP ON THRD. | LAP JOINT | BOLT CIRCLE | |
| 1/2 | 3 3/4 | 9/16 | 2 1/16 | 7/8 | 7/8 | 2 5/8 | 4 - 5/8 |
| 3/4 | 4 5/8 | 5/8 | 2 1/4 | 1 | 1 | 3 1/4 | 4 - 3/4 |
| 1 | 4 7/8 | 11/16 | 2 7/16 | 1 1/16 | 1 1/16 | 3 1/2 | 4 - 3/4 |
| 1 1/4 | 5 1/4 | 3/4 | 2 9/16 | 1 1/16 | 1 1/16 | 3 7/8 | 4 - 3/4 |
| 1 1/2 | 6 1/8 | 13/16 | 2 11/16 | 1 3/16 | 1 3/16 | 4 1/2 | 4 -7/8 |
| 2 | 6 1/2 | 7/8 | 2 3/4 | 1 5/16 | 1 5/16 | 5 | 8-3/4 |
| 2 1/2 | 7 1/2 | 1 | 3 | 1 1/2 | 1 1/2 | 5 7/8 | 8-7/8 |
| 3 | 8 1/4 | 1 1/8 | 3 1/8 | 1 11/16 | 1 11/16 | 6 5/8 | 8-7/8 |
| 3 1/2 | 9 | 1 3/16 | 3 3/16 | 1 3/4 | 1 3/4 | 7 1/4 | 8-7/8 |
| 4 | 10 | 1 1/4 | 3 3/8 | 1 7/8 | 1 7/8 | 7 7/8 | 8-7/8 |
| 5 | 11 | 1 3/8 | 3 7/8 | 2 | 2 | 9 1/4 | 8-7/8 |
| 6 | 12 1/2 | 1 7/16 | 3 7/8 | 2 1/16 | 2 1/16 | 10 5/8 | 12-7/8 |
| 8 | 15 | 1 5/8 | 4 3/8 | 2 7/16 | 2 7/16 | 13 | 12-1 |
| 10 | 17 1/2 | 1 7/8 | 4 5/8 | 2 5/8 | 3 3/4 | 15 1/4 | 16-1 1/8 |
| 12 | 20 1/2 | 2 | 5 1/8 | 2 7/8 | 4 | 17 3/4 | 16-1 1/4 |
| 14 | 23 | 2 1/8 | 5 5/8 | 3 | 4 3/8 | 20 1/4 | 20-1 1/4 |
| 16 | 25 1/2 | 2 1/4 | 5 3/4 | 3 1/4 | 4 3/4 | 22 1/2 | 20-1 3/8 |
| 18 | 28 | 2 3/8 | 6 1/4 | 3 1/2 | 5 1/8 | 24 3/4 | 24-1 3/8 |
| 20 | 30 1/2 | 2 1/2 | 6 3/8 | 3 3/4 | 5 1/2 | 27 | 24-1 3/8 |
| 24 | 36 | 2 3/4 | 6 5/8 | 4 3/16 | 6 | 32 | 24-1 5/8 |

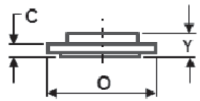
# FLANGE CHARTS



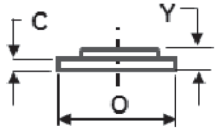

Weld Neck Flange



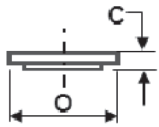

Slip-On Flange




Threaded Flange




Lap Joint Flange

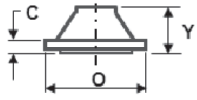



Blind Flange

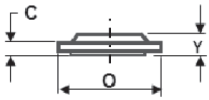
** THE 1/4" RAISED FACE IS NOT INCLUDED IN THE THICKNESS "Y" OR "C"

| | 400 LB. FLANGES - INCHES | | | | | | |
|---|---|---|---|---|---|---|---|
| NOM. PIPE SIZE | O INCHES | C INCHES | Y** (See Note Above) | | | | NO. & SIZE OF HOLES |
| | | | WELD NECK | SLIP ON THRD. | LAP JOINT | BOLT CIRCLE | |
| 1/2 | 3 3/4 | 9/16 | 2 1/16 | 7/8 | 7/8 | 2 5/8 | 4 - 5/8 |
| 3/4 | 4 5/8 | 5/8 | 2 1/4 | 1 | 1 | 3 1/4 | 4 - 3/4 |
| 1 | 4 7/8 | 11/16 | 2 7/16 | 1 1/16 | 1 1/16 | 3 1/2 | 4 - 3/4 |
| 1 1/4 | 5 1/4 | 13/16 | 2 5/8 | 1 1/8 | 1 1/8 | 3 7/8 | 4 - 3/4 |
| 1 1/2 | 6 1/8 | 7/8 | 2 3/4 | 1 1/4 | 1 1/4 | 4 1/2 | 4 -7/8 |
| 2 | 6 1/2 | 1 | 2 7/8 | 1 7/16 | 1 7/16 | 5 | 8-3/4 |
| 2 1/2 | 7 1/2 | 1 1/8 | 3 1/8 | 1 5/8 | 1 5/8 | 5 7/8 | 8-7/8 |
| 3 | 8 1/4 | 1 1/4 | 3 1/4 | 1 13/16 | 1 13/16 | 6 5/8 | 8-7/8 |
| 3 1/2 | 9 | 1 3/8 | 3 5/8 | 1 15/16 | 1 15/16 | 7 1/4 | 8-1 |
| 4 | 10 | 1 3/8 | 3 1/2 | 2 | 2 | 7 7/8 | 8-1 |
| 5 | 11 | 1 1/2 | 4 | 2 1/8 | 2 1/8 | 9 1/4 | 8-1 |
| 6 | 12 1/2 | 1 5/8 | 4 1/16 | 2 1/4 | 2 1/4 | 10 5/8 | 12-1 |
| 8 | 15 | 1 7/8 | 4 5/8 | 2 11/16 | 2 11/16 | 13 | 12-1 1/8 |
| 10 | 17 1/2 | 2 1/8 | 4 7/8 | 2 7/8 | 4 | 15 1/4 | 16-1 1/4 |
| 12 | 20 1/2 | 2 1/4 | 5 3/8 | 3 1/8 | 4 1/4 | 17 3/4 | 16-1 3/8 |
| 14 | 23 | 2 3/8 | 5 7/8 | 3 5/16 | 4 5/8 | 20 1/4 | 20-1 3/8 |
| 16 | 25 1/2 | 2 1/2 | 6 | 3 11/16 | 5 | 22 1/2 | 20-1 1/2 |
| 18 | 28 | 2 5/8 | 6 1/2 | 3 7/8 | 5 3/8 | 24 3/4 | 24-1 1/2 |
| 20 | 30 1/2 | 2 3/4 | 6 5/8 | 4 | 5 3/4 | 27 | 24-1 5/8 |
| 24 | 36 | 3 | 6 7/8 | 4 1/2 | 6 1/4 | 32 | 24-1 7/8 |

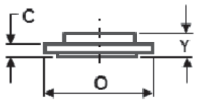
# FLANGE CHARTS



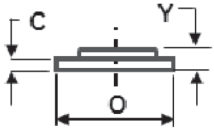

Weld Neck Flange



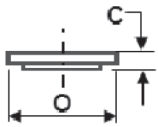

Slip-On Flange




Threaded Flange




Lap Joint Flange

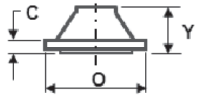



Blind Flange

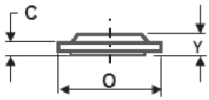
** THE 1/4" RAISED FACE IS NOT INCLUDED IN THE THICKNESS "Y" OR "C"

| | 600 LB. FLANGES - INCHES | | | | | | |
|---|---|---|---|---|---|---|---|
| NOM. PIPE SIZE | O INCHES | C INCHES | Y** (See Note Above) | | | | NO. & SIZE OF HOLES |
| | | | WELD NECK | SLIP ON THRD. | LAP JOINT | BOLT CIRCLE | |
| 1/2 | 3 3/4 | 9/16 | 2 1/16 | 7/8 | 7/8 | 2 5/8 | 4 - 5/8 |
| 3/4 | 4 5/8 | 5/8 | 2 1/4 | 1 | 1 | 6 1/4 | 4 - 3/4 |
| 1 | 4 7/8 | 11/16 | 2 7/16 | 1 1/16 | 1 1/16 | 3 1/2 | 4 - 3/4 |
| 1 1/4 | 5 1/4 | 13/16 | 2 5/8 | 1 1/8 | 1 1/8 | 3 7/8 | 4 - 3/4 |
| 1 1/2 | 6 1/8 | 7/8 | 2 3/4 | 1 1/4 | 1 1/4 | 4 1/2 | 4 -7/8 |
| 2 | 6 1/2 | 1 | 2 7/8 | 1 7/16 | 1 7/16 | 5 | 8-3/4 |
| 2 1/2 | 7 1/2 | 1 1/8 | 3 1/8 | 1 5/8 | 1 5/8 | 5 7/8 | 8-7/8 |
| 3 | 8 1/4 | 1 1/4 | 3 1/4 | 1 13/16 | 1 13/16 | 6 5/8 | 8-7/8 |
| 3 1/2 | 9 | 1 3/8 | 3 3/8 | 1 15/16 | 1 15/16 | 7 1/4 | 8-1 |
| 4 | 10 3/4 | 1 1/2 | 4 | 2 1/8 | 2 1/8 | 8 1/2 | 8-1 |
| 5 | 13 | 1 3/4 | 4 1/2 | 2 3/8 | 2 3/8 | 10 1/2 | 8-1 1/8 |
| 6 | 14 | 1 7/8 | 4 5/8 | 2 5/8 | 2 5/8 | 11 1/2 | 12-1 1/8 |
| 8 | 16 1/2 | 2 3/16 | 5 1/4 | 3 | 3 | 13 3/4 | 12-1 1/4 |
| 10 | 20 | 2 1/2 | 6 | 3 3/8 | 4 3/8 | 17 | 16-1 3/8 |
| 12 | 22 | 2 5/8 | 6 1/8 | 3 5/8 | 4 5/8 | 19 1/4 | 20-1 3/8 |
| 14 | 23 3/4 | 2 3/4 | 6 1/2 | 3 11/16 | 5 | 20 3/4 | 20-1 1/2 |
| 16 | 27 | 3 | 7 | 4 3/16 | 5 1/2 | 23 3/4 | 20-1 5/8 |
| 18 | 29 1/4 | 3 1/4 | 7 1/4 | 4 5/8 | 6 | 25 3/4 | 20-1 3/4 |
| 20 | 32 | 3 1/2 | 7 1/2 | 5 | 6 1/2 | 28 1/2 | 24-1 3/4 |
| 24 | 37 | 4 | 8 | 5 1/2 | 7 1/4 | 33 | 24-2 |

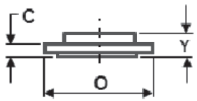
# FLANGE CHARTS



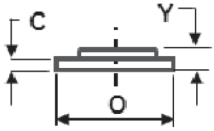

Weld Neck Flange



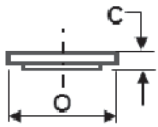

Slip-On Flange




Threaded Flange




Lap Joint Flange

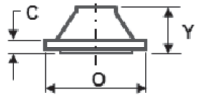



Blind Flange

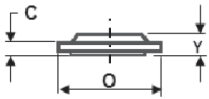
** THE 1/4" RAISED FACE IS NOT INCLUDED IN THE THICKNESS "Y" OR "C"

| | 900 LB. FLANGES - INCHES | | | | | | |
|---|---|---|---|---|---|---|---|
| NOM. PIPE SIZE | O INCHES | C INCHES | Y** (See Note Above) | | | | NO. & SIZE OF HOLES |
| | | | WELD NECK | SLIP ON THRD. | LAP JOINT | BOLT CIRCLE | |
| 1/2 | 4 3/4 | 7/8 | 2 3/8 | 1 1/4 | 1 1/4 | 3 1/4 | 4 - 7/8 |
| 3/4 | 5 1/8 | 1 | 2 3/4 | 1 3/8 | 1 3/8 | 3 1/2 | 4 - 7/8 |
| 1 | 5 7/8 | 1 1/8 | 2 7/8 | 1 5/8 | 1 5/8 | 4 | 4-1 |
| 1 1/4 | 6 1/4 | 1 1/8 | 2 7/8 | 1 5/8 | 1 5/8 | 4 3/8 | 4-1 |
| 1 1/2 | 7 | 1 1/4 | 3 1/4 | 1 3/4 | 1 3/4 | 4 7/8 | 4 -1 1/8 |
| 2 | 8 1/2 | 1 1/2 | 4 | 2 1/4 | 2 1/4 | 6 1/2 | 8-1 |
| 2 1/2 | 9 5/8 | 1 5/8 | 4 1/8 | 2 1/2 | 2 1/2 | 7 1/2 | 8-1 1/8 |
| 3 | 9 1/2 | 1 1/2 | 4 | 2 1/8 | 2 1/8 | 7 1/2 | 8-1 |
| 3 1/2 | | | | | | | |
| 4 | 11 1/2 | 1 3/4 | 4 1/2 | 2 3/4 | 2 3/4 | 9 1/4 | 8-1 1/4 |
| 5 | 13 3/4 | 2 | 5 | 3 1/8 | 3 1/8 | 11 | 8-1 3/8 |
| 6 | 15 | 2 3/16 | 5 1/2 | 3 3/8 | 3 3/8 | 12 1/2 | 12-1 1/4 |
| 8 | 18 1/2 | 2 1/2 | 6 3/8 | 4 | 4 1/2 | 15 1/2 | 12-1 1/2 |
| 10 | 21 1/2 | 2 3/4 | 7 1/4 | 4 1/4 | 5 | 18 1/2 | 16-1 1/2 |
| 12 | 24 | 3 1/8 | 7 7/8 | 4 5/8 | 5 5/8 | 21 | 20-1 1/2 |
| 14 | 25 1/4 | 3 3/8 | 8 3/8 | 5 1/8 | 6 1/8 | 22 | 20-1 5/8 |
| 16 | 27 3/4 | 3 1/2 | 8 1/2 | 5 1/4 | 6 1/2 | 24 1/4 | 20-1 3/4 |
| 18 | 31 | 4 | 9 | 6 | 7 1/2 | 27 | 20-2 |
| 20 | 33 3/4 | 4 1/4 | 9 3/4 | 6 1/4 | 8 1/4 | 29 1/2 | 24-2 1/8 |
| 24 | 41 | 5 1/2 | 11 1/2 | 8 | 10 1/2 | 35 1/2 | 24-2 5/8 |

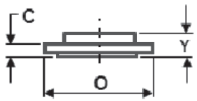
# FLANGE CHARTS



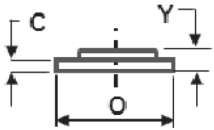

Weld Neck Flange



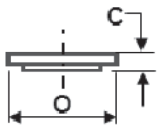

Slip-On Flange




Threaded Flange




Lap Joint Flange




Blind Flange

** THE 1/4" RAISED FACE IS NOT INCLUDED IN THE THICKNESS "Y" OR "C"

| | 1500 LB. FLANGES - INCHES | | | | | | |
|---|---|---|---|---|---|---|---|
| NOM. PIPE SIZE | O INCHES | C INCHES | Y** (See Note Above) | | | | NO. & SIZE OF HOLES |
| | | | WELD NECK | SLIP ON THRD. | LAP JOINT | BOLT CIRCLE | |
| 1/2 | 4 3/4 | 7/8 | 2 3/8 | 1 1/4 | 1 1/4 | 3 1/4 | 4 - 7/8 |
| 3/4 | 5 1/8 | 1 | 2 3/4 | 1 3/8 | 1 3/8 | 3 1/2 | 4 - 7/8 |
| 1 | 5 7/8 | 1 1/8 | 2 7/8 | 1 5/8 | 1 5/8 | 4 | 4-1 |
| 1 1/4 | 6 1/4 | 1 1/8 | 2 7/8 | 1 5/8 | 1 5/8 | 4 3/8 | 4-1 |
| 1 1/2 | 7 | 1 1/4 | 3 1/4 | 1 3/4 | 1 3/4 | 4 7/8 | 4 -1 1/8 |
| 2 | 8 1/2 | 1 1/2 | 4 | 2 1/4 | 2 1/4 | 6 1/2 | 8-1 |
| 2 1/2 | 9 5/8 | 1 5/8 | 4 1/8 | 2 1/2 | 2 1/2 | 7 1/2 | 8-1 1/8 |
| 3 | 10 1/2 | 1 7/8 | 4 5/8 | 2 7/8 | 2 7/8 | 8 | 8-1 1/4 |
| 3 1/2 | | | | | | | |
| 4 | 12 1/4 | 2 1/8 | 4 7/8 | 3 9/16 | 3 9/16 | 9 1/2 | 8-1 3/8 |
| 5 | 14 3/4 | 2 7/8 | 6 1/8 | 4 1/8 | 4 1/8 | 11 1/2 | 8-1 5/8 |
| 6 | 15 1/2 | 3 1/4 | 6 3/4 | 4 11/16 | 4 11/16 | 12 1/2 | 12-1 1/2 |
| 8 | 19 | 3 5/8 | 8 3/8 | 5 5/8 | 5 5/8 | 15 1/2 | 12-1 3/4 |
| 10 | 23 | 4 1/4 | 10 | 6 1/4 | 7 | 19 | 12-2 |
| 12 | 26 1/2 | 4 7/8 | 11 1/8 | 7 1/8 | 8 5/8 | 22 1/2 | 16-2 1/8 |
| 14 | 29 1/2 | 5 1/4 | 11 3/4 | 9 1/2 | 25 | 16-2 3/8 | |
| 16 | 32 1/2 | 5 3/4 | 12 1/4 | 10 1/4 | 27 3/4 | 16 - 2 5/8 | |
| 18 | 36 | 6 3/8 | 12 7/8 | 10 7/8 | 30 1/2 | 16- 2 7/8 | |
| 20 | 38 3/4 | 7 | 14 | 11 1/2 | 32 3/4 | 16-3 1/8 | |
| 24 | 46 | 8 | 16 | 13 | 39 | 16 -3 5/8 | |

# FLANGE CHARTS

| ENGLISH | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE | 150# WNFLG. WR WT. LBS. | 150# SO-FLG. WT. LBS. | 150# Thrd-FLG. WT. LBS. | 150# Lap-FLG. WT. LBS. | 150# Blind-FLG. WT. LBS. |
| 1/2 | 2 | 1 | 1 | 1 | 2 |
| 3/4 | 2 | 1.5 | 1.5 | 1.5 | 2 |
| 1 | 2.5 | 2 | 2 | 2 | 2 |
| 1 1/4 | 2.5 | 2.5 | 2.5 | 2.5 | 3 |
| 1 1/2 | 4 | 3 | 3 | 3 | 3 |
| 2 | 6 | 5 | 5 | 5 | 4 |
| 2 1/2 | 10 | 8 | 8 | 8 | 7 |
| 3 | 11.5 | 9 | 10 | 9 | 9 |
| 3 1/2 | 12 | 11 | 12 | 11 | 13 |
| 4 | 16.5 | 13 | 13 | 12 | 17 |
| 5 | 21 | 15 | 15 | 13 | 20 |
| 6 | 26 | 17 | 19.5 | 18 | 27 |
| 8 | 42 | 28 | 30 | 28 | 47 |
| 10 | 54 | 40 | 41 | 36 | 67 |
| 12 | 88 | 61 | 65 | 60 | 102 |
| 14 | 114 | 83 | 85 | 77 | 139 |
| 16 | 142 | 106 | 93 | 104 | 187 |
| 18 | 165 | 109 | 120 | 146 | 217 |
| 20 | 197 | 148 | 155 | 159 | 283 |
| 24 | 268 | 204 | 210 | 195 | 415 |

| METRIC | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE MM | 150# WNFLG. WT. **KG** | 150# SO-FLG. WT. **KG** | 150# Thrd-FLG. WT. **KG** | 150# Lap-FLG. WT. **KG** | 150# Blind-FLG. WT. **KG** |
| 12.70 | 0.9 | 0.5 | 0.5 | 0.5 | 0.9 |
| 19.05 | 0.9 | 0.7 | 0.7 | 0.7 | 0.9 |
| 25.40 | 1.1 | 0.9 | 0.9 | 0.9 | 0.9 |
| 31.75 | 1.1 | 1.1 | 1.1 | 1.1 | 1.4 |
| 38.10 | 1.8 | 1.4 | 1.4 | 1.4 | 1.4 |
| 63.50 | 2.7 | 2.3 | 2.3 | 2.3 | 1.8 |
| 63.50 | 4.5 | 3.6 | 3.6 | 3.6 | 3.2 |
| 76.20 | 5.2 | 4.1 | 4.5 | 4.1 | 4.1 |
| 88.90 | 5.4 | 5.0 | 5.4 | 5.0 | 5.9 |
| 101.60 | 7.5 | 5.9 | 5.9 | 5.4 | 7.7 |
| 152.40 | 9.5 | 6.8 | 6.8 | 5.9 | 9.1 |
| 152.40 | 11.8 | 7.7 | 8.8 | 8.2 | 12.2 |
| 203.20 | 19.1 | 12.7 | 13.6 | 12.7 | 21.3 |
| 254.00 | 24.5 | 18.1 | 18.6 | 16.3 | 30.4 |
| 304.80 | 39.9 | 27.7 | 29.5 | 27.2 | 46.3 |
| 406.40 | 51.7 | 37.6 | 38.6 | 34.9 | 63.0 |
| 406.40 | 64.4 | 48.1 | 42.2 | 47.2 | 84.8 |
| 457.20 | 74.8 | 49.4 | 54.4 | 66.2 | 98.4 |
| 508.00 | 89.4 | 67.1 | 70.3 | 72.1 | 128.4 |
| 609.60 | 121.6 | 92.5 | 95.3 | 88.5 | 188.2 |

# FLANGE CHARTS

| ENGLISH | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE | 300# WNFLG. WR WT. LBS. | 300# SO-FLG. WT. LBS. | 300# Thrd-FLG. WT. LBS. | 300# Lap-FLG. WT. LBS. | 300# Blind-FLG. WT. LBS. |
| 1/2 | 2 | 1.5 | 1.5 | 1.5 | 2 |
| 3/4 | 3 | 2.5 | 2.5 | 2.5 | 3 |
| 1 | 4 | 3 | 3 | 3 | 4 |
| 1 1/4 | 5 | 4.5 | 4.5 | 4.5 | 6 |
| 1 1/2 | 7 | 6.5 | 6.5 | 6.5 | 7 |
| 2 | 8 | 7 | 7 | 7 | 8 |
| 2 1/2 | 12 | 10 | 10 | 10 | 12 |
| 3 | 18 | 13 | 14 | 14.5 | 16 |
| 3 1/2 | 20 | 16 | 16 | 16 | 21 |
| 4 | 26.5 | 23.5 | 24 | 24 | 28 |
| 5 | 36 | 29 | 31 | 26 | 37 |
| 6 | 45 | 36 | 36 | 38 | 48 |
| 8 | 69 | 56 | 56 | 55 | 79 |
| 10 | 100 | 77 | 80 | 88 | 122 |
| 12 | 142 | 113 | 110 | 139 | 183 |
| 14 | 206 | 159 | 164 | 184 | 241 |
| 16 | 249 | 210 | 220 | 234 | 315 |
| 18 | 306 | 253 | 280 | 305 | 414 |
| 20 | 369 | 307 | 325 | 375 | 515 |
| 24 | 519 | 490 | 490 | 530 | 800 |

| METRIC | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE MM | 300# WNFLG. WT. KG | 300# SO-FLG. WT. KG | 300# Thrd-FLG. WT. KG | 300# Lap-FLG. WT. KG | 300# Blind-FLG. WT. KG |
| 12.70 | 0.9 | 0.7 | 0.7 | 0.7 | 0.9 |
| 19.05 | 1.4 | 1.1 | 1.1 | 1.1 | 1.4 |
| 25.40 | 1.8 | 1.4 | 1.4 | 1.4 | 1.8 |
| 31.75 | 2.3 | 2.0 | 2.0 | 2.0 | 2.7 |
| 38.10 | 3.2 | 2.9 | 2.9 | 2.9 | 3.2 |
| 63.50 | 3.6 | 3.2 | 3.2 | 3.2 | 3.6 |
| 63.50 | 5.4 | 4.5 | 4.5 | 4.5 | 5.4 |
| 76.20 | 8.2 | 5.9 | 6.4 | 6.6 | 7.3 |
| 88.90 | 9.1 | 7.3 | 7.3 | 7.3 | 9.5 |
| 101.60 | 12.0 | 10.7 | 10.9 | 10.9 | 12.7 |
| 152.40 | 16.3 | 13.2 | 14.1 | 11.8 | 16.8 |
| 152.40 | 20.4 | 16.3 | 16.3 | 17.2 | 21.8 |
| 203.20 | 31.3 | 25.4 | 25.4 | 24.9 | 35.8 |
| 254.00 | 45.4 | 34.9 | 36.3 | 39.9 | 55.3 |
| 304.80 | 64.4 | 51.3 | 49.9 | 63.0 | 83.0 |
| 406.40 | 93.4 | 72.1 | 74.4 | 83.5 | 109.3 |
| 406.40 | 112.9 | 95.3 | 99.8 | 106.1 | 142.9 |
| 457.20 | 138.8 | 114.8 | 127.0 | 138.3 | 187.8 |
| 508.00 | 167.4 | 139.3 | 147.4 | 170.1 | 233.6 |
| 609.60 | 235.4 | 222.3 | 222.3 | 240.4 | 362.9 |

# FLANGE CHARTS

| ENGLISH | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE | 400# WNFLG. WR WT. LBS. | 400# SO-FLG. WT. LBS. | 400# Thrd-FLG. WT. LBS. | 400# Lap-FLG. WT. LBS. | 400# Blind-FLG. WT. LBS. |
| 1/2 | 3 | 2 | 2 | 2 | 2 |
| 3/4 | 3.5 | 3 | 3 | 3 | 3 |
| 1 | 4 | 3.5 | 3.5 | 3.5 | 4 |
| 1 1/4 | 5.5 | 4.5 | 4.5 | 4.5 | 6 |
| 1 1/2 | 8 | 6.5 | 6.5 | 6.5 | 8 |
| 2 | 10 | 8 | 8 | 8 | 10 |
| 2 1/2 | 14 | 12 | 12 | 11 | 15 |
| 3 | 18 | 15 | 15 | 14 | 20 |
| 3 1/2 | 26 | 21 | 21 | 20 | 29 |
| 4 | 30 | 24 | 24 | 22 | 33 |
| 5 | 39 | 31 | 31 | 29 | 44 |
| 6 | 49 | 39 | 39 | 37 | 61 |
| 8 | 78 | 63 | 63 | 59 | 100 |
| 10 | 110 | 91 | 91 | 95 | 155 |
| 12 | 160 | 129 | 129 | 152 | 226 |
| 14 | 233 | 191 | 191 | 210 | 310 |
| 16 | 294 | 253 | 253 | 280 | 398 |
| 18 | 260 | 310 | 310 | 345 | 502 |
| 20 | 445 | 378 | 378 | 420 | 621 |
| 24 | 640 | 539 | 539 | 615 | 936 |

| METRIC | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE MM | 400# WNFLG. WT. KG | 400# SO-FLG. WT. KG | 400# Thrd-FLG. WT. KG | 400# Lap-FLG. WT. KG | 400# Blind-FLG. WT. KG |
| 12.70 | 1.4 | 0.9 | 0.9 | 0.9 | 0.9 |
| 19.05 | 1.6 | 1.4 | 1.4 | 1.4 | 1.4 |
| 25.40 | 1.8 | 1.6 | 1.6 | 1.6 | 1.8 |
| 31.75 | 2.5 | 2.0 | 2.0 | 2.0 | 2.7 |
| 38.10 | 3.6 | 2.9 | 2.9 | 2.9 | 3.6 |
| 63.50 | 4.5 | 3.6 | 3.6 | 3.6 | 4.5 |
| 63.50 | 6.4 | 5.4 | 5.4 | 5.0 | 6.8 |
| 76.20 | 8.2 | 6.8 | 6.8 | 6.4 | 9.1 |
| 88.90 | 11.8 | 9.5 | 9.5 | 9.1 | 13.2 |
| 101.60 | 13.6 | 10.9 | 10.9 | 10.0 | 15.0 |
| 152.40 | 17.7 | 14.1 | 14.1 | 13.2 | 20.0 |
| 152.40 | 22.2 | 17.7 | 17.7 | 16.8 | 27.7 |
| 203.20 | 35.4 | 28.6 | 28.6 | 26.8 | 45.4 |
| 254.00 | 49.9 | 41.3 | 41.3 | 43.1 | 70.3 |
| 304.80 | 72.6 | 58.5 | 58.5 | 68.9 | 102.5 |
| 406.40 | 105.7 | 86.6 | 86.6 | 95.3 | 140.6 |
| 406.40 | 133.4 | 114.8 | 114.8 | 127.0 | 180.5 |
| 457.20 | 117.9 | 140.6 | 140.6 | 156.5 | 227.7 |
| 508.00 | 201.8 | 171.5 | 171.5 | 190.5 | 281.7 |
| 609.60 | 290.3 | 244.5 | 244.5 | 279.0 | 424.6 |

# FLANGE CHARTS

| ENGLISH | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE | 600# WNFLG. WR WT. LBS. | 600# SO-FLG. WT. LBS. | 600# Thrd-FLG. WT. LBS. | 600# Lap-FLG. WT. LBS. | 600# Blind-FLG. WT. LBS. |
| 1/2 | 3 | 2 | 2 | 2 | 2 |
| 3/4 | 3.5 | 3 | 3 | 3 | 3 |
| 1 | 4 | 3.5 | 3.5 | 3.5 | 4 |
| 1 1/4 | 5.5 | 4.5 | 4.5 | 4.5 | 6 |
| 1 1/2 | 8 | 6.5 | 6.5 | 6.5 | 8 |
| 2 | 10 | 8 | 8 | 8 | 10 |
| 2 1/2 | 14 | 12 | 12 | 11 | 15 |
| 3 | 18 | 15 | 15 | 14 | 20 |
| 3 1/2 | 26 | 21 | 21 | 20 | 29 |
| 4 | 37 | 33 | 33 | 31 | 41 |
| 5 | 68 | 56 | 63 | 63 | 68 |
| 6 | 73 | 66 | 80 | 78 | 86 |
| 8 | 112 | 97 | 97 | 112 | 139 |
| 10 | 189 | 177 | 177 | 195 | 231 |
| 12 | 226 | 215 | 215 | 240 | 295 |
| 14 | 268 | 259 | 259 | 290 | 378 |
| 16 | 481 | 366 | 366 | 400 | 527 |
| 18 | 555 | 476 | 476 | 469 | 665 |
| 20 | 690 | 612 | 612 | 604 | 855 |
| 24 | 977 | 876 | 876 | 866 | 1175 |

| METRIC | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE MM | 600# WNFLG. WT. KG | 600# SO-FLG. WT. KG | 600# Thrd-FLG. WT. KG | 600# Lap-FLG. WT. KG | 600# Blind-FLG. WT. KG |
| 12.70 | 1.4 | 0.9 | 0.9 | 0.9 | 0.9 |
| 19.05 | 1.6 | 1.4 | 1.4 | 1.4 | 1.4 |
| 25.40 | 1.8 | 1.6 | 1.6 | 1.6 | 1.8 |
| 31.75 | 2.5 | 2.0 | 2.0 | 2.0 | 2.7 |
| 38.10 | 3.6 | 2.9 | 2.9 | 2.9 | 3.6 |
| 63.50 | 4.5 | 3.6 | 3.6 | 3.6 | 4.5 |
| 63.50 | 6.4 | 5.4 | 5.4 | 5.0 | 6.8 |
| 76.20 | 8.2 | 6.8 | 6.8 | 6.4 | 9.1 |
| 88.90 | 11.8 | 9.5 | 9.5 | 9.1 | 13.2 |
| 101.60 | 16.8 | 15.0 | 15.0 | 14.1 | 18.6 |
| 152.40 | 30.8 | 25.4 | 28.6 | 28.6 | 30.8 |
| 152.40 | 33.1 | 29.9 | 36.3 | 35.4 | 39.0 |
| 203.20 | 50.8 | 44.0 | 44.0 | 50.8 | 63.0 |
| 254.00 | 85.7 | 80.3 | 80.3 | 88.5 | 104.8 |
| 304.80 | 102.5 | 97.5 | 97.5 | 108.9 | 133.8 |
| 406.40 | 121.6 | 117.5 | 117.5 | 131.5 | 171.5 |
| 406.40 | 218.2 | 166.0 | 166.0 | 181.4 | 239.0 |
| 457.20 | 251.7 | 215.9 | 215.9 | 212.7 | 301.6 |
| 508.00 | 313.0 | 277.6 | 277.6 | 274.0 | 387.8 |
| 609.60 | 443.2 | 397.3 | 397.3 | 392.8 | 533.0 |

# FLANGE CHARTS

| ENGLISH | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE | 900# WNFLG. WR WT. LBS. | 900# SO-FLG. WT. LBS. | 900# Thrd-FLG. WT. LBS. | 900# Lap-FLG. WT. LBS. | 900# Blind-FLG. WT. LBS. |
| 1/2 | 7 | 6 | 6 | 6 | 4 |
| 3/4 | 7 | 6 | 6 | 6 | 6 |
| 1 | 8.5 | 7.5 | 7.5 | 7.5 | 9 |
| 1 1/4 | 10 | 10 | 10 | 10 | 10 |
| 1 1/2 | 14 | 14 | 14 | 14 | 14 |
| 2 | 24 | 22 | 22 | 21 | 25 |
| 2 1/2 | 36 | 36 | 36 | 29 | 35 |
| 3 | 29 | 31 | 31 | 25 | 32 |
| 4 | 51 | 53 | 53 | 51 | 54 |
| 5 | 86 | 83 | 83 | 81 | 87 |
| 6 | 110 | 108 | 108 | 105 | 113 |
| 8 | 187 | 172 | 172 | 188 | 197 |
| 10 | 268 | 245 | 245 | 277 | 290 |
| 12 | 372 | 326 | 326 | 371 | 413 |
| 14 | 562 | 380 | 380 | 397 | 494 |
| 16 | 685 | 459 | 459 | 488 | 619 |
| 18 | 924 | 647 | 647 | 670 | 880 |
| 20 | 1164 | 792 | 792 | 868 | 1107 |
| 24 | 2107 | 1480 | 1480 | 1659 | 2099 |

| METRIC | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE MM | 900# WNFLG. WT. KG | 900# SO-FLG. WT. KG | 900# Thrd-FLG. WT. KG | 900# Lap-FLG. WT. KG | 900# Blind-FLG. WT. KG |
| 12.70 | 3.2 | 2.7 | 2.7 | 2.7 | 1.8 |
| 19.05 | 3.2 | 2.7 | 2.7 | 2.7 | 2.7 |
| 25.40 | 3.9 | 3.4 | 3.4 | 3.4 | 4.1 |
| 31.75 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| 38.10 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 |
| 63.50 | 10.9 | 10.0 | 10.0 | 9.5 | 11.3 |
| 63.50 | 16.3 | 16.3 | 16.3 | 13.2 | 15.9 |
| 76.20 | 13.2 | 14.1 | 14.1 | 11.3 | 14.5 |
| 101.60 | 23.1 | 24.0 | 24.0 | 23.1 | 24.5 |
| 152.40 | 39.0 | 37.6 | 37.6 | 36.7 | 39.5 |
| 152.40 | 49.9 | 49.9 | 49.9 | 47.6 | 51.3 |
| 203.20 | 84.8 | 78.0 | 78.0 | 85.3 | 89.4 |
| 254.00 | 121.6 | 111.1 | 111.1 | 125.6 | 131.5 |
| 304.80 | 168.7 | 147.9 | 147.9 | 168.3 | 187.3 |
| 406.40 | 254.9 | 172.4 | 172.4 | 180.1 | 224.1 |
| 406.40 | 310.7 | 208.2 | 208.2 | 221.4 | 280.8 |
| 457.20 | 419.1 | 293.5 | 293.5 | 303.9 | 399.2 |
| 508.00 | 528.0 | 359.2 | 359.2 | 393.7 | 502.1 |
| 609.60 | 955.7 | 671.3 | 671.3 | 752.5 | 952.1 |

# FLANGE CHARTS

| ENGLISH | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE | 1500# WNFLG. WR WT. LBS. | 1500# SO-FLG. WT. LBS. | 1500# Thrd-FLG. WT. LBS. | 1500# Lap-FLG. WT. LBS. | 1500# Blind-FLG. WT. LBS. |
| 1/2 | 7 | 6 | 6 | 6 | 7 |
| 3/4 | 7 | 6 | 6 | 6 | 10 |
| 1 | 8.5 | 7.5 | 7.5 | 7.5 | 12 |
| 1 1/4 | 10 | 10 | 10 | 10 | 18 |
| 1 1/2 | 14 | 14 | 14 | 14 | 25 |
| 2 | 24 | 22 | 23 | 21 | 39 |
| 2 1/2 | 36 | 36 | 36 | 29 | 56 |
| 3 | 48 | 48 | 48 | 38 | 86 |
| 4 | 69 | 73 | 73 | 75 | 133 |
| 5 | 132 | 132 | 132 | 138 | 223 |
| 6 | 164 | 164 | 164 | 170 | 345 |
| 8 | 273 | 258 | 258 | 286 | 533 |
| 10 | 454 | 436 | 436 | 485 | 1025 |
| 12 | 690 | 667 | 667 | 749 | 1464 |
| 14 | | | | | |
| 16 | | | | | |
| 18 | | | | | |
| 20 | | | | | |
| 24 | | | | | |

| METRIC | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE MM | 1500# WNFLG. WT. KG | 1500# SO-FLG. WT. KG | 1500# Thrd-FLG. WT. KG | 1500# Lap-FLG. WT. KG | 1500# Blind-FLG. WT. KG |
| 12.70 | 3.2 | 2.7 | 2.7 | 2.7 | 3.2 |
| 19.05 | 3.2 | 2.7 | 2.7 | 2.7 | 4.5 |
| 25.40 | 3.9 | 3.4 | 3.4 | 3.4 | 5.4 |
| 31.75 | 4.5 | 4.5 | 4.5 | 4.5 | 8.2 |
| 38.10 | 6.4 | 6.4 | 6.4 | 6.4 | 11.3 |
| 63.50 | 10.9 | 10.0 | 10.4 | 9.5 | 17.7 |
| 63.50 | 16.3 | 16.3 | 16.3 | 13.2 | 25.4 |
| 76.20 | 21.8 | 21.8 | 21.8 | 17.2 | 39.0 |
| 101.60 | 31.3 | 33.1 | 33.1 | 34.0 | 60.3 |
| 152.40 | 59.9 | 59.9 | 59.9 | 62.6 | 101.2 |
| 152.40 | 74.4 | 74.4 | 74.4 | 77.1 | 156.5 |
| 203.20 | 123.8 | 117.0 | 117.0 | 129.7 | 241.8 |
| 254.00 | 205.9 | 197.8 | 197.8 | 220.0 | 464.9 |
| 304.80 | 313.0 | 302.5 | 302.5 | 339.7 | 664.1 |
| 406.40 | | | | | |
| 406.40 | | | | | |
| 457.20 | | | | | |
| 508.00 | | | | | |
| 609.60 | | | | | |

# FLANGE CHARTS

| ENGLISH | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE | 2500# WNFLG. WR WT. LBS. | 2500# SO-FLG. WT. LBS. | 2500# Thrd-FLG. WT. LBS. | 2500# Lap-FLG. WT. LBS. | 2500# Blind-FLG. WT. LBS. |
| 1/2 | 8 | 7 | 7 | 7 | 7 |
| 3/4 | 9 | 9 | 9 | 8 | 10 |
| 1 | 13 | 12 | 12 | 12 | 12 |
| 1 1/4 | 20 | 18 | 18 | 17 | 18 |
| 1 1/2 | 28 | 25 | 25 | 24 | 25 |
| 2 | 42 | 38 | 38 | 37 | 39 |
| 2 1/2 | 52 | 55 | 55 | 53 | 56 |
| 3 | 94 | 83 | 83 | 80 | 86 |
| 4 | 146 | 127 | 127 | 122 | 133 |
| 5 | 244 | 210 | 210 | 204 | 223 |
| 6 | 378 | 323 | 323 | 314 | 345 |
| 8 | 576 | 485 | 485 | 471 | 533 |
| 10 | 1068 | 925 | 925 | 897 | 1025 |
| 12 | 1608 | 1300 | 1300 | 1262 | 1464 |
| 14 | | | | | |
| 16 | | | | | |
| 18 | | | | | |
| 20 | | | | | |
| 24 | | | | | |

| METRIC | | | | | |
|---|---|---|---|---|---|
| NOM. PIPE SIZE MM | 2500# WNFLG. WT. KG | 2500# SO-FLG. WT. KG | 2500# Thrd-FLG. WT. KG | 2500# Lap-FLG. WT. KG | 2500# Blind-FLG. WT. KG |
| 12.70 | 3.6 | 3.2 | 3.2 | 3.2 | 3.2 |
| 19.05 | 4.1 | 4.1 | 4.1 | 3.6 | 4.5 |
| 25.40 | 5.9 | 5.4 | 5.4 | 5.4 | 5.4 |
| 31.75 | 9.1 | 8.2 | 8.2 | 7.7 | 8.2 |
| 38.10 | 12.7 | 11.3 | 11.3 | 10.9 | 11.3 |
| 63.50 | 19.1 | 17.2 | 17.2 | 16.8 | 17.7 |
| 63.50 | 23.6 | 24.9 | 24.9 | 24.0 | 25.4 |
| 76.20 | 42.6 | 37.6 | 37.6 | 36.3 | 39.0 |
| 101.60 | 66.2 | 57.6 | 57.6 | 55.3 | 60.3 |
| 152.40 | 110.7 | 95.3 | 95.3 | 92.5 | 101.2 |
| 152.40 | 171.5 | 146.5 | 146.5 | 142.4 | 156.5 |
| 203.20 | 261.3 | 220.0 | 220.0 | 213.6 | 241.8 |
| 254.00 | 484.4 | 419.6 | 419.6 | 406.9 | 464.9 |
| 304.80 | 729.4 | 589.7 | 589.7 | 572.4 | 664.1 |
| 406.40 | | | | | |
| 406.40 | | | | | |
| 457.20 | | | | | |
| 508.00 | | | | | |
| 609.60 | | | | | |

# GASKETS

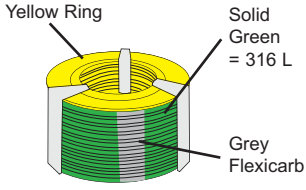
## There are a large variety of gaskets used within our industry. Each type has specific purposes, material types and chemical resistant properties.

There are non-metallic, semi-metallic and metallic types. Often the non-metallic gaskets are referred to as sheet gaskets after being cut from a specific sheet of material to a specific layout pattern. Trade names include Garlock, Flexitallic and Lamons to name a few.

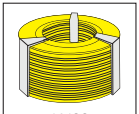
For this manual our photos demonstrate the spiral wound metallic and semi-metallic types. Careful consideration and adherence to the client design specifications must be considered when selecting the proper gasket. Please refer to your piping specifications prior to installing all gaskets and that the bolt torque is established with the gasket data information used for final bolt torque calculations.

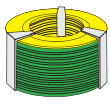
Contact your supervisor or QC department if there are any concerns with gasket specification types.

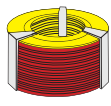
# GASKET COLOR CODES
## Metallic Winding Materials

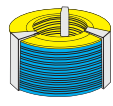


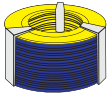

316/Flexicarb

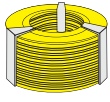

304SS
Yellow

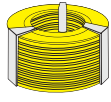

316L SS
Green

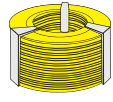

317L
Maroon


321SS
Turquoise

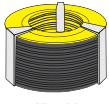

347SS
Blue

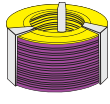

310SS
No Color

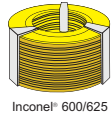

304LSS
No Color

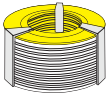

309SS
No Color

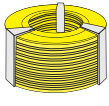

430SS
No Color

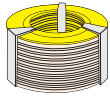

Alloy 20
Black

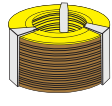

Titanium®
Purple


Inconel® 600/625
Gold


Incoloy® 800/825
White

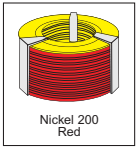

Inconel® X750
No Color

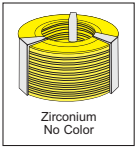

Hastelloy® C276
Beige


Hastelloy® B2
Brown

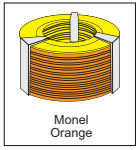
# GASKET COLOR CODES
## Metallic Winding Materials

CONTINUED

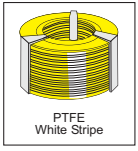

Nickel 200
Red

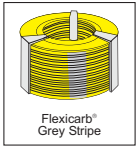

Zirconium
No Color

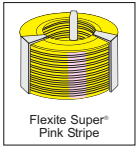

Carbon Steel
Silver

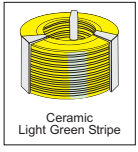

Monel
Orange

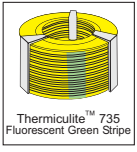
## Metallic Winding Materials

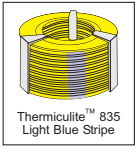

PTFE
White Stripe


Flexicarb®
Grey Stripe


Flexite Super®
Pink Stripe


Ceramic
Light Green Stripe


Thermiculite™ 735
Fluorescent Green Stripe


Thermiculite™ 835
Light Blue Stripe

# GASKET ASSEMBLY, BOLTING AND COMPRESSION

### Flange Inspection

1. Ensure flange faces are clean and fee from imperfections. These could be detrimental to sealing performance.
2. Carefully remove any solid residue from the flanges using scrapers, wire brush or cloth.

### Surface Finish Recommendations

**Sheet Jointing**
3.2 to 12.5 micro meter
Ra is dependent on gasket thickness (125 to 500 micro inch RMS

**Spiral Wound Gaskets**
Preferred Finish 3.2 to 6.3 micro meter Ra (125 to 250 micro inch RMS) on all pressure classes and critical applications

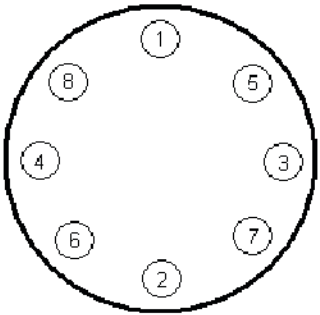
**Flexicarb RG & NR**
3.2 to 6.3 micro meter Ra (125 to 250 micro inch RMS)

**Jacketed Gaskets**
2.5 to 125 micro meter Ra (100 to 125 micro inch RMS)

**Solid Metal Gaskets**
1.6 micro meter max Ra (63 micro inch RMS max

### Bolting Recommendations

1. When utilizing Torque wrenches the use of suitable lubricants on the stud threads and nut bearing faces is recommended, e.g. Molybdenum disulphide or Nickel powder anti-seize compounds.
2. We recommend a 4 stage tightening method as follows:
   - Tighten the bolts at 30% of the final loading using the diametrical sequence.
   - 60% of final load following diametrical sequence.
   - 100% of final load following diametrical sequence.
   - 100% of final torque on adjacent bolts.



# BOLT SEQUENCE FOR PROPER TORQUEING

For easy handling, bolt numbering shall be done clockwise around the flange with the following sequence.

| | |
|---|---|
| 4 bolt Flange | 1,3,2,4 |
| 8 bolt Flange | 1,5,3,7,2,6,4,8 |
| 12 bolt Flange | 1,7,4,10,2,8,5,11,3,9,6,12 |
| 16 bolt Flange | 1,9,5,13,3,11,7,15,2,10,6,14,4,12,8,16 |
| 20 bolt Flange | 1,11,6,16,3,13,8,18,5,15,10,20,2,12,17,4,14,9,19 |
| 24 bolt Flange | 1,13,7,19,4,16,10,22,2,14,8,20,5,17,11,23,6,18,12,24,3,15,9,21 |
| 28 bolt Flange | 1,15,8,22,4,18,11,25,6,20,13,27,2,16,9,23,5,19,12,26,3,17,10,24,7,21,14,28 |
| 32 bolt Flange | 1,17,9,25,5,21,13,29,3,19,11,27,7,23,15,31,2,18,10,26,6,22,14,30,8,24,16,32,4,20,12,28 |

# BOLT TORQUE DATA

## Torque Table for Class 150 Flange

Flange Materials : ASTM A105, ASTM A182 grades F50 and F51, ASTM A350 grades LF2 and LF3, ASTM A694 grade F52

Bolting Materials : ASTM A193 grades B7 and B7M, ASTM A320 grades L7, L7M and L43.

Gasket Type : Spiral Wound Gasket

| SIZE IN INCH | SIZE IN MM | NO. OF BOLT | BOLT DIA. | THREAD TYPE | BOLT STRESS LB/IN2 | TORQUE LBF.FT. | TORQUE NM |
|---|---|---|---|---|---|---|---|
| 1/2 | 15 | 4 | ½" | UNC | 25,000 | 22 | 30 |
| 3/4 | 20 | 4 | ½" | UNC | 30,000 | 26 | 36 |
| 1 | 35 | 4 | ½" | UNC | 33,000 | 29 | 39 |
| 1 ½ | 40 | 4 | ½" | UNC | 50,000 | 44 | 60 |
| 2 | 50 | 4 | 5/8" | UNC | 50,000 | 86 | 117 |
| 3 | 80 | 4 | 5/8" | UNC | 50,000 | 86 | 117 |
| 4 | 100 | 8 | 5/8" | UNC | 40,000 | 69 | 93 |
| 6 | 150 | 8 | ¾" | UNC | 45,000 | 137 | 185 |
| 8 | 200 | 8 | ¾" | UNC | 45,000 | 137 | 185 |
| 10 | 250 | 12 | 7/8" | UNC | 40,000 | 194 | 263 |
| 12 | 300 | 12 | 7/8" | UNC | 40,000 | 194 | 263 |
| 14 | 350 | 12 | 1" | UN8 | 41,000 | 296 | 401 |
| 16 | 400 | 16 | 1" | UN8 | 40,000 | 289 | 392 |
| 18 | 450 | 16 | 1 1/8" | UN8 | 40,000 | 421 | 571 |
| 20 | 500 | 20 | 1 1/8" | UN8 | 40,000 | 421 | 571 |
| 24 | 600 | 20 | 1 ¼" | UN8 | 40,000 | 588 | 797 |

# BOLT TORQUE DATA

## Torque Table for Class 300 Flange

| |
|---|
| Flange Materials : ASTM A105, ASTM A182 grades F50 and F51, ASTM A350 grades LF2 and LF3, ASTM A694 grade F52 |
| Bolting Materials : ASTM A193 grades B7 and B7M, ASTM A320 grades L7, L7M and L43. |
| Gasket Type : Spiral Wound and Ring Joint |
| Bolt Lubricant Molykote 1000 (μ = 0.11) |

| SIZE IN INCH | SIZE IN MM | NO. OF BOLT | BOLT DIA. | THREAD TYPE | BOLT STRESS LB/IN2 | TORQUE LBF.FT. | TORQUE NM |
|---|---|---|---|---|---|---|---|
| 1/2 | 15 | 4 | ½" | UNC | 40,000 | 35 | 47 |
| 3/4 | 20 | 4 | ½" | UNC | 40,000 | 69 | 93 |
| 1 | 35 | 4 | ½" | UNC | 40,000 | 69 | 93 |
| 1 ½ | 40 | 4 | ½" | UNC | 31,000 | 94 | 128 |
| 2 | 50 | 4 | 5/8" | UNC | 37,000 | 64 | 87 |
| 3 | 80 | 4 | 5/8" | UNC | 42,000 | 127 | 173 |
| 4 | 100 | 8 | 5/8" | UNC | 45,000 | 137 | 185 |
| 6 | 150 | 8 | ¾" | UNC | 45,000 | 137 | 185 |
| 8 | 200 | 8 | ¾" | UNC | 45,000 | 218 | 296 |
| 10 | 250 | 12 | 7/8" | UNC | 45,000 | 325 | 441 |
| 12 | 300 | 12 | 7/8" | UNC | 43,000 | 453 | 614 |
| 14 | 350 | 12 | 1" | UN8 | 45,000 | 474 | 643 |
| 16 | 400 | 16 | 1" | UN8 | 31,000 | 456 | 618 |
| 18 | 450 | 16 | 1 1/8" | UN8 | 34,000 | 500 | 678 |
| 20 | 500 | 20 | 1 1/8" | UN8 | 40,000 | 588 | 797 |
| 24 | 600 | 20 | 1 ¼" | UN8 | 31,000 | 809 | 1097 |

# VICTOR OXYGEN & ACETYLENE CUTTING PRESSURE & TIP CHART

| METAL THICKNESS | VICTOR TIP # | OXYGEN P.S.I. CUTTING PRESSURE | | FUEL P.S.I ACETYLENE @REGULATOR | CONSUMPTION C.F.H. | | | CUTTING SPEED I.P.M. | KERF WIDTH | TIP CLEANING DRILL SIZES | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | @ REGULATOR | @TORCH | | CUTTING OXYGEN | PREHEAT OXYGEN | FUEL ACETY-LENE | | | CUTTING | PREHEAT |
| 1/8" | 000 | 20 | 20 | 3 | 18 | 7 | 6.5 | 28 | 0.035 | 72 | 75 |
| 3/16" | 00 | 20 | 20 | 3 | 24 | 7 | 6.5 | 26 | 0.05 | 68 | 75 |
| 1/4" | 0 | 30 | 30 | 4 | 40 | 7.5 | 7 | 22 | 0.055 | 62 | 73 |
| 3/8" | 0 | 35 | 35 | 4 | 50 | 7.5 | 7 | 20 | 0.055 | 62 | 73 |
| 1/2" | 1 | 35 | 35 | 4 | 75 | 11 | 9.5 | 19 | 0.08 | 56 | 71 |
| 5/8" | 1 | 40 | 40 | 4 | 85 | 11 | 9.5 | 17 | 0.08 | 56 | 71 |
| 3/4" | 2 | 35 | 35 | 4 | 105 | 12 | 10.5 | 16 | 0.095 | 54 | 70 |
| 1" | 2 | 41 | 40 | 4 | 115 | 12 | 10.5 | 14 | 0.095 | 54 | 70 |
| 1 1/4" | 2 | 51 | 50 | 4 | 135 | 12 | 10.5 | 13 | 0.095 | 54 | 70 |
| 1 1/2" | 3 | 42 | 40 | 5 | 170 | 14 | 12 | 12 | 0.100 | 51 | 68 |
| 2" | 3 | 47 | 45 | 5 | 180 | 14 | 12 | 10 | 0.100 | 51 | 68 |
| 2 1/2" | 4 | 38 | 35 | 5 | 240 | 15 | 13 | 9 | 0.125 | 45 | 62 |
| 3" | 4 | 44 | 40 | 5 | 265 | 15 | 13 | 8 | 0.125 | 45 | 62 |
| 4" | 4 | 54 | 50 | 5 | 315 | 16 | 14 | 7 | 0.125 | 45 | 62 |
| 5" | 5 | 56 | 50 | 6 | 420 | 29 | 25 | 7 | 0.150 | 41 | 60 |
| 6" | 5 | 67 | 60 | 6 | 485 | 2 | 25 | 6 | 0.150 | 41 | 60 |
| 8" | 5 | 78 | 70 | 6 | 550 | 30 | 26 | 5.5 | 0.150 | 41 | 60 |
| 10" | 6 | 83 | 70 | 6 | 750 | 32 | 28 | 5 | 0.203 | 32 | 60 |
| 12" | 6 | 125 | 90 | 6 | 975 | 32 | 28 | 4.5 | 0.230 | 32 | 60 |
| 14" | 7 | 100 | 82 | 7 | 1250 | 34 | 30 | 4 | 0.250 | 28 | 56 |

# ANSI BOLTING CHART
## ½" – 4"

| PRES-SURE RATING | BOLTING | FLANGE FACING | NORMAL PIPE SIZE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/2 | 3/4 | 1 | 1 1/4 | 1 1/2 | 2 | 2 1/2 | 3 | 3 1/2 | 4 |
| 150 Pound | Number | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 8 | 8 |
| | Diameter | | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 5/8 | 5/8 | 5/8 | 5/8 | 5/8 |
| | Length of Stud Bolts | 1 1/16 RF | 2 1/2 | 2 1/2 | 2 3/4 | 2 3/4 | 3 | 3 1/4 | 3 1/2 | 3 3/4 | 3 3/4 | 3 3/4 |
| | | RTJ | – | – | 3 1/4 | 3 1/4 | 3 1/2 | 3 3/4 | 4 | 4 1/4 | 4 1/4 | 4 1/4 |
| | Ring Size | R | – | – | 15 | 17 | 19 | 22 | 25 | 29 | 33 | 36 |
| 300 Pound | Number | | 4 | 4 | 4 | 4 | 4 | 8 | 8 | 8 | 8 | 8 |
| | Diameter | | 1/2 | 5/8 | 5/8 | 5/8 | 3/4 | 5/8 | 3/4 | 3/4 | 3/4 | 3/4 |
| | Length of Stud Bolts | 1/16 RF | 2 3/4 | 3 | 3 1/4 | 3 1/4 | 3 3/4 | 3 1/2 | 4 | 4 1/4 | 4 1/2 | 4 1/2 |
| | | RTJ | 3 1/4 | 3 1/2 | 3 3/4 | 3 3/4 | 4 1/4 | 4 1/4 | 4 3/4 | 5 | 5 1/4 | 5 1/4 |
| | Ring Size | R | 11 | 13 | 16 | 18 | 20 | 23 | 26 | 31 | 34 | 37 |
| | | RX | – | – | – | – | 20 | 23 | 26 | 31 | 34 | 37 |
| 400 Pound | Number | | 4 | 4 | 4 | 4 | 4 | 8 | 8 | 8 | 8 | 8 |
| | Diameter | | 1/2 | 5/8 | 5/8 | 5/8 | 3/4 | 5/8 | 3/4 | 3/4 | 7/8 | 7/8 |
| | Length of Stud Bolts | 1/4 RF | 3 1/4 | 3 1/2 | 3 3/4 | 4 | 4 1/4 | 4 1/4 | 4 3/4 | 5 | 5 1/2 | 5 1/2 |
| | | RTJ | 3 1/4 | 3 1/2 | 3 3/4 | 4 | 4 1/4 | 4 1/2 | 5 | 5 1/4 | 5 3/4 | 5 3/4 |
| | Ring Size | R | 11 | 13 | 16 | 18 | 20 | 23 | 26 | 31 | 34 | 37 |
| | | RX | – | – | – | – | 20 | 23 | 26 | 31 | 34 | 37 |
| 600 Pound | Number | | 4 | 4 | 4 | 4 | 4 | 8 | 8 | 8 | 8 | 8 |
| | Diameter | | 1/2 | 5/8 | 5/8 | 5/8 | 3/4 | 5/8 | 3/4 | 3/4 | 7/8 | 7/8 |
| | Length of Stud Bolts | 1/4 RF | 3 1/4 | 3 1/2 | 3 3/4 | 4 | 4 1/4 | 4 1/4 | 4 3/4 | 5 | 5 1/2 | 5 3/4 |
| | | RTJ | 3 1/4 | 3 1/2 | 3 3/4 | 4 | 4 1/4 | 4 1/2 | 5 | 5 1/4 | 5 3/4 | 6 |
| | Ring Size | R | 11 | 13 | 16 | 18 | 20 | 23 | 26 | 31 | 34 | 37 |
| | | RX | – | – | – | – | 20 | 23 | 26 | 31 | 34 | 37 |
| 900 Pound | Number | | 4 | 4 | 4 | 4 | 4 | 8 | 8 | 8 | – | 8 |
| | Diameter | | 3/4 | 3/4 | 7/8 | 7/8 | 1 | 7/8 | 1 | 7/8 | – | 1 1/8 |
| | Length of Stud Bolts | 1/4 RF | 4 1/4 | 4 1/2 | 5 | 5 | 5 1/2 | 5 3/4 | 6 1/4 | 5 3/4 | – | 6 3/4 |
| | | RTJ | 4 1/4 | 4 1/2 | 5 | 5 | 5 1/2 | 6 | 6 1/2 | 6 | – | 7 |
| | Ring Size | R | 12 | 14 | 16 | 18 | 20 | 24 | 27 | 31 | – | 37 |
| | | RX | – | – | – | – | 20 | 24 | 27 | 31 | – | 37 |

# ANSI BOLTING CHART
# 5" - 24"

| PRESSURE RATING | BOLTING | FLANGE FACING | NORMAL PIPE SIZE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 24 |
| 150 Pound | Number | | 8 | 8 | 8 | 12 | 12 | 12 | 16 | 16 | 20 | 20 |
| | Diameter | | 3/4 | 3/4' | 3/4 | 7/8' | 7/8' | 1 | 1 | 1 1/8 | 1 1/8 | 1 1/4 |
| | Length of | 1 1/16 RF | 4 | 4 | 4 1/4 | 4 3/4 | 4 3/4 | 5 1/4 | 5 1/2 | 6 | 6 1/4 | 7 |
| | Stud Bolts | RTJ | 4 1/2 | 4 1/2 | 4 1/2 | 5 1/4 | 5 1/4 | 5 3/4 | 6 | 6 1/2 | 6 3/4 | 7 1/2 |
| | Ring Size | R | 40 | 43 | 48 | 52 | 56 | 59 | 64 | 68 | 72 | 76 |
| 300 Pound | Number | | 8 | 12 | 12 | 16 | 16 | 20 | 20 | 24 | 24 | 24 |
| | Diameter | | 3/4 | 3/4 | 7/8' | 1 | 1 1/8 | 1 1/8 | 1 1/4 | 1 1/4 | 1 1/4 | 1 1/2 |
| | Length of | 1/4 RF | 4 3/4 | 5 | 5 1/2 | 6 1/4 | 6 3/4 | 7 | 7 1/2 | 7 3/4 | 8 1/4 | 9 1/4 |
| | Stud Bolts | RTJ | 5 1/2 | 5 3/4 | 6 1/4 | 7 | 7 1/2 | 7 3/4 | 8 1/4 | 8 1/2 | 9 | 10 1/4 |
| | Ring Size | R | 41 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 73 | 77 |
| | | RX | 41 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 73 | 77 |
| 400 Pound | Number | | 8 | 12 | 12 | 16 | 16 | 20 | 20 | 24 | 24 | 24 |
| | Diameter | | 7/8 | 7/8 | 1 | 1 1/8 | 1 1/4 | 1 1/4 | 1 3/8 | 1 3/8 | 1 1/2 | 1 3/4 |
| | Length of | 1/4 RF | 5 3/4 | 6 | 6 3/4 | 7 1/2 | 8 | 8 1/4 | 8 3/4 | 9 | 9 3/4 | 10 3/4 |
| | Stud Bolts | RTJ | 6 | 6 1/4 | 7 | 7 3/4 | 8 1/4 | 8 1/2 | 9 | 9 1/4 | 10 | 11 1/4 |
| 600 Pound | Number | | 8 | 12 | 12 | 16 | 20 | 20 | 20 | 20 | 24 | 24 |
| | Diameter | | 1 | 1 | 1 1/8 | 1 1/4 | 1 1/4 | 1 3/8 | 1 1/2 | 1 5/8 | 1 5/8 | 1 7/8 |
| | Length of | 1/4 RF | 6 1/2 | 6 3/4 | 7 3/4 | 8 1/2 | 8 3/4 | 9 1/4 | 10 | 10 3/4 | 11 1/2 | 13 |
| | Stud Bolts | RTJ | 6 3/4 | 7 | 8 | 8 3/4 | 9 | 9 1/2 | 10 1/4 | 11 | 11 3/4 | 13 1/2 |
| | Ring | R | 41 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 73 | 77 |
| | Size | RX | 41 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 73 | 77 |
| 900 Pound | Number | | 8 | 12 | 12 | 16 | 20 | 20 | 20 | 20 | 20 | 20 |
| | Diameter | | 1 1/4 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 1/2 | 1 5/8 | 1 7/8 | 2 | 2 1/2 |
| | Length of | 1/4 RF | 7 1/2 | 7 3/4 | 8 3/4 | 9 1/4 | 10 | 10 3/4 | 11 1/4 | 13 | 13 3/4 | 17 1/4 |
| | Stud Bolts | RTJ | 7 3/4 | 7 3/4 | 9 | 9 1/2 | 10 1/4 | 11 1/4 | 11 3/4 | 13 1/2 | 14 1/4 | 18 |
| | Ring | R | 41 | 45 | 49 | 53 | 57 | 62 | 66 | 70 | 74 | 78 |
| | Size | RX | 41 | 45 | 49 | 53 | 57 | 62 | 66 | 70 | 74 | 78 |
| 1500 Pound | Number | | 8 | 12 | 12 | 12 | 12 | 16 | 16 | 16 | 16 | 16 |
| | Diameter | | 1 1/2 | 1 3/8 | 1 5/8 | 1 7/8 | 2 | 2 1/4 | 2 1/2 | 2 3/4 | 3 | 3 1/2 |
| | Length of | 1/4 RF | 9 3/4 | 10 1/4 | 11 1/2 | 13 1/2 | 15 | 16 1/4 | 17 3/4 | 19 1/2 | 21 1/4 | 24 1/4 |
| | Stud Bolts | RTJ | 10 | 10 1/2 | 12 | 13 3/4 | 15 1/2 | 17 | 18 3/4 | 20 1/2 | 22 1/2 | 25 1/2 |
| | Ring | R | 44 | 46 | 50 | 54 | 58 | 63 | 67 | 71 | 75 | 79 |
| | Size | RX | 44 | 46 | 50 | 54 | 58 | 63 | 67 | 71 | 75 | 79 |
| 2500 Pound | Number | | 8 | 12 | 12 | 12 | 12 | – | – | – | – | – |
| | Diameter | | 1 3/4 | 2 | 2 | 2 1/2 | 2 3/4 | – | – | – | – | – |
| | Length of | 1/4 RF | 11 3/4 | 13 3/4 | 15 1/4 | 19 1/4 | 21 1/4 | – | – | – | – | – |
| | Stud Bolts | RTJ | 12 1/2 | 14 1/4 | 15 3/4 | 20 1/4 | 22 1/4 | – | – | – | – | – |
| | Ring | R | 42 | 47 | 51 | 55 | 60 | – | – | – | – | – |
| | Size | RX | 42 | 47 | 51 | 55 | 60 | – | – | – | – | – |

# WELD-O-LETS

| RUN SIZE | WT. OR SCH. | CENTER OF RUN TO FACE FITTING | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | OUTLET SIZE | | | | | | | |
| | | 1/2 | 3/4 | 1 | 1 1/2 | 2 | 2 1/2 | 3 | 4 |
| **1/2** | STD | 1 3/16 | | | | | | | |
| | XS | 1 3/16 | | | | | | | |
| | 160&XXS | 1 1/2 | | | | | | | |
| **3/4** | STD | 1 1/4 | 1 7/16 | | | | | | |
| | XS | 1 1/4 | 1 7/16 | | | | | | |
| | 160&XXS | 1 5/8 | 1 3/4 | | | | | | |
| **1** | STD | 1 3/8 | 1 1/2 | 1 11/16 | | | | | |
| | XS | 1 3/8 | 1 1/2 | 1 11/16 | | | | | |
| | 160&XXS | 1 3/4 | 1 7/8 | 2 1/8 | | | | | |
| **1 1/2** | STD | 1 11/16 | 1 13/16 | 2 | 2 1/4 | | | | |
| | XS | 1 11/16 | 1 13/16 | 2 | 2 1/4 | | | | |
| | 160&XXS | 2 1/16 | 2 3/16 | 2 7/16 | 2 15/16 | | | | |
| **2** | STD | 1 15/16 | 2 1/16 | 2 1/4 | 2 1/2 | 3 5/6 | | | |
| | XS | 1 15/16 | 2 1/16 | 2 1/4 | 2 1/2 | 2 11/16 | | | |
| | 160&XXS | 2 5/16 | 2 7/16 | 2 11/16 | 3 3/16 | 3 3/8 | | | |
| **2 1/2** | STD | 2 3/16 | 2 5/16 | 2 1/2 | 2 3/4 | 2 15/16 | 3 1/16 | | |
| | XS | 2 3/16 | 2 5/16 | 2 1/2 | 2 3/4 | 2 15/16 | 3 1/16 | | |
| | 160&XXS | 2 9/16 | 2 11/16 | 2 15/16 | 3 7/16 | 3 5/8 | 3 7/8 | | |
| **3** | STD | 2 1/2 | 2 5/8 | 2 13/16 | 3 1/16 | 3 1/4 | 3 3/8 | 3 1/2 | |
| | XS | 2 1/2 | 2 5/8 | 2 13/16 | 3 1/16 | 3 1/4 | 3 3/8 | 3 1/2 | |
| | 160&XXS | 2 7/8 | 3 | 3 1/4 | 3 3/4 | 3 15/16 | 4 3/16 | 4 5/8 | |
| **4** | STD | 3 | 3 1/8 | 3 5/16 | 3 9/16 | 3 3/4 | 3 7/8 | 4 | 4 1/4 |
| | XS | 3 | 3 1/8 | 3 5/16 | 3 9/16 | 3 3/4 | 3 7/8 | 4 | 4 1/4 |
| | 160&XXS | 3 3/8 | 3 1/2 | 3 3/4 | 4 1/4 | 4 7/16 | 4 11/16 | 5 1/8 | 5 9/16 |

# WELD-O-LETS

*USE HEAVY WALL WELD-O-LET

| RUN SIZE | WT. OR SCH. | CENTER OF RUN TO FACE FITTING | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | OUTLET SIZE | | | | | | | |
| | | 1/2 | 3/4 | 1 | 1 1/2 | 2 | 2 1/2 | 3 | 4 |
| **6** | STD | 4 1/16 | 4 3/16 | 4 3/8 | 4 5/8 | 4 13/16 | 4 15/16 | 5 1/16 | 5 5/16 |
| | XS | 4 1/16 | 4 3/16 | 4 3/8 | 4 5/8 | 4 13/16 | 4 15/16 | 5 1/16 | 5 5/16 |
| | 160&XXS | 4 7/16 | 4 9/16 | 4 13/16 | 5 5/16 | 5 1/2 | 5 3/4 | 6 3/16 | 6 5/8 |
| **8** | STD | 5 1/16 | 5 3/16 | 5 3/8 | 5 5/8 | 5 13/16 | 5 15/16 | 6 1/16 | 6 5/16 |
| | XS | 5 1/16 | 5 3/16 | 5 3/8 | 5 5/8 | 5 13/16 | 5 15/16 | 6 1/16 | 6 5/16 |
| | 160&XXS | | | | | 6 1/2 | 6 3/4 | 7 3/16 | 7 5/8 |
| **10** | STD | 6 1/8 | 6 1/4 | 6 7/16 | 6 11/16 | 6 7/8 | 7 | 7 1/8 | 7 3/8 |
| | XS | 6 1/8 | 6 1/4 | 6 7/16 | 6 11/16 | 6 7/8 | 7 | 7 1/8 | 7 3/8 |
| | 160&XXS | | | | | 7 9/16 | 7 13/16 | 8 1/4 | 8 11/16 |
| **12** | STD | 7 1/8 | 7 1/4 | 7 7/16 | 7 11/16 | 7 7/8 | 8 | 8 1/8 | 8 3/8 |
| | XS | 7 1/8 | 7 1/4 | 7 7/16 | 7 11/16 | 7 7/8 | 8 | 8 1/8 | 8 3/8 |
| | 160&XXS | | | | | 8 9/16 | 8 13/16 | 9 1/4 | 9 11/16 |
| **14** | STD | 7 3/4 | 7 7/8 | 8 1/16 | 8 5/16 | 8 1/2 | 8 5/8 | 8 3/4 | 9 |
| | XS | 7 3/4 | 7 7/8 | 8 1/16 | 8 5/16 | 8 1/2 | 8 5/8 | 8 3/4 | 9 |
| | 160&XXS | | | | | 9 3/16 | 9 7/16 | 9 7/8 | 10 5/16 |
| **16** | STD | 8 3/4 | 8 7/8 | 9 1/16 | 9 5/16 | 9 1/2 | 9 5/8 | 9 3/4 | 10 |
| | XS | 8 3/4 | 8 7/8 | 9 1/16 | 9 5/16 | 9 1/2 | 9 5/8 | 9 3/4 | 10 |
| | 160&XXS | | | | | 10 3/16 | 10 7/16 | 10 7/8 | 11 5/16 |
| **18** | STD | 9 3/4 | 9 7/8 | 10 1/16 | 10 5/16 | 10 1/2 | 10 5/8 | 10 3/4 | 11 |
| | XS | 9 3/4 | 9 7/8 | 10 1/16 | 10 5/16 | 10 1/2 | 10 5/8 | 10 3/4 | 11 |
| | 160&XXS | | | | | 11 3/16 | 11 7/16 | 11 7/8 | 12 5/16 |
| **20** | STD | 10 3/4 | 10 7/8 | 11 1/16 | 11 5/16 | 11 1/2 | 11 5/8 | 11 3/4 | 12 |
| | XS | 10 3/4 | 10 7/8 | 11 1/16 | 11 5/16 | 11 1/2 | 11 5/8 | 11 3/4 | 12 |
| | 160&XXS | | | | | 12 3/16 | 12 7/16 | 12 7/8 | 13 5/16 |
| **24** | STD | 12 3/4 | 12 7/8 | 13 1/16 | 13 5/16 | 13 1/2 | 13 5/8 | 13 3/4 | 14 |
| | XS | 12 3/4 | 12 7/8 | 13 1/16 | 13 5/16 | 13 1/2 | 13 5/8 | 13 3/4 | 14 |
| | 160&XXS | | | | | 14 3/16 | 14 7/16 | 14 7/8 | 15 5/16 |

# WELD-O-LETS

| RUN SIZE | WT. OR SCH. | CENTER OF RUN TO FACE FITTING | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | OUTLET SIZE | | | | | | | | |
| | | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 24 |
| **6** | STD | 5 11/16 | | | | | | | | |
| | XS | 6 3/8 | | | | | | | | |
| | 160&XXS | 7 7/16 | | | | | | | | |
| **8** | STD | 6 11/16 | 7 1/16 | | | | | | | |
| | XS | 7 3/8 | 8 3/16 | | | | | | | |
| | 160&XXS | 8 7/16 | * | | | | | | | |
| **10** | STD | 7 3/4 | 8 1/8 | 8 7/16 | | | | | | |
| | XS | 8 7/16 | 9 1/4 | 9 1/8 | | | | | | |
| | 160&XXS | 9 1/2 | * | * | | | | | | |
| **12** | STD | 8 3/4 | 9 1/8 | 9 7/16 | 9 3/4 | | | | | |
| | XS | 9 7/16 | 10 1/4 | 10 1/16 | 10 5/16 | | | | | |
| | 160&XXS | 10 1/2 | * | * | * | | | | | |
| **14** | STD | 9 3/8 | 9 3/4 | 10 1/16 | 10 3/8 | 10 1/2 | | | | |
| | XS | 10 1/16 | 10 7/8 | 10 11/16 | 11 1/16 | 11 1/8 | | | | |
| | 160&XXS | 11 1/8 | * | * | * | * | | | | |
| **16** | STD | 10 3/8 | 10 3/4 | 11 1/16 | 11 3/8 | 11 1/2 | 11 11/16 | | | |
| | XS | 11 1/16 | 11 7/8 | 11 11/16 | 12 1/16 | 11 15/16 | 12 7/16 | | | |
| | 160&XXS | 12 1/8 | * | * | * | * | * | | | |
| **18** | STD | 11 3/8 | 11 3/4 | 12 1/16 | 12 3/8 | 12 1/2 | 12 11/16 | 13 1/16 | | |
| | XS | 12 1/16 | 12 7/8 | 12 11/16 | 13 1/16 | 12 15/16 | 13 3/16 | 13 11/16 | | |
| | 160&XXS | 13 1/8 | * | * | * | * | * | * | | |
| **20** | STD | 12 3/8 | 12 3/4 | 13 1/16 | 13 3/8 | 13 1/2 | 13 11/16 | 13 13/16 | 14 5/8 | |
| | XS | 13 1/16 | 13 7/8 | 13 11/16 | 14 1/16 | 13 15/16 | 14 3/16 | 14 3/8 | 15 | |
| | 160&XXS | 14 1/8 | * | * | * | * | * | * | * | |
| **24** | STD | 14 3/8 | 14 3/4 | 15 1/16 | 15 3/8 | 15 1/2 | 15 11/16 | 15 13/16 | 16 | 17 3/8 |
| | XS | 15 1/16 | 15 7/8 | 15 11/16 | 16 1/16 | 15 15/16 | 16 3/16 | 16 3/8 | 16 11/16 | 17 1/2 |
| | 160&XXS | 16 1/8 | * | * | * | * | * | * | * | * |

# ASTM MATERIAL CODES

### Carbon Steel

| PIPE | VALVES | FLANGES | WELD FITTINGS | SCREWED & SOCKET FITTINGS |
|---|---|---|---|---|
| A53 | A105 | A105 Grade 2 | A234 WPB | A105 Grade 2 |
| | A216 WCB | A181 Grade 2 | | A181 Grade 2 |
| A106B | A105 | A105 Grade 2 | A234 WPB | A105 Grade 2 |
| | A216 WCB | A181 Grade 2 | | A181 Grade 2 |

### Stainless Steels

| PIPE | VALVES | FLANGES | WELD FITTINGS | SCREWED & SOCKET FITTINGS |
|---|---|---|---|---|
| A312 T304 | A182 F-304/A351 CF8 | A182 F-304 | A403 WP-316L | A182 F-304 |
| A312 304L | A182 F-304L/A296 CF3 | A182 F-304L | A403 WP-304L | A182 F-304L |
| A312 T316 | A182 F-316/A351 CF8M | A182 F-316 | A403 WP-316 | A182 F-316 |
| A312 316L | A182 F-316L/A296 CF3M | A182 F-316L | A403 WP-316L | A182 F-316L |
| A312 321 | A182 F-321/A351 CF8C | A182 F-321 | A403 WP-321 | A182 F-321 |
| A312 347 | A182 F/347/A351 CF8CMO | A182 F-347 | A403 WP-347 | A182 F-347 |

### Low-Temperature Steels

| PIPE | VALVES | FLANGES | WELD FITTINGS | SCREWED & SOCKET FITTINGS |
|---|---|---|---|---|
| A333 Grade 6 | A350 LF-2/A352 LCB | A350 LF-2 | A420 WPL-6 | A350 LF-2 |
| A333 Grade 3 | A350 LF-3/A352 LCS | A350 LF-3 | A420 WPL-3 | A350 LF-3 |

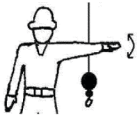
### Chrome-Moly Alloys

| PIPE | VALVES | FLANGES | WELD FITTINGS | SCREWED & SOCKET FITTINGS |
|---|---|---|---|---|
| A335 P-1 | A217 WC-6 | A182 F-1 | A234 WP-1 | A182 F-1 |
| A335 P-12 | A217 WC-6 | A182 F-12 | A234 WP-12 | A182 F-12 |
| A335 P-11 | A182 F11/A217 WC-6 | A182 F-11 | A234 WP-11 | A182 F-11 |
| A335 P-22 | A182 F-22/A217 WC-9 | A182 F-22 | A234 WP-22 | A182 F-22 |
| A335 P-5 | A182 F-5/A217 WC-5 | A182 F-5 | A234 WP-5 | A182 F-5 |
| A335 P-7 | A182 F-7/A217 WC-12 | A182 F-7 | A234 WP-7 | A182 F-7 |
| A335 P-9 | A182 F-9/A217 WC-12 | A182 F-9 | A234 WP-9 | A182 F-9 |
| A268 T-410 | A182 F-6/A351 CA15 | A182 F-6 | A234 WP-410 | A182 F-6 |

SECTION 6:

# RIGGING AND CRANE

# RIGGING SIGNALS

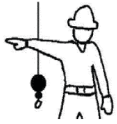


**STOP:** With arm extended horizontally to the side, palm down, arm is wung back and forth.

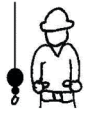
**EMERGENCY STOP:** With both arms extended horizontally to the side, palms down, arms are swung back and forth.

**HOIST:** With upper arm extended to the side, forearm and index finger pointing straight up, hand and finger make small circles.

**RAISE BOOM:** With arm extended horizontally to the side, thumb points up with other fingers closed.



**SWING:** With arm extended horizontally, index finger points in direction that boom is to swing.



**RETRACT TELESCOPING BOOM:** With hands to the front at waist level, thumbs point at each other with other fingers closed.

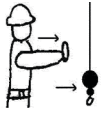
**RAISE THE BOOM AND LOWER THE LOAD:** With arm extended horizontally to the side and thumb pointing up, fingers open and close while load movement is desired.

**DOG EVERYTHING** Hands held together at waist level.

**LOWER** With arm and index finger pointing down, hand and finger make small circles.

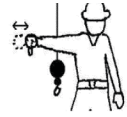
**LOWER BOOM:** With arm extended horizontally to the side, thumb points down with other fingers closed.

**EXTEND TELESCOPING BOOM**: With hands to the front at waist level, thumbs point outward with other fingers closed.



**TRAVEL/TOWER TRAVEL:** With all fingers pointing up, arm is extended horizontally out and back to make a pushing motion in the direction of travel.

# RIGGING SIGNALS



**LOWER THE BOOM AND RAISE THE LOAD:** With arm extended horizontally to the side and thumb pointing down, fingers open and close while load movement is desired.

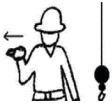
**MOVE SLOWLY:** A hand is placed in front of the hand that is giving the action signal.

**USE AUXILIARY HOIST (WHIPLINE):** With arm bent at elbow and forearm vertical, elbow is tapped with other hand. Then regular signal is used to indicate desired action.

**CRAWLER CRANE TRAVEL, BOTH TRACKS:** Rotate fists around each other in front of body; direction of rotation away from body indicates travel forward; rotation towards body indicates travel backward.

**USE MAIN HOIST:** A hand taps on top of the head. Then regular signal is given to indicate desired direction.

**CRAWLER CRANE TRAVEL, ONE TRACK:** Indicate track to be locked by raising fist on that side. Rotate other fist in front of body in direction that other track is to travel.



**TROLLEY TRAVEL:** With palm up, fingers closed and thumb pointing in direction of motion, hand is jerked horizontally in direction trolley is to travel.

SOURCE FOR HAND SIGNALS: OSHA 29 CFR 1926, SUBPART CC, APPENDIX A

# CRANE & RIGGING QUALIFICATIONS

## Operator Training, Qualification and Certification

Only employees who are qualified by the possession of a current accredited NCCCO as applicable crane operator testing certification and on-site qualifications may operate a crane.

A state or local license is required if:

1. working within a state or locality that has licensing requirements, and

2. the licensing program meets the licensing and certification criteria listed in subpart CC.

3. A state or local license is valid for the period of time stipulated by the licensing office, but no longer than 5 years. It is portable only within the jurisdiction of the issuing agency.

WRITTEN TESTS MAY BE ADMINISTERED IN A LANGUAGE UNDERSTOOD BY THE OPERATOR CANDIDATE. WHEN AN OPERATOR'S TESTING IS BASED ON A LANGUAGE OTHER THAN ENGLISH, IT MUST BE NOTED ON THE CERTIFICATE.

## Rigger Training, Qualification and Certification

All rigging work will be performed by a qualified rigger. A qualified rigger means a person who, by possession of a recognized degree, certificate or professional standing, or who by extensive knowledge, training and experience, successfully demonstrated the ability to solve/resolve problems relating to the subject matter, the work, or the project.

Riggers will be qualified by an accredited organization or assessed by a third Party (DOL, NCCER, NCCCO, etc.).

# RIGGING SIGNAL TIPS
## Common Safety for Crane Operation

- The preferred method of communication is to have visual signals, however it is not always feasible, in those cases radios must be utilized.
- A crane operator should always move loads according to the established code of signals, and use a signaler. Hand signals are preferred and should be clarified before work begins.
- Only a qualified person should give signals to the crane operator.
- There should be only one designated person at a time giving crane signals.
- A crane operator should move loads only on crane signals from one person. A crane operator must obey a STOP signal regardless of who gives it.
- When feasible the person giving crane signals must be in clear view of the crane operator.
- The person giving crane signals must have a clear view of the load and the equipment.
- The person giving the crane signals must keep people outside the crane's operating area. Any request or question should be addressed to the signaler.
- The person giving crane signals should never direct a load over a person.
- No part of a crane or load should come within 15 feet of any power line. High power transmission lines may require additional clearances.
- Each crane operator is directly responsible for the safe operation of the crane. Whenever there is any doubt as to safety, the crane operator should stop the crane and refuse to handle loads until safety has been assured.
- These safety rules should not be considered complete for all situations of crane operation. Each situations is unique.

**FREQUENTLY ASKED QUESTIONS:**

**When should the crane operator follow hand signals?**
A crane operator should always move loads according to the established code of signals, and use a signaler. Hand signals are preferred, but radios are allowed as well.

**Who can give hand signals or who can be a signaler?**

- A qualified signaler must be designated,
- A person qualified to give crane signals to the operator,
- There should be only one designated signaler at a time,
- A crane operator should move loads only on signals from one signaler,
- A crane operator must obey STOP signals regardless of who gives it.

**What should you do when you are in charge of signaling?**
The signaler must:

- When feasible be in clear view of the crane operator or communicate via radio,
- Have a clear view of the load and the equipment,
- Keep persons outside the crane's operating area,
- Never direct a load over a person.

# RIGGING INFORMATION
## Risk Management

Risk Management is a comprehensive set of actions that reduces the risk of a problem, a failure, or an accident.

ASME B30.9 requires that sling users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices. Sling identification is required on all types of slings.

ASME B30.26 requires that rigging hardware users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices. All rigging hardware is to be identified by manufacturer with name of trademark or manufacturer.

**TERMINOLOGY**

- **Working Load Limit (WLL):** The maximum mass or force which the product is authorized to support in a particular service
- **Proof Test:** A test applied to a product solely to determine injurious material or manufacturing defects
- **Ultimate Strength:** The average load or force at which the product fails or no longer supports the load
- **Design Factor:** An industrial term denoting a product's theoretical reserve capability; usually computed by the working load limit and generally expressed a ratio e.g. 5 to 1

## Planning And Responsibilities

Plan every lift and include the following questions with the questions your experience provides:

1. Who is responsible (competent) for the rigging?
2. Has communications been established?
3. Is the rigging in acceptable condition?
4. Is the rigging appropriate for lifting?
5. Does the rigging have proper identification?
6. Does all gear have known working load limits?
7. What is the weight of the load?
8. Where is the loads center of gravity?
9. What is the sling angle?
10. Will there be any side or angular loading?
11. Are the slings padded against sharp corners (**softeners**)?
12. Are the working load limits adequate?
13. Is the load rigged to the center of gravity?
14. Is the hitch appropriate for the load?
15. Is a tag line required to control the load?
16. Will personnel be clear of suspended loads?
17. Does a load have a clear path?
18. Will the load be level and stable?
19. Any unusual environmental concerns?
20. Any special requirements?

The rigging must be used within manufacturer's recommendations and industry standards that include OSHA, ASME, ANSI, API and others.

# RIGGING INFORMATION

**User Responsibility**

- Utilize appropriate rigging gear suitable for overhead lifting
- Utilize the rigging gear within industry standards and the manufacturer's recommendations
- Conduct Regular inspection and maintenance of the rigging gear
- Provide employees with training to meet OSHA and ASME (B30.9, B30.26, etc.) requirements

## Inspection of Rigging Hardware

**Inspection Frequency per ASME B30.26** A visual inspection shall be performed by the user or designated person each day before the rigging hardware is used. A periodic inspection shall be performed by a designated person, at least annually. The rigging hardware shall be examined and a determination made as to whether they constitute a hazard. Written records are not required. Semi-permanent and inaccessible locations where frequent inspections are not feasible shall have periodic inspections performed.

**Rejection Criteria per ASME B30.26**

- Missing or illegible manufacturer's name or trademark and/or rated load identification (or size and required)
- A 10% or more reduction of the original dimension
- Bent, twisted, distorted, stretched, elongated, cracked or broken load bearing components
- Excessive nicks, gouges, pitting and corrosion
- Indications of heat damage including weld splatter or arc strikes, evidence of unauthorized welding
- Loose or missing nuts, bolts, cotter pins, snap rings, or other fasteners and retaining devices
- Unauthorized replacement components or other visible conditions that cause doubt as to the continued use of the sling

Additionally, inspect wedge sockets for:

- Indications of damaged wire rope or wire rope slippage
- Improper assembly

**Additional Rejection Criteria per ASME B30.10 - Hooks**

- Any visibly apparent bend or twist from the plane of the unbent hook
- Any distortion causing an increase in throat opening of 5% not to exceed ¼"

# RIGGING INFORMATION
## Inspection of Slings

**Inspection Frequency per ASME B30.9**
A visual inspection for damage shall be performed by the user or designated person each day or shift the sling is used. A complete inspection for damage shall be performed periodically by a designated person at least annually.

**Rejection Criteria per ASME B30.9**

- Missing or illegible sling identification
- Evidence of heat damage
- Slings that are knotted
- Fittings that are pitted, corroded, cracked, bent, twisted, gouged or broken
- Other conditions including visible damage that causes doubt as to the continued use of the sling

**Wire Rope Slings**

- Excessive broken wires, for strand-laid and single part slings, ten (10) randomly distributed broken wires in one (1) rope lay or five (5) broken wires in one (1) strand in one (1)rope lay
- Severe localized abrasion or scraping, kinking, crushing, bird caging and any other damage resulting in distortion of the rope structure
- Corrosion of the rope or end attachments

**Web Slings**

- Chemical Damage including Acid or caustic burns
- Melting or charring of any part of the sling surface
- Holes, tears, cuts or snags
- Broken or work stitching in load bearing splices
- Excessive abrasive wear
- Discoloration and brittle or stiff areas on any part of the sling, which may mean chemical or ultraviolet/sunlight damage

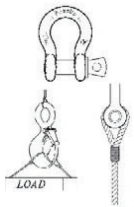
**Round Slings**

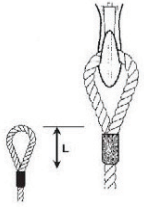
- Chemical Damage including Acid or caustic burns
- Extensive abrasive wear
- Holes, tears, cuts, abrasive wear or snags that expose the core yarns
- Broken or damaged core yarns and/or stitching
- Weld splatter that exposes core yarns
- Discoloration and brittle or stiff areas on any part of the slings

# RIGGING INFORMATION
## Wire Rope Sling Connections and Hitches

**Connection to Fittings**

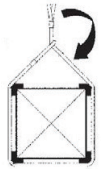
- Use a thimble eye to protect sling and increase D/d
- Never place eye over a fitting with a smaller diameter or width than the ropes diameter
- Never place a sling eye over a fitting with a diameter or width greater than one half the length of the eye



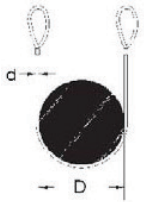

**Choker Capacity**

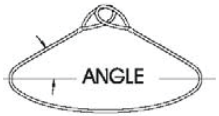
A choker hitch has 75% of the capacity of a single leg sling only if the angle of the choke is 120 degrees or greater. A choke angle less than 120 degrees can result in a capacity as low as 40% of the single leg.



**Basket Hitch Capacity**

A basket hitch has twice the capacity of a single leg only if D/d ration is 25/1 and the legs are vertical.




| Angle | Capacity % of Single Leg |
|---|---|
| 90 | 200% |
| 60 | 170% |
| 45 | 140% |
| 30 | 100% |

**Multiple Leg Slings**

Triple leg slings have 50% more capacity than double leg slings (at same sling angle) only if the center of gravity is in center of connection points and legs are adjusted properly (they must have an equal share of the load).

Quad (4 leg) slings offer improved stability, but provide increased capacity only if all legs share an equal share of the load.

# RIGGING INFORMATION
## Chain Sling Connections and Hitches

**Connection to Fittings**

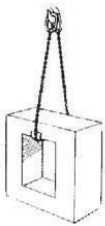
- Use master links to collect slings and to connect to hook
- Use Grade 8 (80) or Grade 10 (100) fitting that match the WLL of chain and offer proper securement

**Choker Capacity**

- A choker hitch has 80% of the capacity of a single leg sling only if the angle of choke is 120 degrees or greater. Choke angles less than 120 degrees will result in a significantly reduced capacity.
- No loss in capacity results if a cradle crab hook is used

**Basket Hitch Capacity**

A true basket hitch has twice the capacity of a single leg only if the legs are vertical. Note: The basket is formed by using a chain sling with two master links at each end connected to the hook.



| Angle | Capacity % of Single Leg |
|---|---|
| 90 | 200% |
| 60 | 170% |
| 45 | 140% |
| 30 | 100% |

**Multiple Leg Slings**

Triple leg slings have 50% more capacity than double leg slings (at same sling angle) only if the center of gravity is in center of connection points and legs are adjusted properly (they must have an equal share of the load).

Quad (4 leg) slings offer improved stability, but do not provide increased capacity. The capacity of a four leg chain sling is considered the same as three leg chain sling.

# RIGGING INFORMATION
## Synthetic Sling Connections and Hitches

Web sling identification includes:

**Sling Type**

TC - Triangle Choker

TT - Triangle Triangle

EE - Eye Eye

EN - Endless

Number of plies: 1 or 2

Webbing Grade: 9 or 6

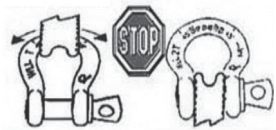
Sling Width (inch)

**EE 2-9 04 X 12** ← Sling Length (inch)

Round Sling Identification Includes:

- Sling Number: 1 – 13
- Sling numbers are for reference only. Some round slings have different ratings.
- Sling Color: purple, green, yellow, tan, red, white, blue, and orange
- Sling color is not followed by all manufacturers and some colors have more than one rated load

Folding, bunching or pinching or synthetic slings, which occurs when used with shackles, hooks or other application, will reduce the rated load.




**Choker Capacity**

A choker hitch has 80% of the capacity of a single leg sling only if the angle of choke is 120 degrees or greater. Choke angles less than 120 degrees will result in a capacity as low as 40% of the single leg.

**Basket Hitch Capacity**

A true basket hitch has twice the capacity of a single leg only if the legs are vertical.

| Angle | Capacity % of Single Leg |
|---|---|
| 90 | 200% |
| 60 | 170% |
| 45 | 140% |
| 30 | 100% |

**Multiple Leg Slings**

Triple leg slings have 50% more capacity than double leg slings (at same sling angle) only if the center of gravity is in center of connection points and legs are adjusted properly (they must have an equal share of the load).

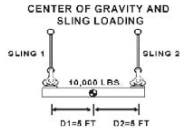
Quad (4 leg) slings offer improved stability, but provide increased capacity only if all legs share an equal share of the load.

Always select and use web slings and round slings by the rated load shown on the sling identification and not by the width, color or sling number.

# RIGGING INFORMATION
## Center of Gravity, Weights and Measures

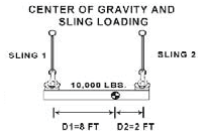
When lifting vertically, the load will be shared equally when the center of gravity is placed equally between the pick points.

If the weight of the load is 10,000 lbs. then each sling will have a load of 5,000 lbs. and each shackle and eyebolt will also have a load of 5,000 lbs.




## Weight and Measurement Data

**Center of Gravity and Sling Loading**
When the center of gravity is not equally spaced between the pick points, the sling and fittings will not carry an equal share of the load. The sling connected to the pick point closest to the center of gravity will carry the greatest share of the load.




Sling 2 is closest to COG. It will have the greatest share of the load.

Ex. Sling 2 = 10,000 x 8/(8+2) = 8,000 lbs.
Sling 1 = 10,000 x 2/(8+2) = 2,000 lbs.

Unit weight steel = 490 lbs./cu ft
Unit weight aluminum = 168 lbs./cu ft
Unit weight concrete = 150 lbs./cu ft
Unit weight wood = 40 lbs./cu ft
Unit weight water = 62 lbs./cu ft
Unit weight sand and gravel = 120 lbs./cu ft
Unit weight copper = 560 lbs./cu ft
Unit weight oil = 58 lbs./cu ft

1 cubic ft. = 7.5 gals
½ inch = 12.7 mm
1 inch - 25.4 mm
1 metric ton = 1.1 US tons
1 kilogram = 2.2 lbs.

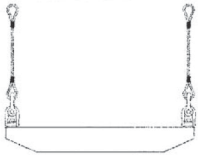
Volume of Cube = height x width x length

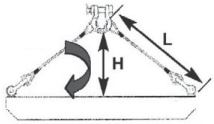
Volume of Sphere =
3.14 x (diameter x diameter x diameter)/6

Volume of Cylinder =
3.14 x (diameter x diameter x length)/4

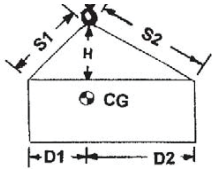
# RIGGING INFORMATION
## Sling Angle Information

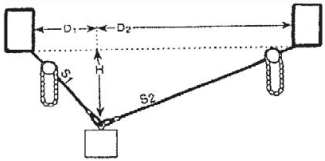
Vertical share of load on slings are equal if center of gravity is in the middle of the pick points.






| Horizontal Sling Angle (A) degree | Horizontal Sling Angle Load Angle Factor = L/H |
|---|---|
| 90 | 1,000 |
| 60 | 1,155 |
| 50 | 1,305 |
| 45 | 1,414 |
| 30 | 2,000 |




**Load on sling calculated**

Tension 1 = Load x D2 x S1/(H(D1+D2))

Tension 2 = Load x D1 x S2/(H(D1+D2))

**Load on sling calculated**

Tension 1 = Load x D2 x S1/(H(D1+D2))

Tension 2 = Load x D1 x S2/(H(D1+D2))

Horizontal sling angles of less than 30 degrees are not recommended. Refer to ANSI B30.9 for full information.

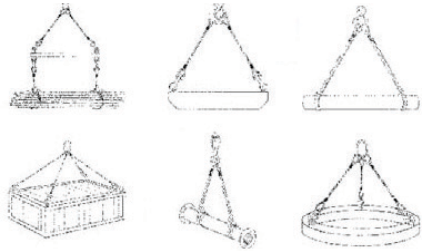
# RIGGING INFORMATION
## ASME B30.9 Operating Practices and Load Control

Whenever any sling is used, the following practices shall be observed.

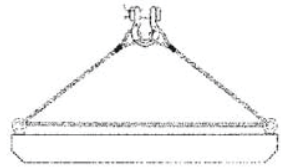
1. Slings that are damaged or defective shall not be used
2. Slings shall not be shortened with knots or bolts or other makeshift devices
3. Sling legs shall not be kinked
4. Slings shall not be loaded in excess of their rated capacities
5. Slings used in a basket hitch shall have the loads balance to prevent slippage
6. Slings shall be securely attached to their load
7. Slings shall be padded or protected from the sharp edges of their loads
8. Suspended loads shall be kept clear of all obstruction
9. All employees shall be kept clear of loads about to be lifted and of all suspended loads
10. Hand or fingers shall not be placed between the sling and its load while the sling is being tightened around the load
11. Shock loading is prohibited
12. A sling shall not be pulled from under a load when the load is resting on the sling.

**Inspection:** Each day before being used, the sling and all fastenings and attachments shall be inspected for damage or defects by a competent person designated by the employer. Additional inspections shall be performed during sling use where service conditions warrant. Damaged or defective slings shall be immediately removed from service.

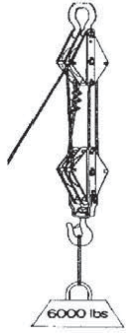
**Positive Load Control**



Reeving through connections to the load increases the load on connection fittings by as much as two times. DO NOT REEVE!



# RIGGING INFORMATION
## Block Concepts




**Mechanical Advantage**

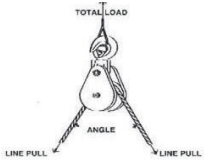
- Mechanical advantage is the leverage gained by a multiple part block
- The theoretical (ignore friction) advantage is equal to the number of parts of line supporting the traveling block (load)
- Total load on the block is sum of all loads placed on the block end fitting

Ex.
Parts of line = 4
Mechanical advantage = 4
Line pull required = 6,000/4 = 1,500 lbs.
Lower block load = 6,000 lbs.
Required WLL = 6,000 lbs.
Upper block load = 6,000 + line pull + gear
6,000 + 1,500 + gear = 7,500 lbs. plus
Required WLL = 7,500 lbs. plus

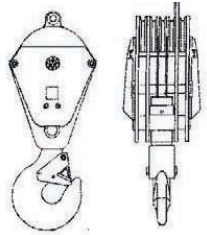
**Angle Factor Multipliers**
A single line snatch block used to change load line direction can be subjected to total loads greatly different from the line pull.

| Angle | Factor | Angle | Factor |
|---|---|---|---|
| 0° | 2.00 | 100° | 1.29 |
| 10° | 1.99 | 110° | 1.15 |
| 20° | 1.97 | 120° | 1.00 |
| 30° | 1.93 | 130° | .84 |
| 40° | 1.87 | 135° | .76 |
| 45° | 1.84 | 140° | .68 |
| 50° | 1.81 | 150° | .52 |
| 60° | 1.73 | 160° | .35 |
| 70° | 1.64 | 170° | .17 |
| 80° | 1.53 | 180° | .00 |
| 90° | 1.41 | -- | -- |

Total Load =
Line Pull x Angle Factor Multiplier

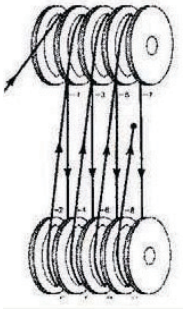


# RIGGING INFORMATION
## Working With Blocks



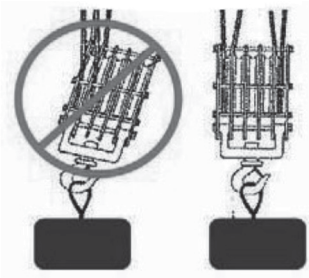
**Overhaul Weight**

To determine the weight of the block or overhaul ball that is required to free fall the block, the following information is needed: size of wire rope, number of line parts, type of sheave bearing, length of crane boom, and drum friction.



**Block Reeving**

Straight laced reeving is a basic method of placing the rope through a set of blocks. The end of the rope is fed through the outside sheave of the upper block to the outside sheave of the lower (traveling) block. This continues to the last sheave.

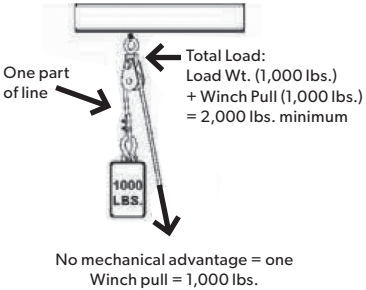


**Symmetrical Reeving**

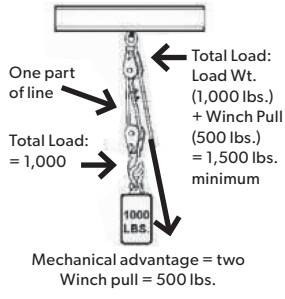
Reeve blocks symmetrically to distribute load evenly. All sheaves must be reeved to achieve the full working load limit of the block.

# RIGGING INFORMATION

## Rigging with Blocks



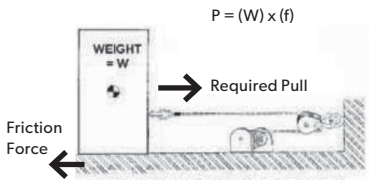

No mechanical advantage = one
Winch pull = 1,000 lbs.



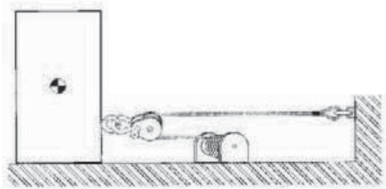

Mechanical advantage = two
Winch pull = 500 lbs.

Pull (P) required (level ground) =
weight (W) x friction factor (f)

Many surfaces have a friction factor <1
(f) for steel on steel is .16 lubricated
(f) for steel on steel is .8 clean
(f) for wood on steel is .2 to .6 clean
(f) for wood on wood is .25 to .5 clean




Winch pull required = weight x friction
factor mechanical advantage

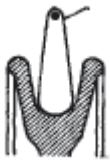


# RIGGING INFORMATION
## Block and Sheave Inspection

At a minimum, examine the following inspection points and remove from service or correct before use:

1. Excessive wear on pins or axles, rope grooves, side plates, bushings or bearings and end fittings
2. Deformation in side plates, pins and axles, lifting attachment points and trunnions
3. Misalignment or wobble in sheaves
4. Security of nuts, bolts, and other locking methods
5. Missing or loose snap rings on pins
6. Excessive end play of sheave bearings on shaft, more than .031 clearance per sheave with bushing or straight roller bearings
7. Excessive swivel case clearance (more than .12" - .18")
8. Hook with deformation, corrosion of cook or nut threads, missing or defective latch
9. Welding side plates with weld cracking or corrosion

**Sheave Groove**



"No daylight" between groove and gauge shows groove acceptable

"Daylight" between groove and gauge shows wear

Corrugated grooves accelerate wear of wire rope

**Fleet Angle**

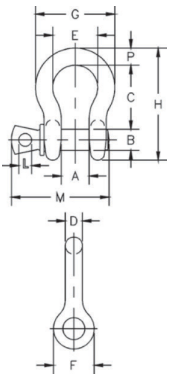
Fleet Angle is the entrance and exit angles of the wire rope relative to the sheave.

Fleet Angle should be no more than 1-1/2 degrees to 2 degrees.

# RIGGING INFORMATION
## Block Hook Inspection

**Crosby Recommends as a Minimum:**

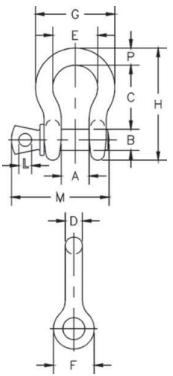
1. A visual inspection for cracks, nicks, wear, gouges and deformation as part of a comprehensive documented inspection program, should be conducted by trained personnel in compliance with the schedule in ANSI B30.10.
2. For hooks used in frequent load cycles or pulsating load, or exposed to corrosive conditions (road salt, etc.) the hook and thread should be periodically inspected by Magnetic Particle or Dye Penetrant.




## G-209 & S209 Style Screw Pin Anchor Shackles

| NOM. SIZE (IN.) | WORKING LOAD LIMIT (T)* | WEIGHT EACH (LBS.) | DIMENSIONS (IN.) | | | | | | | | | | | TOLERANCE + / - | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | H | L | M | P | C | A |
| 3/16 | 1/3 | 0.06 | 0.38 | 0.25 | 0.88 | 0.19 | 0.6 | 0.56 | 0.98 | 1.47 | 0.16 | 1.14 | 0.19 | 0.06 | 0.06 |
| 1/4 | 1/2 | 0.1 | 0.47 | 0.31 | 1.13 | 0.25 | 0.78 | 0.61 | 1.28 | 1.84 | 0.19 | 1.43 | 0.25 | 0.06 | 0.06 |
| 5/16 | 3/4 | 0.19 | 0.53 | 0.38 | 1.22 | 0.31 | 0.84 | 0.75 | 1.47 | 2.09 | 0.22 | 1.71 | 0.31 | 0.06 | 0.06 |
| 3/8 | 1 | 0.31 | 0.66 | 0.44 | 1.44 | 0.38 | 1.03 | 0.91 | 1.78 | 2.49 | 0.25 | 2.02 | 0.38 | 0.13 | 0.06 |
| 7/16 | 1-1/2 | 0.38 | 0.75 | 0.5 | 1.69 | 0.44 | 1.16 | 1.06 | 2.03 | 2.91 | 0.31 | 2.37 | 0.44 | 0.13 | 0.06 |
| 1/2 | 2 | 0.72 | 0.81 | 0.63 | 1.88 | 0.5 | 1.31 | 1.19 | 2.31 | 3.28 | 0.38 | 2.69 | 0.5 | 0.13 | 0.06 |
| 5/8 | 3-1/4 | 1.37 | 1.06 | 0.75 | 2.38 | 0.63 | 1.69 | 1.5 | 2.94 | 4.19 | 0.44 | 3.34 | 0.69 | 0.13 | 0.06 |
| 3/4 | 4-3/4 | 2.35 | 1.25 | 0.88 | 2.81 | 0.75 | 2 | 1.81 | 3.5 | 4.97 | 0.5 | 3.97 | 0.81 | 0.25 | 0.06 |
| 7/8 | 6-1/2 | 3.62 | 1.44 | 1 | 3.31 | 0.88 | 2.28 | 2.09 | 4.03 | 5.83 | 0.5 | 4.5 | 0.97 | 0.25 | 0.06 |
| 1 | 8-1/2 | 5.03 | 1.69 | 1.13 | 3.75 | 1 | 2.69 | 2.38 | 4.69 | 6.56 | 0.56 | 5.13 | 1.06 | 0.25 | 0.06 |
| 1-1/8 | 9-1/2 | 7.41 | 1.81 | 1.25 | 4.25 | 1.16 | 2.91 | 2.69 | 5.16 | 7.47 | 0.63 | 5.71 | 1.25 | 0.25 | 0.06 |
| 1-1/4 | 12 | 9.5 | 2.03 | 1.38 | 4.69 | 1.29 | 3.25 | 3 | 5.75 | 8.25 | 0.69 | 6.25 | 1.38 | 0.25 | 0.06 |
| 1-3/8 | 13-1/2 | 13.53 | 2.25 | 1.5 | 5.25 | 1.42 | 3.63 | 3.31 | 6.38 | 9.16 | 0.75 | 6.83 | 1.5 | 0.25 | 0.13 |
| 1-1/2 | 17 | 17.2 | 2.38 | 1.63 | 5.75 | 1.54 | 3.88 | 3.63 | 6.88 | 10 | 0.81 | 7.33 | 1.62 | 0.25 | 0.13 |
| 1-3/4 | 25 | 27.78 | 2.88 | 2 | 7 | 1.84 | 5 | 4.19 | 8.86 | 12.34 | 1 | 9.06 | 2.25 | 0.25 | 0.13 |
| 2 | 35 | 45 | 3.25 | 2.25 | 7.75 | 2.08 | 5.75 | 4.81 | 9.97 | 13.68 | 1.22 | 10.35 | 2.4 | 0.25 | 0.13 |
| 2-1/2 | 55 | 85.75 | 4.13 | 2.75 | 2.75 | 2.71 | 7.25 | 5.69 | 12.87 | 17.84 | 1.38 | 13 | 3.13 | 0.25 | 0.25 |

NOTE: MAXIMUM PROOF LOAD IS 2.0 TIMES THE WORKING LOAD LIMIT.
MINIMUM ULTIMATE STRENGTH IS 6 TIMES THE WORKING LOAD LIMIT.




## G-210 & S210 Style Screw Pin Chain Shackles

| NOM. SIZE (IN.) | WORKING LOAD LIMIT (T)* | WEIGHT EACH (LBS.) | DIMENSIONS (IN.) | | | | | | | | | | TOLERANCE + / - | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | F | G | K | L | M | C | A |
| 1/4 | 1/2 | 0.11 | 0.47 | 0.31 | 0.25 | 0.25 | 0.97 | 0.62 | 0.97 | 1.59 | 0.19 | 1.43 | 0.06 | 0.06 |
| 5/16 | 3/4 | 0.17 | 0.53 | 0.38 | 0.31 | 0.31 | 1.15 | 0.75 | 1.07 | 1.91 | 0.22 | 1.71 | 0.06 | 0.06 |
| 3/8 | 1 | 0.28 | 0.66 | 0.44 | 0.38 | 0.38 | 1.42 | 0.92 | 1.28 | 2.31 | 0.25 | 2.02 | 0.13 | 0.06 |
| 7/16 | 1-1/2 | 0.43 | 0.75 | 0.5 | 0.44 | 0.44 | 1.63 | 1.06 | 1.48 | 2.67 | 0.31 | 2.37 | 0.13 | 0.06 |
| 1/2 | 2 | 0.59 | 0.81 | 0.63 | 0.5 | 0.5 | 1.81 | 1.18 | 1.66 | 3.03 | 0.38 | 2.69 | 0.13 | 0.06 |
| 5/8 | 3-1/4 | 1.25 | 1.06 | 0.75 | 0.63 | 0.63 | 2.32 | 1.5 | 2.04 | 3.76 | 0.44 | 3.34 | 0.13 | 0.06 |
| 3/4 | 4-3/4 | 2.63 | 1.25 | 0.88 | 0.81 | 0.75 | 2.75 | 1.81 | 2.4 | 4.53 | 0.5 | 3.97 | 0.25 | 0.06 |
| 7/8 | 6-1/2 | 3.16 | 1.44 | 1 | 0.97 | 0.88 | 3.2 | 2.1 | 2.86 | 5.33 | 0.5 | 4.5 | 0.25 | 0.06 |
| 1 | 8-1/2 | 4.75 | 1.69 | 1.13 | 1 | 1 | 3.69 | 2.38 | 3.24 | 5.94 | 0.56 | 5.13 | 0.25 | 0.06 |
| 1-1/8 | 9-1/2 | 6.75 | 1.81 | 1.25 | 1.25 | 1.13 | 4.07 | 2.69 | 3.61 | 6.78 | 0.63 | 5.71 | 0.25 | 0.06 |
| 1-1/4 | 12 | 9.06 | 2.03 | 1.38 | 1.38 | 1.25 | 4.53 | 3 | 3.97 | 7.5 | 0.69 | 6.25 | 0.25 | 0.13 |
| 1-3/8 | 13-1/2 | 11.63 | 2.25 | 1.5 | 1.5 | 1.38 | 5.01 | 3.31 | 4.43 | 8.28 | 0.75 | 6.83 | 0.25 | 0.13 |
| 1-1/2 | 17 | 15.95 | 2.38 | 1.63 | 1.62 | 1.5 | 5.38 | 3.62 | 4.84 | 9.05 | 0.81 | 7.33 | 0.25 | 0.13 |
| 1-3/4 | 25 | 26.75 | 2.88 | 2 | 2.12 | 1.75 | 6.38 | 4.19 | 5.78 | 10.97 | 1 | 9.06 | 0.25 | 0.13 |
| 2 | 35 | 42.31 | 3.25 | 2.25 | 2.36 | 2.1 | 7.25 | 5 | 6.77 | 12.74 | 1.13 | 10.35 | 0.13 | 0.25 |
| 2-1/2 | 55 | 71.75 | 4.12 | 2.75 | 2.63 | 2.63 | 9.38 | 5.68 | 8.07 | 14.85 | 1.38 | 13 | 0.25 | 0.25 |

NOTE: MAXIMUM PROOF LOAD IS 2.0 TIMES THE WORKING LOAD LIMIT.
MINIMUM ULTIMATE STRENGTH IS 6 TIMES THE WORKING LOAD LIMIT.

# NOTES

# ANSI BOLTING CHART
## ½" – 4"

| PRES-SURE RATING | BOLTING | FLANGE FACING | NORMAL PIPE SIZE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/2 | 3/4 | 1 | 1 1/4 | 1 1/2 | 2 | 2 1/2 | 3 | 3 1/2 | 4 |
| 150 Pound | Number | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 8 | 8 |
| | Diameter | | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 5/8 | 5/8 | 5/8 | 5/8 | 5/8 |
| | Length of Stud Bolts | 1 1/16 RF | 2 1/2 | 2 1/2 | 2 3/4 | 2 3/4 | 3 | 3 1/4 | 3 1/2 | 3 3/4 | 3 3/4 | 3 3/4 |
| | | RTJ | – | – | 3 1/4 | 3 1/4 | 3 1/2 | 3 3/4 | 4 | 4 1/4 | 4 1/4 | 4 1/4 |
| | Ring Size | R | – | – | 15 | 17 | 19 | 22 | 25 | 29 | 33 | 36 |
| 300 Pound | Number | | 4 | 4 | 4 | 4 | 4 | 8 | 8 | 8 | 8 | 8 |
| | Diameter | | 1/2 | 5/8 | 5/8 | 5/8 | 3/4 | 5/8 | 3/4 | 3/4 | 3/4 | 3/4 |
| | Length of Stud Bolts | 1/16 RF | 2 3/4 | 3 | 3 1/4 | 3 1/4 | 3 3/4 | 3 1/2 | 4 | 4 1/4 | 4 1/2 | 4 1/2 |
| | | RTJ | 3 1/4 | 3 1/2 | 3 3/4 | 3 3/4 | 4 1/4 | 4 1/4 | 4 3/4 | 5 | 5 1/4 | 5 1/4 |
| | Ring Size | R | 11 | 13 | 16 | 18 | 20 | 23 | 26 | 31 | 34 | 37 |
| | | RX | – | – | – | – | 20 | 23 | 26 | 31 | 34 | 37 |
| 400 Pound | Number | | 4 | 4 | 4 | 4 | 4 | 8 | 8 | 8 | 8 | 8 |
| | Diameter | | 1/2 | 5/8 | 5/8 | 5/8 | 3/4 | 5/8 | 3/4 | 3/4 | 7/8 | 7/8 |
| | Length of Stud Bolts | 1/4 RF | 3 1/4 | 3 1/2 | 3 3/4 | 4 | 4 1/4 | 4 1/4 | 4 3/4 | 5 | 5 1/2 | 5 1/2 |
| | | RTJ | 3 1/4 | 3 1/2 | 3 3/4 | 4 | 4 1/4 | 4 1/2 | 5 | 5 1/4 | 5 3/4 | 5 3/4 |
| | Ring Size | R | 11 | 13 | 16 | 18 | 20 | 23 | 26 | 31 | 34 | 37 |
| | | RX | – | – | – | – | 20 | 23 | 26 | 31 | 34 | 37 |
| 600 Pound | Number | | 4 | 4 | 4 | 4 | 4 | 8 | 8 | 8 | 8 | 8 |
| | Diameter | | 1/2 | 5/8 | 5/8 | 5/8 | 3/4 | 5/8 | 3/4 | 3/4 | 7/8 | 7/8 |
| | Length of Stud Bolts | 1/4 RF | 3 1/4 | 3 1/2 | 3 3/4 | 4 | 4 1/4 | 4 1/4 | 4 3/4 | 5 | 5 1/2 | 5 3/4 |
| | | RTJ | 3 1/4 | 3 1/2 | 3 3/4 | 4 | 4 1/4 | 4 1/2 | 5 | 5 1/4 | 5 3/4 | 6 |
| | Ring Size | R | 11 | 13 | 16 | 18 | 20 | 23 | 26 | 31 | 34 | 37 |
| | | RX | – | – | – | – | 20 | 23 | 26 | 31 | 34 | 37 |

# ANSI BOLTING CHART
# 5" - 24"

| PRESSURE RATING | BOLTING | FLANGE FACING | NORMAL PIPE SIZE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 24 |
| 150 Pound | Number | | 8 | 8 | 8 | 12 | 12 | 12 | 16 | 16 | 20 | 20 |
| | Diameter | | 3/4 | 3/4" | 3/4 | 7/8" | 7/8" | 1 | 1 | 1 1/8 | 1 1/8 | 1 1/4 |
| | Length of Stud Bolts | 1 1/16 RF | 4 | 4 | 4 1/4 | 4 3/4 | 4 3/4 | 5 1/4 | 5 1/2 | 6 | 6 1/4 | 7 |
| | | RTJ | 4 1/2 | 4 1/2 | 4 1/2 | 5 1/4 | 5 1/4 | 5 3/4 | 6 | 6 1/2 | 6 3/4 | 7 1/2 |
| | Ring Size | R | 40 | 43 | 48 | 52 | 56 | 59 | 64 | 68 | 72 | 76 |
| 300 Pound | Number | | 8 | 12 | 12 | 16 | 16 | 20 | 20 | 24 | 24 | 24 |
| | Diameter | | 3/4 | 3/4 | 7/8" | 1 | 1 1/8 | 1 1/8 | 1 1/4 | 1 1/4 | 1 1/4 | 1 1/2 |
| | Length of Stud Bolts | 1/4 RF | 4 3/4 | 5 | 5 1/2 | 6 1/4 | 6 3/4 | 7 | 7 1/2 | 7 3/4 | 8 1/4 | 9 1/4 |
| | | RTJ | 5 1/2 | 5 3/4 | 6 1/4 | 7 | 7 1/2 | 7 3/4 | 8 1/4 | 8 1/2 | 9 | 10 1/4 |
| | Ring Size | R | 41 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 73 | 77 |
| | | RX | 41 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 73 | 77 |
| 400 Pound | Number | | 8 | 12 | 12 | 16 | 16 | 20 | 20 | 24 | 24 | 24 |
| | Diameter | | 7/8 | 7/8 | 1 | 1 1/8 | 1 1/4 | 1 1/4 | 1 3/8 | 1 3/8 | 1 1/2 | 1 3/4 |
| | Length of Stud Bolts | 1/4 RF | 5 3/4 | 6 | 6 3/4 | 7 1/2 | 8 | 8 1/4 | 8 3/4 | 9 | 9 3/4 | 10 3/4 |
| | | RTJ | 6 | 6 1/4 | 7 | 7 3/4 | 8 1/4 | 8 1/2 | 9 | 9 1/4 | 10 | 11 1/4 |
| 600 Pound | Number | | 8 | 12 | 12 | 16 | 20 | 20 | 20 | 20 | 24 | 24 |
| | Diameter | | 1 | 1 | 1 1/8 | 1 1/4 | 1 1/4 | 1 3/8 | 1 1/2 | 1 5/8 | 1 5/8 | 1 7/8 |
| | Length of Stud Bolts | 1/4 RF | 6 1/2 | 6 3/4 | 7 3/4 | 8 1/2 | 8 3/4 | 9 1/4 | 10 | 10 3/4 | 11 1/2 | 13 |
| | | RTJ | 6 3/4 | 7 | 8 | 8 3/4 | 9 | 9 1/2 | 10 1/4 | 11 | 11 3/4 | 13 1/2 |
| | Ring Size | R | 41 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 73 | 77 |
| | | RX | 41 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 73 | 77 |
| 900 Pound | Number | | 8 | 12 | 12 | 16 | 20 | 20 | 20 | 20 | 20 | 20 |
| | Diameter | | 1 1/4 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 1/2 | 1 5/8 | 1 7/8 | 2 | 2 1/2 |
| | Length of Stud Bolts | 1/4 RF | 7 1/2 | 7 3/4 | 8 3/4 | 9 1/4 | 10 | 10 3/4 | 11 1/4 | 13 | 13 3/4 | 17 1/4 |
| | | RTJ | 7 3/4 | 7 3/4 | 9 | 9 1/2 | 10 1/4 | 11 1/4 | 11 3/4 | 13 1/2 | 14 1/4 | 18 |
| | Ring Size | R | 41 | 45 | 49 | 53 | 57 | 62 | 66 | 70 | 74 | 78 |
| | | RX | 41 | 45 | 49 | 53 | 57 | 62 | 66 | 70 | 74 | 78 |
| 1500 Pound | Number | | 8 | 12 | 12 | 12 | 12 | 16 | 16 | 16 | 16 | 16 |
| | Diameter | | 1 1/2 | 1 3/8 | 1 5/8 | 1 7/8 | 2 | 2 1/4 | 2 1/2 | 2 3/4 | 3 | 3 1/2 |
| | Length of Stud Bolts | 1/4 RF | 9 3/4 | 10 1/4 | 11 1/2 | 13 1/2 | 15 | 16 1/4 | 17 3/4 | 19 1/2 | 21 1/4 | 24 1/4 |
| | | RTJ | 10 | 10 1/2 | 12 | 13 3/4 | 15 1/2 | 17 | 18 3/4 | 20 1/2 | 22 1/2 | 25 1/2 |
| | Ring Size | R | 44 | 46 | 50 | 54 | 58 | 63 | 67 | 71 | 75 | 79 |
| | | RX | 44 | 46 | 50 | 54 | 58 | 63 | 67 | 71 | 75 | 79 |
| 2500 Pound | Number | | 8 | 12 | 12 | 12 | 12 | – | – | – | – | – |
| | Diameter | | 1 3/4 | 2 | 2 | 2 1/2 | 2 3/4 | – | – | – | – | – |
| | Length of Stud Bolts | 1/4 RF | 11 3/4 | 13 3/4 | 15 1/4 | 19 1/4 | 21 1/4 | – | – | – | – | – |
| | | RTJ | 12 1/2 | 14 1/4 | 15 3/4 | 20 1/4 | 22 1/4 | – | – | – | – | – |
| | Ring Size | R | 42 | 47 | 51 | 55 | 60 | – | – | – | – | – |
| | | RX | 42 | 47 | 51 | 55 | 60 | – | – | – | – | – |

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