EPRI

Rigger's Handbook

1009706

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REPORT SUMMARY

This EPRI *Rigger's Handbook* (1009706) was produced as an additional activity included in the production of the EPRI *Lifting, Rigging, and Small Hoist Usage Program Guide* (1007914).

For additional information on this handbook, refer to report number 1007914.

CONTENTS

LIST OF TABLES

CONVERSION TABLES

Designation of Units

In some cases, source material was provided from U.S. manufacturers that designate their products only in U.S. units. To assist the user of this report, a conversion chart designating U.S. and metric units is provided. In most tables and figures, however, variables are designated in both U.S. and metric units.

The following information is provided to assist the user of this report in converting units to metric designations.

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
lb	short tons (2000 lb)	0.9	metric ton	t
		VOLUME		
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
in^3	cubic inches	16	milliliters	mL
fl oz	fluid ounces	30	milliliters	mL
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	degrees Fahrenheit	subtract 32, multiply by 5/9	degrees Celsius	°C
		RADIATION		
	rads	0.01	grays	Gy

Courtesy of National Institute of Standards and Technology (NIST)

DEFINITIONS

Advanced Rigger –

A Rigger who is trained, qualified, and responsible for developing lift plans and rigging configurations, and selecting, attaching, and securing rigging hardware to perform complex load lifts or special lifting tasks. The Advanced Rigger will:

- Successfully complete Advanced Rigger training and all prerequisites
- Successfully complete a written or oral examination
- Adequately demonstrate skills and abilities necessary for the proper inspection, operation, and use of specialized lifting equipment

An Advanced Rigger is an individual who has received training on the inspection and operating requirements of rigging hardware and lifting equipment and has been qualified in its correct use as a Rigger, with the addition of below-the-hook lifting devices (lift beams, spreader beams, fabricated lifting devices), base-mounted drum hoists in all configurations, lift rigs, snatch blocks, handling of vessels and shells, load shift, load balance, and the use of personnel baskets. Advanced Riggers will know how to:

- Determine or calculate the center of gravity (CG) of a load
- Ensure load stability, stress calculations, and rigging product use associated with load- and material-handling tasks such as:
  - Rotating and upending a load
  - Handling of vessels and shells
  - Performing tandem lifts using two cranes or two hooks on the same crane
  - Using equalizer beams for load balancing and stabilization, high-line tension rigging, hand chain or lever-operated hoist tension rigging, and Personnel Basket Design, Fabrication, Testing, Inspection, and Lifting Process requirements

Below-the-Hook Lifting Devices –

Any fabricated assembly designed to hold and attach a load to a hoist mechanism that is used to lift and transport the load by raising, suspending, or lowering. Lifting devices shall be designed, fabricated, tested, inspected, and marked for identification.

Common Loads –

Loads having any of the following characteristics:

- Known center of gravity
- Rigging configurations where the slings are equal to or greater than 30-degree angles from the horizontal or less than 60-degree angles from the vertical
- Easy to balance and secure
- Lift attachment points located above the center of gravity
- Use of one crane or one hook on the same crane
- Usually repetitive lifts

WARNING: The type of lift SHALL be determined by use of the Lift Plan Checklist, NOT by the type of load.

Complex Loads –

Loads having any of the following characteristics:

- Center-of-gravity locations unknown or more than 12 inches off center
- Lift attachment points located on the bottom of the load
- Rigging configurations where the slings are less than 30-degree angles from the horizontal or greater than 60-degree angles from the vertical
- Difficult to balance or secure
- Using two cranes or two hooks on the same crane to perform tandem lifts
- When cranes are used on a barge
- When load handling is difficult and requires emphasis on crane operating skills and experience
- When the load or mobile crane exceeds recommended approach distances
- Performance of a lift using a personnel basket

WARNING: The type of lift SHALL be determined by use of the Lift Plan Checklist NOT by the type of load.

Crane Operator –

An individual who is responsible for the safe handling of the load while operating crane equipment. The crane operator will:

- Retain the physical abilities required by OSHA regulations and ASME/ANSI standards
- Successfully complete training in the inspection, maintenance, operation, and use of crane equipment
- Successfully complete a written or oral examination
- Adequately demonstrate skills and abilities required to properly inspect, maintain, and operate crane equipment

D/d Ratio –

D is the diameter of the curvature around which the body of a wire rope sling is bent; d is the diameter of a wire rope sling.

Flagger –

An individual who provides direction to the equipment operator during the raising, transporting, and lowering of loads.

Hand Chain or Lever-Operated Hoist Tension Rigging –

Use of TWO hand chain or lever-operated hoists positioned at the same elevation so that only the load creates tension on each hoist to control the raising, drifting, and lowering of a load.

Heavy Equipment Operator –

An individual who is qualified and designated by their immediate supervisor to operate the heavy equipment used to perform lifting activities.

High Line Tension Rigging –

A method used to position a load that is not accessible by a crane or overhead hoist or in situations where Hand Chain or Lever-Operated Hoist Tension Rigging cannot be used. This method consists of lashing wrapped around two building members with wire rope pulled tight between them. A snatch block secured to the wire rope is then used to lift the load and move it laterally.

Lifting Coordinator –

The designated individual in the department or at each nuclear site who retains an Engineering degree, possesses rigging hardware and lifting equipment knowledge, training, or experience, and is considered a subject matter expert. This individual is responsible for:

- Answering questions about crane operations
- Resolving crane concerns
- Interpreting issues on standards, codes, criteria, and procedures
- Providing technical support for complex or specialized rigging lift planning efforts
- Preparing and reviewing purchase specifications for cranes and associated rigging hardware
- Supporting lifting equipment inspection, maintenance, and retrofit activities
- Serving as a general technical resource for lifting activities

Lift Plan –

A plan for performing a lift, which is developed by the lift team and those involved in or affected by the lift. It is a step-by-step process that ensures all aspects of a successful lift are considered and addressed. Lift plans might require sketches, drawings, roped-off areas, investigation of interferences, load drop areas, and so on.

Lift Equipment –

A mechanical device or equipment (other than cranes or rigging hardware) used to raise, suspend, or lower equipment or materials.

Rated Capacity –

Also known as the Maximum Safe Working Load, this is the maximum load that the rigging component is designed to lift and handle safely. The Rated Capacity shall not be exceeded.

Rigger's Assistant –

An individual who successfully completes the rigging and weight-handling portion of the licensee's mechanical maintenance course (or the equivalent) and who, under the direction of a Qualified Rigger, attaches and secures the lifting hardware to the load, lifting device, and support structure, and operates the equipment.

Rigger –

An individual who is trained, qualified, and responsible for developing lift plans and rigging configurations, selecting rigging hardware, and attaching and securing rigging hardware to perform common load lifts. The Rigger will:

- Successfully complete the Rigger course and all prerequisites
- Successfully complete a written or oral examination
- Adequately demonstrate skills and abilities necessary to properly inspect, operate, and use lifting equipment

A Rigger is an individual who has received training on the inspection and operating requirements of rigging hardware and lifting equipment and has been qualified in the correct use of jacks, slings, shackles, eye bolts, lever hoists, fabricated lifting devices, hoist rings, master links, swivels, beam clamps, turnbuckles, softeners, plate dogs, wire rope clips, thimbles, manual- and power-operated hoists (two-motion), trolleys, rollers, spreader beams, and snatch blocks (rigged for vertical pull only and manually performed). Either as directed by the Advanced Rigger who completed the base-mounted drum hoist set up or by following an approved documented lift plan, a Rigger might also operate a base-mounted drum hoist.

Specialized Rigging Task Team –

A project team of subject matter experts including Advanced Riggers, Riggers, Rigger Assistants, and Crane Operators. With Crane Operators, the Advanced Riggers plan the material-handling tasks and identify training needs, equipment, tooling, and processes necessary to perform the tasks. These same individuals execute the plan along with Riggers, Rigger Assistants, and Crane Operators. Task examples include steam generator replacement, heat exchanger replacement, feedwater heater replacement, and generator/excitor replacement.

REQUIREMENTS FOR INCIDENT REPORTING

All rigging incidents will be reported. During the course of a lift process, a rigging incident is an event in which any of the following occur:

- Plant equipment is damaged
- Rigging hardware is damaged
- Damaged rigging equipment or hardware is determined to be in use without the Lift Coordinator's approval
- There is a load drop
- There is a near miss
- There is personal injury

All rigging incidents shall be reported using each licensee's reporting process. The Rigger or Advanced Rigger responsible for the lift when the incident occurs will fill out the report form.

LIFTING PROCESS

The Lifting Process uses a team approach to lifting. The team consists of Riggers, a Flagger, and a crane or equipment operator. The roles of the team members are as follows:

Rigger: Responsible for the rigging configuration, appropriate rigging hardware, and the attachment and securing of the rigging hardware to the load.

Flagger: Responsible for the safe transport of the load, clear transport path, and communication with the crane or equipment operator.

Crane or Equipment Operator: Operates the crane or equipment and is responsible for the safe handling of the load.

The lifting team members shall review each step of the Lifting Process, develop a Lift Plan, and discuss and document the Lift Plan as required. For more information, see the Lifting Process Checklist, Lift Plan Checklist, and Lift Plan Form at the back of this handbook.

The lifting process shall include:

- Lift planning (every lift requires lift planning)
- Equipment inspection
- Setup
- Securing the load
- Establishing communications
- Raising and lifting the load
- Transporting and moving the load
- Lowering and setting the load
- Securing the load
- Removing and inspecting the rigging hardware
- Returning the rigging hardware to tool issue

Planning a lift can be accomplished in as little as five minutes or might take as long as several days according to the complexity of the lift. After the work scope has been identified and the appropriate individuals have been selected to perform the associated lifting tasks, the lifting team members shall review the following Lifting Process steps and perform their individual responsibilities:

1. Use the Lift Plan Checklist in this handbook as a tool or job aid. Use should be by an individual who successfully completed either the Rigger Lifting Process training or the Advanced Rigger training, or by a Lifting Coordinator or Engineer to determine:
   - Whether the lift is a common lift or a complex lift
   - When a verbal discussion of the lift plan is sufficient
   - When to DEVELOP a lift plan
   - When to DOCUMENT a lift plan
2. Develop a Lift Plan. This is developed by a Qualified Rigger, Advanced Rigger, Lifting Coordinator, or Engineer and a Qualified Crane or Equipment Operator (if applicable).
3. Conduct a pre-lift briefing to ensure that roles and responsibilities are clearly understood and to review the Lift Plan.
4. Obtain rigging hardware from tool issue. Ensure that a copy of the Rigger's Handbook is available and, as necessary, that the Crane Operator's IPT Handbook is also available for reference.
5. Perform frequent inspection of all rigging hardware in accordance with the licensee's inspection requirements.
6. Verify the Rated Capacity of the hoist or crane.
7. Perform pre-operational crane inspection as applicable.
8. When using a mobile crane, verify that the mobile crane setup is correct.
9. For outdoor lifts, determine that weather conditions are acceptable.
10. Verify rigging hardware for appropriate size and type. Correctly attach rigging hardware to the load and hoist or crane hook. Use softeners and tag lines as required.
11. Verify a clear load travel path. Rope off the load travel path as required.

12. Notify individuals located near or (when necessary) at elevations below the travel path that the lift is in progress.

Note: When transporting a load that is heavy enough to damage the floor or that might pass over hatchways or openings in the floor, rope off the load travel path at the affected lower elevations and/or notify individuals in nearby areas prior to making the lift.

13. Verify that the set point location will support the load weight. As required, place or erect cribbing at the laydown or set point location.
14. Establish and verify communications between the Crane Operator and Flagger.
15. Tension the slings and rigging hardware to a taut condition. Secure the load by:
    - Visually inspecting the rigging hardware for safe configuration, correct installation, and any deficiencies
    - Make any necessary adjustments
    - Verify that the hook is located over the center of gravity of the material or equipment
16. Raise or lift the load to verify the center of gravity. If the load shifts and it appears that the load is not secure or is in an unbalanced condition, stop the lift. Make adjustments as necessary to balance and secure the load.
17. Raise or lift the load just enough to clear the support mechanism (floor, pedestal, trailer, and so on). Verify safe lifting configuration.
18. Raise or lift the load no higher than necessary. Transport or move the load. Avoid travel over individuals. Keep individuals clear of the load path. Stop movement of the load if individuals enter the load path area. Follow the travel path to the set point location.
19. Lower or set the load on the pre-determined location or cribbing so that the rigging hardware can be removed safely.
20. Ensure stability of the load prior to de-coupling the rigging hardware.
21. Remove the rigging hardware and inspect each component. If a component is defective, tag and document the deficiency on the tag.

RESPONSIBILITIES

Rigger Responsibilities

- Be qualified by an approved Qualified Evaluator.
- Maintain proficient skills and advise supervisor(s) of additional training and qualification needs.
- Provide instruction for teammates during the lifting process(es).
- Develop common load lift plans.
- Include teammates in lift plan development. Inform all replacement, additional, or shift-change teammates of lift plan and work status.
- Use this handbook (when required by the utility's program).
- Obtain weight and center of gravity of the load by drawings, engineering, or conservative estimating, as appropriate.
- Understand limits of the equipment and ensure that limits are not exceeded.
- Use rigging hardware and lifting equipment within its design capabilities and features.
- Determine and understand the specific requirements for lifting in specific or local surroundings (environment, site procedures, unique characteristics).
- Identify and comply with plant-unique requirements for the load travel path.
- Determine attachment points, rigging configuration, and required rigging hardware and lifting equipment.
- Verify that surrounding structures and attachment points will support the applied loads.
- Ensure compliance with lifting program requirements for the application, rigging configuration, inspection, operation, and use of rigging hardware and lifting equipment.

- Ensure that rigging hardware and lifting equipment are sized to exceed the load weight and dynamic effects.
- Identify needed rigging hardware and lifting equipment and issue an equipment list to tool issue in advance.
- Shall use softeners whenever possible.
- Ensure that laydown area will support the load and contact the engineering organization as required.
- Perform frequent inspection of all rigging hardware and lifting equipment before, during, and after use. For hardware and equipment that fails the inspection criteria, tag the defective equipment as *remove from service*. Identify and record the discrepancy on the tag, and return the equipment to tool issue.
- For non-labeled wire rope slings, determine the vertical Rated Capacity of the wire rope construction type using this handbook.
- Prior to use, ensure that all modified or fabricated rigging hardware satisfies the requirements for below-the-hook lifting devices.
- Inspect hoist block, sheaves, wire rope, hook, and latch.
- Recheck the rigging attachment points after the load is brought to a taut condition.
- Ensure that tag line and rigging hardware and lifting equipment is installed and secured.
- Ensure that the tag line person knows the travel path and their responsibilities for stabilizing the load to prevent load swing.
- Understand and comply with Flagger responsibilities.
- Perform flagging for common loads.
- Perform final equipment inspection and return equipment to tool issue.
- To prevent failures, observe other lifts to develop a knowledge base or identify inadequate rigging.
- Only use snatch blocks to perform manually operated lifts.
- Use hand chain or lever-operated hoist tension rigging to control the drifting of a load. This uses two hoists positioned at the same elevation so that only the load creates tension on each hoist.

- Operate base-mounted drum hoists only as directed by an Advanced Rigger or in accordance with a documented lift plan prepared and approved by Advanced Riggers, Lifting Coordinators, or Engineers.
- Perform complex load lifts only under the direction of an Advanced Rigger or in accordance with a documented lift plan prepared and approved by Advanced Riggers, Lifting Coordinators, or Engineers.
- Obtain approval from Engineering before rigging or attaching to lugs that have been modified, torch-cut, or are suspect.
- Obtain approval from Engineering before welding or altering any rigging hardware, lifting equipment, or lifting devices.
- Ensure that the Advanced Rigger or Crane Operator directs the installation of a crane wire rope replacement.
- Perform rigging and flagging for personnel basket operations under the direction of Qualified Crane Operators.
- Ensure that the rigging configuration is in accordance with the manufacturer's literature before lifting material using forklifts.

Advanced Rigger Responsibilities

- Shall be qualified by an approved Qualified Evaluator.
- Includes all Rigger responsibilities.
- Demonstrate leadership skills.
- Provide instruction for teammates during the training process.
- Provide feedback or concerns regarding the Lifting Program to the Lifting Coordinators.
- Provide feedback concerning Rigger skills and training needs throughout the site to the Lifting Coordinators.
- To prevent failures, observe other lifts to develop knowledge base or identify inadequate rigging.
- Develop complex load lift plans and rigging configurations, and ensure that the correct rigging hardware and lifting equipment are used and properly set up.
- Use this handbook.
- Identify fabricated lifting devices or alternate rigging hardware that improves safe work practices and reduces labor hours during rigging cycle time.

- Develop base-mounted drum hoist rigging configurations. Determine the base-mounted drum hoist configuration capacity. Tag the base-mounted drum hoist with the Rated Capacity of the system and all operating requirements or directions. Set up, install, and operate base-mounted drum hoists.
- Perform lifts with sling angles less than 30° from the horizontal.
- Develop rigging configurations using snatch blocks.
- Develop High Line Tension Rigging and perform high line operations.
- Develop and perform Hand Chain or Lever-Operated Hoist Tension Rigging while drifting a load.
- Perform tandem lifts using two cranes or two hooks on the same crane.
- Use equalizer beams to equally distribute loads or for load balancing and stabilization.
- Develop and perform lift plans for the handling of vessels or shells.
- Understand the requirements for performing lifting operations near electrical power lines and switchyards, during inclement weather, and during nighttime operation.
- Perform flagging for complex loads.

Note: The following Advanced Rigger responsibilities require additional training.

- Set up and perform air pallet operations.
- Install crane and hoist replacement wire rope. Ensure that the wire rope is secured, reeved, and spooled correctly. Ensure proper fleet angles. Check limit switch settings upon completion for correct operation.
- Responsible (with the Crane Operator) for assembling and disassembling mobile cranes and lattice booms.
- Responsible (with the Crane Operator) for assembling and disassembling mobile cranes on barges.

Flagger Responsibilities

- Shall wear a colored reflective vest or reflective gloves.
- Shall be a Qualified Rigger to be a Flagger for common lifts.
- Shall be a Qualified Advanced Rigger to be a Flagger for complex lifts.
- Understand the utility-specific Lifting Program processes.
- Maintain proficient skills in lifting operations.
- Responsible and accountable for directing the safe transport of the load.
- Request work assignments to stay proficient.
- Provide instruction for teammates during planning and lifting processes.
- Be involved and know the lift plan. Discuss with the operator the blind or inaccessible areas, how flagging will be performed, and who will be flagging.
- Shall know the location of the crane mainline disconnect.
- Suspend or discontinue flagging of crane operations in weather that causes unsafe conditions.
- Shall not direct a lift requiring side pull unless approved by the Lifting Coordinator.
- Responsible (with the Crane Operator) for compliance with operating procedures involving the use of personnel baskets to lift individuals.
- Be aware of the environment and capabilities of the crane, rigging hardware, and lifting equipment and devices.
- Ensure or perform a frequent inspection of rigging hardware and lifting equipment.
- Obtain Engineering approval before rigging or attaching to lugs that have been modified, torch cut, or are suspect.
- Ensure by inspection or verification with the Rigger that the correct rigging configuration is being used, or do not direct lifting of the load.
- Determine the load path and secure it by roping off as necessary. Prior to lift, review the load path, set point, and lay-down areas for acceptable conditions.

- Ensure that shipping crates are appropriately designed and approved for material handling when using cranes or hoists to raise, suspend, move, transport, or lower materials in shipping crates.
- Transport loose parts in material handling containers.
- Ensure that the swing path of the counterweight is roped off.
- During lifting operations, the Flagger shall remain attentive to the lifting task, focused on the transport of the load, and not be distracted by other individuals.
- Ensure that individuals are not positioned between the load and surrounding objects.
- Shall be in constant communication (radio or visible) with the operator at all times.
- Watch for individuals entering the load path and ensure that individuals clear the area.
- Responsible (with the Rigger) to ensure that the lay-down area will support the load (contact Engineering as required).
- During operation of the crane, if it is suspected that any equipment is damaged, discontinue operation and inspect the equipment.

Specialized Rigging Task Team Rigger Responsibilities

- **Includes all Rigger and Advanced Rigger responsibilities.**
- Direct or participate in the specialized lifting task.
- Develop Lift Plans for the specialized project lifting tasks.
- Provide input into team selection.
- Be knowledgeable of all rigging hardware, lifting equipment, and cranes to be used.
- Identify additional training needs for the task.
- Identify rigging hardware, lifting equipment, cranes, and processes needed to perform the task. Include Crane Operators in planning of the lift.
- Sufficiently communicate responsibilities to all personnel affected or involved in the task.

- Include a Qualified Electrical Worker when performing lifting tasks or crane operations near energized equipment and closer than the approach distances allowed in existing program procedures.

Note: A specialized rigging task team can consist of Advanced Riggers, Rigger Assistants, and Crane Operators. However, at least one Advanced Rigger who is a subject matter expert in lifting tasks shall be on the team.

Responsibilities for Supervisors of Teams with Lifting Tasks

First Line Supervisors

- Ensure that individuals are qualified for and proficient in lifting tasks.
- Ensure that individuals performing lifting activities know and understand their responsibilities and comply with the Lifting Program requirements.
- Ensure that vendor and contractor individuals are qualified to perform or direct lifting tasks before being assigned to teams with lifting tasks. However, vendor and contractor individuals who assist qualified individuals in lifting tasks are not required to be qualified.
- Ensure that qualified individuals remain proficient at the task.
- Ensure the development of individuals using the appropriate training process and through the direction of their activities by qualified individuals.
- Only send recommended, proficient individuals who satisfy the prerequisites through the qualification process.
- Be aware of the environmental effects and surrounding conditions of the area where lifting operations will be performed to determine the complexity of the lift.
- Ensure that required, documented Lift Plans for lifting activities are recorded and issued to Work Control, Planning, or the Lifting Coordinator for future retrieval.
- Ensure that pre-operational and frequent inspections are performed.
- Ensure that rigging hardware, lifting equipment, and crane discrepancies are reported.

Planning and/or Work Control Responsibilities

- Understand the Lifting Program processes.
- Identify the lifting work activities and where lift planning is needed.
- Schedule time for planning the lift and selecting, inspecting, installing, and removing rigging hardware.
- Respond to Rigger's request to task out the fabricated lifting devices or alternate rigging hardware to aid safe work practices or reduce labor hours.
- Identify when the lifting of individuals is required or being implemented.

Equipment and Material Issue Responsibilities

- Maintain adequate inventory of quality rigging hardware, lifting equipment, and cranes to meet business needs.
- Route all identified defective equipment to repair area.
- Discard rigging hardware, lifting equipment, and cranes that are not repairable.
- Solicit feedback from users regarding improvements that will better satisfy their lifting needs.
- Use an effective method for providing rigging hardware, lifting equipment, and cranes during emergencies.
- Provide Defective Tags for identifying defective equipment.
- Only issue rigging hardware, lifting equipment, and cranes that have current inspection dates.
- Store rigging hardware, lifting equipment, and cranes in a manner that prevents damage and provides ease of access.
- Post job aids, charts, and so on that are provided by the Lifting Coordinator.
- Provide softeners and other support products needed for routine rigging configurations as standard stock items.
- Inform management of equipment abuse.

Supervisor Responsibilities for Lifting Operations Using Cranes

Definition: Any Supervisor who has a Crane Operator on their team.

- Understand the Lifting Program processes.
- Ensure that the Operator and Flagger know their responsibilities for the Lifting Program.
- Ensure the development of individuals by using the appropriate training process and through the direction of craning tasks by a Qualified Operator.
- Send only recommended, proficient individuals who satisfy the prerequisites through the qualification process.
- Ensure that assigned individuals remain proficient at task.
- Ensure that an individual is qualified and proficient for a specific crane.
- Ensure that a Qualified Flagger/Rigger is assigned to the lift team.
- Ensure that vendors and contractors are qualified to perform or direct craning tasks before being assigned to teams with lifting tasks.
- Evaluate the effects of the environment and conditions of the surrounding area where crane operations will be performed to determine the complexity of the lift.
- Ensure that Lift Plan development is included in the work scope of support teams (Planning, Work Control, and Engineering).
- Ensure that pre-operational and periodic inspections are performed and documentation is completed.
- Ensure that reported discrepancies are resolved for equipment in question.

Mobile Lattice Boom Cranes, Mobile Hydraulic Cranes, Tower Cranes, and Boom Truck Crane Operator Responsibilities

- Shall attend the Rigger Lifting Process course. However, not required to be qualified unless performing or directing rigging activities.
- Shall be qualified by an approved Qualified Evaluator.
- Understand the Lifting Program processes.

- Meet physical and mental requirements to operate equipment safely daily.
- Request work assignments to stay proficient.
- Provide instruction for Crane Operator trainees during the training process.
- Review the crane manufacturer's operator manual and become familiar with the operating features of the crane prior to operating.
- Review unique crane operating characteristics. Verify that pre-operational, quarterly, and periodic inspection documentation is posted in the crane cab or at the operator's station. Ensure that quarterly and periodic inspections are current prior to operating equipment.
- Shall assess their skill level and proficiency in operating equipment prior to attempting a lift when the lift is:
  - Near Rated Capacity.
  - Performed in unfamiliar surroundings or operating conditions.
  - Performed on an infrequent basis.
  - The difficulty or risk requires additional skills, abilities, or knowledge.
  - Crane Operators shall seek assistance as required.
- Determine and understand the specific requirements for operating the crane in its specific surrounding (environment, site procedures, or unique characteristics).
- Responsible (with the Advanced Rigger) for following manufacturer's recommendations for assembly and disassembly of mobile cranes and booms.
- Responsible (with the Advanced Rigger) for ensuring that the stowed jib boom is attached properly.
- Maintain proficient skills by operating the crane prior to performing a lift to refresh familiarity with crane features, handling, setup, and so on.
- Responsible and accountable for the safe handling of the load.
- Responsible for performing pre-operational inspections, ensuring that periodic inspections are current, documenting all deficiencies on the crane discrepancy form, reporting deficiencies to the Crane Operator Supervisor, and sending the Lifting Coordinator a copy of the discrepancy report.

- Responsible (with Crane Inspector) for performing quarterly inspections, ensuring that quarterly inspections are current, documenting all deficiencies on the crane discrepancy form, reporting deficiencies to the Crane Operator Supervisor, and sending the Lifting Coordinator a copy of the discrepancy report.
- If equipment fails inspection criteria, follow site tag-out procedures.
- If a question arises concerning equipment operability, tag the crane as inoperable and discuss with Supervisor or Lifting Coordinator to determine the appropriate action.
- During operation of the crane, if it is suspected that any equipment is damaged, discontinue operation and inspect the equipment.
- Know the lift plan and be involved in the lift plan development. Discuss with Flagger the blind or inaccessible areas, how flagging will be performed, and who will be flagging.
- Be knowledgeable of setup and operation in rough terrain.
- Ensure that the area where the crane is setup is acceptable for the crane in all configurations needed to perform the work. All configurations that are not required and are unacceptable for the setup area shall be prohibited and the restriction posted in the crane cab.
- Ensure that the swing path of the counterweight is roped off.
- Rope off the area where the crane boom might pass to avoid carrying a load over individuals who might enter the area.
- Ensure that individuals are not positioned between the load and surrounding objects.
- If the operator does not have clear vision of hook, load, and travel path, DO NOT operate the crane without a **Qualified** Flagger.
- Ensure that the Flagger wears a reflective vest or gloves and remains in constant communication at all times.
- Responsible (with Flagger) for compliance with operating procedures involving the use of personnel baskets to lift personnel. Must be a Qualified Crane Operator in the use of personnel baskets and assigned the responsibility by a rigging hardware and lifting equipment supervisor knowledgeable about the Personnel Basket Lifting Process.

- If within 50 feet of power lines, refer to the special instructions in the Lifting Program.
- Ensure that the hook or load block does not exceed the lower limit by observing the paint on the running cable and discontinuing lowering when the fluorescent paint is visually detected.
- If any guards have been removed or damaged, DO NOT operate the crane.
- Obtain Lifting Coordinator approval before altering or overriding any safety devices.
- Suspend or discontinue crane operation in weather that causes unsafe conditions.
- Shall be qualified in the repair, disassembly, adjustment, or modification of crane equipment prior to performing work.

Cab-Operated Bridge and Gantry Crane Operator Responsibilities

- Shall attend the Lifting Process course. However, not required to be qualified unless performing or directing rigging activities.
- Shall be qualified by an approved Qualified Evaluator.
- Understand the Lifting Program processes.
- Meet physical and mental requirements to operate equipment safely on a daily basis.
- Become familiar with the operating features of the crane prior to operating.
- Review unique crane operating characteristics. Verify that pre-operational, quarterly, and periodic inspection documentation is posted in the cab. Ensure that quarterly and periodic inspections are current prior to operating equipment.
- Crane Operators shall assess their skill level and proficiency in operating equipment prior to attempting a lift when the lift is:
  - Near Rated Capacity.
  - Performed in unfamiliar surroundings or operating conditions.
  - Performed on an infrequent basis or the difficulty or risk requires additional skills, abilities, or knowledge.
  - Crane Operators shall seek assistance as required.

- Request work assignments to stay proficient.
- Shall know the location of the crane mainline disconnect.
- During operation of the crane, if it is suspected that any equipment is damaged, discontinue operation and inspect the equipment.
- Shall not side pull unless approved by the Lifting Coordinator.
- Determine and understand the specific requirements for operating the crane in its specific surrounding (environment, site procedures, or unique characteristics).
- Maintain proficient skills by operating the crane to refresh familiarity with the crane features prior to performing a lift.
- Operator and Flagger will become a team and be accountable for the safe lifting of the load.
- Perform pre-operational inspections and ensure that periodic inspections are current. Document all deficiencies on the crane discrepancy form and report them to the Crane Operator Supervisor. Send the Lifting Coordinator a copy of the discrepancy report.
- Perform quarterly inspections (with the Crane Inspector). Ensure that periodic inspections are current; document all deficiencies on the crane discrepancy form; report deficiencies to the Crane Operator Supervisor, and send the Lifting Coordinator a copy of the discrepancy report.
- If equipment fails inspection criteria, follow site tag-out procedures.
- If a question arises concerning equipment operability, tag the crane as inoperable and discuss with the Supervisor or Lifting Coordinator to determine appropriate action.
- Know the lift plan and be involved in the lift plan development. Discuss the blind or inaccessible areas with the Flagger, how flagging will be performed, and who will be flagging.
- Ensure that individuals are not positioned between the load and surrounding objects.
- If the operator does not have clear vision of the hook, load, and travel path, DO NOT operate the crane without a Qualified Flagger.

- Ensure that the Flagger wears a reflective vest or gloves and remains in constant communication at all times.
- Responsible (with the Flagger) for compliance with operating procedures involving the use of personnel baskets to lift individuals. Must be a Qualified Crane Operator in the use of personnel baskets and assigned the responsibility by a Rigging Hardware and Lifting Equipment Supervisor knowledgeable about the Personnel Basket Lifting Process.
- If any guards have been removed or damaged, DO NOT operate the crane.
- Obtain Lifting Coordinator approval before altering or overriding any safety devices.
- Suspend or discontinue crane operation in weather that causes unsafe conditions.
- Shall be qualified in the repair, disassembly, adjustment, or modification of crane equipment prior to performing work.

Floor-Operated Bridge and Gantry Crane Operator Responsibilities

- Shall attend the Lifting Process course. However, not required to be qualified unless performing or directing rigging activities.
- Shall be qualified by an approved Qualified Evaluator. Operator SHALL NOT operate from the crane cab.
- Understand the Lifting Program processes.
- Meet physical and mental requirements to operate equipment safely on a daily basis.
- Provide instruction for Crane Operator trainees during the training process.
- Review the crane manufacturer's operator and maintenance manual and become familiar with the operating features of the crane prior to operating.
- Review the unique crane operating characteristics. Verify that pre-operational, quarterly, and periodic inspection documentation is posted in the cab. Ensure that quarterly and periodic inspections are current prior to operating equipment.
- Shall assess their skill level and proficiency in operating equipment prior to attempting a lift when the lift is near Rated Capacity, performed in unfamiliar surroundings or operating

conditions, performed on an infrequent basis, or the difficulty or risk requires additional skills, abilities, or knowledge. Shall seek assistance as required.

- Request work assignments to stay proficient.
- Shall know the location of the crane mainline disconnect.
- During operation of the crane, if it is suspected that any equipment is damaged, discontinue operation and inspect the equipment.
- Shall not side pull unless approved by the Lifting Coordinator.
- Determine and understand the specific requirements for operating the crane in its specific surrounding (environment, site procedures, unique characteristics).
- Maintain proficient skills operating the crane to refresh familiarity with the crane features prior to performing a lift.
- Operator and Flagger become a team and are accountable for the safe lifting of the load.
- Perform pre-operational inspections and ensure that periodic inspections are current. Document all deficiencies on the Crane Discrepancy Form; report deficiencies to the Crane Operator Supervisor, and send the Lifting Coordinator a copy of the discrepancy report.
- Responsible (with the Crane Inspector) for performing quarterly inspections and ensuring that quarterly inspections are current. Document all deficiencies on the crane discrepancy form; report deficiencies to the Crane Operator Supervisor, and send the Lifting Coordinator a copy of the discrepancy report.
- If equipment fails inspection criteria, follow site tag-out procedures.
- If a question arises concerning equipment operability, tag the crane as inoperable and discuss with the Supervisor or Lifting Coordinator to determine appropriate action.
- Know the lift plan and be involved in the lift plan development. Discuss with Flagger the blind or inaccessible areas, how flagging will be performed and who will be flagging.
- Ensure that individuals are not positioned between the load and surrounding objects.
- If the operator does not have clear vision of hook, load, and travel path, DO NOT operate the crane without a Qualified Flagger.

- Ensure direct communication with the Flagger.
- SHALL NOT perform Personnel Basket Lifts. Cab, bridge, and gantry Crane Operator is required to perform lifting of individuals.
- If any guards have been removed or damaged, DO NOT operate the crane.
- Obtain Lifting Coordinator approval before altering or overriding any safety devices.
- Suspend or discontinue crane operation in weather that causes unsafe conditions.
- Shall be qualified in the repair, disassembly, adjustment, or modification of crane equipment prior to performing work.

Responsibilities When Cranes Are in Motion

- A pre-job briefing is required anytime a mobile crane is moved around a generating plant site.
- All persons involved will participate in the pre-job briefing that includes discussion of the following:
  - Location of overhead power lines
  - Condition of the terrain
  - Weather and wind conditions
  - Potential obstructions in the travel path
  - Roles and responsibilities of all persons involved
  - Need for a spotter to direct the movement of the crane (see next bullet point)
- A spotter is required to direct the movement of a mobile crane being relocated on a generating plant site under the conditions listed below. Under these conditions, the spotter will be a Qualified Rigger or Crane Operator.
  - Overhead power lines are within 50 feet.
  - Mobile crane is not in its folded (collapsed) condition.
  - Potential obstructions or terrain problems are identified in the pre-job briefing.
- If it is determined in the pre-job briefing that a spotter is not necessary, the Crane Operator will walk down the path prior to moving the crane and note all potential problems.

INSPECTION REQUIREMENTS

Rigging Hardware Inspection Requirements

Inspection of the rigging hardware listed in this Handbook shall be performed as follows:

- An **initial** inspection shall be performed on all new rigging hardware prior to initial use by lifting equipment inspectors in accordance with the applicable Lifting Program Requirements and Procedures.
- A **frequent** inspection shall be performed on all rigging hardware before, during, and after use by Qualified Riggers in accordance with applicable Lifting Program Requirements and Procedures. "After use" is defined as performing an inspection of rigging hardware at job completion or prior to return to tool issue or storage location.
- A **periodic** inspection shall be performed by lifting equipment inspectors on all rigging hardware (see Note 1) at intervals of 12 months in accordance with Lifting Program Requirements and Procedures.
- Periodic inspections on NUREG-0612 special lifting devices shall be performed by qualified inspection individuals in accordance with the criteria as prescribed by ANSI N14.6, ASME B30.9, appropriate licensee procedures, and additional station procedures and/or requirements. Inspection intervals shall be established in accordance with specific NRC commitments at each site.

Note 1: Where Frequent Inspections are equivalent to the OSHA-required Periodic Inspection, the Lifting Program takes credit for the Frequent Inspection performed by a Qualified Rigger. Thus, some previously required periodic documented inspections have been superseded by the user Frequent Inspections. The table on the next page only reflects the inspection intervals required by the Lifting Program. Those periodic inspections required by OSHA regulations superseded by Frequent Inspections are not reflected

in the table. However, in accordance with Lifting Program requirements, the Lifting Coordinators shall ensure random inspection of rigging hardware to assess the effectiveness of user inspections, evaluate findings, and determine if inspection interval revisions are necessary.

Note 2: All chain slings, spreader beams, lifting beams, personnel baskets, nuclear lifting devices (NUREG-0612, ANSI N14.6), plate dogs, drum turners, jacks, pumps, engineered fabricated devices, beam clamps, and manual- and power-operated hoists shall be marked with a unique Tool Issue Tracking Number, Manufacturer's Number, Site/Utility-specific Drawing Number, or Calculation Number (including sketch).

Rigging Hardware Inspection Intervals

Table 1
Rigging Hardware Inspection Intervals

Rigging Hardware	Initial	Frequent	Periodic	ANSI N14.6
Chain Slings	X	X	X	
Wire Rope and Synthetic Slings	X	X		
Spreader Beams, Lifting Beams, Lift Rigs	X	X		
Personnel Baskets	X	X	X	
Nuclear Lifting Devices (NUREG-0612, ANSI N14.6)	X	X	X	X
Shackles, Turnbuckles	X	X		
Rollers	X	X		
Snatch Blocks	X	X		
Master Links (Oval, Oblong, Pear), Hoist Rings, Swivels, Eye Bolts	X	X		
Beam Clamps	X	X		
Plate Dogs, Drum Turners	X	X	X	
Wire Rope Clips, Thimbles	X	X		
Jacks and Hydraulic Pumps	X	X	X	
Engineered Fabricated Lifting Devices	X	X		
Air Pallets	X	X		
Manual- or Power-Operated Hoists and Trolleys	X	X	X	
Trolleys Not Attached to Hoists	X	X		

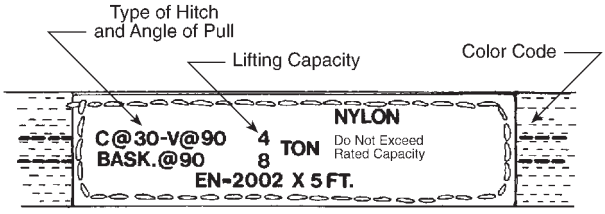
Inspection of Slings

Cautions When Using Slings

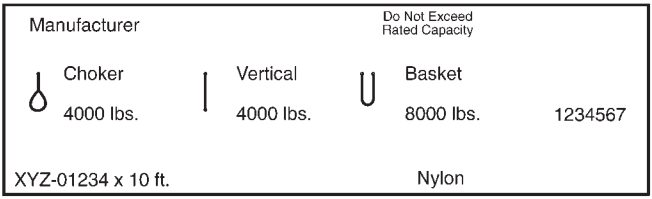
- Specific chemically active environments can affect the strength of certain synthetic slings. Prior to use in a chemically active environment, check with the manufacturer's literature, an Advanced Rigger, or the Lifting Coordinator.
- Kevlar is resistant to most weak acids and alkalis, ketones, alcohols, hydrocarbons, oils, and dry cleaning solvents. Strong acids and bases and sodium hypochlorite bleach attack Kevlar, particularly at high temperatures or high concentrations.
- Sling material can be susceptible to caustic damage or acid fumes. Strongly oxidizing environments attack all common types of sling material.
- Carbon steel slings with fiber core (FC) shall not be used at temperatures below -60°F or above 180°F without approval from the manufacturer or Lifting Coordinator.
- All other carbon steel slings shall not be used at temperatures above 400°F without approval from the manufacturer or Lifting Coordinator.
- Stainless steel slings shall not be used at temperatures above 800°F without approval from the manufacturer or Lifting Coordinator.
- Synthetic slings shall not be used at temperatures above 180°F without approval from the manufacturer or Lifting Coordinator.
- Metal mesh slings without an elastomer coating shall not be used at temperatures below -20°F or above 400°F without approval from the manufacturer or Lifting Coordinator.
- Metal mesh slings with an elastomer coating shall not be used at temperatures below 0°F or above 200°F without approval from the manufacturer or Lifting Coordinator.
- Chain slings shall not be used at temperatures below -40°F or above 600°F without approval from the manufacturer or Lifting Coordinator.
- Natural and synthetic fiber rope slings shall not be used at temperatures below -20°F or above 150°F without approval from the manufacturer or Lifting Coordinator.
- Use softeners whenever possible to prevent damage to slings. Do not use softeners that could be cut by sharp edges (for example, thin, un-reinforced rubber).

Rated Lifting Capacity Tag Examples for Synthetic Web Slings

How to Find Rated Lifting Capacities of Nylon Slings



Note: C @ 30 - V @ 90 is defined as using the sling in a choker hitch at any choke angle, at any sling angle, or in a vertical hitch at the same Rated Capacity. For example, the sling can be used in a choker hitch at a 30° choke angle and a sling angle of 20° for an applied stress on the sling of up to 8000 lbs.



Wire Rope Slings

Prior to use, all wire rope slings shall be identified as follows:

- Material Construction (Grade)
- Vertical Rated Capacity
- Diameter Length

Note: If wire rope sling markings are not readable or the tag has been lost, perform a Frequent Inspection, identify the vertical Rated Capacity of either Independent Wire Rope Core (IWRC) or Fiber Core improved plow steel wire rope slings as illustrated in this handbook and re-label the sling.

Wire Rope

Wire rope is a machine. When put under load, the wire rope must be able to move and adjust. Wire rope sling strength is dependent upon the wire rope's structural integrity, a firm and undamaged inner core to provide the stability for the outer strands, and free movement of the outer strands.

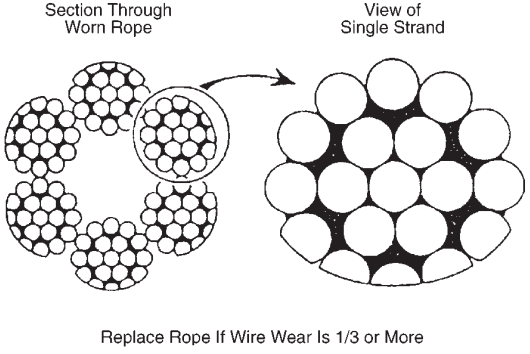
The following four distinct conditions necessitate the removal of wire rope from service:

- Broken wires or equivalent
- Metal loss and/or degradation
- Permanent deformation of the rope by freezing or locking wires and strands, which prevents them from sliding and adjusting
- Unbalance or distortion of the sling by wires and strands being deformed and pushed out of their original position

If any one of the following conditions are visually observed or a combination of any three considered to be marginal but not defective conditions are found in one sling, the wire rope shall be immediately removed from service.

Inspect the Sling for Metal Loss or Degradation

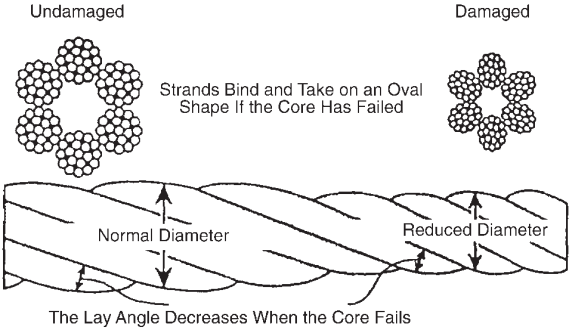
Case 1: Wear or scraping of 1/3 the original diameter of outside individual wires.



Wire Rope Localized Wear

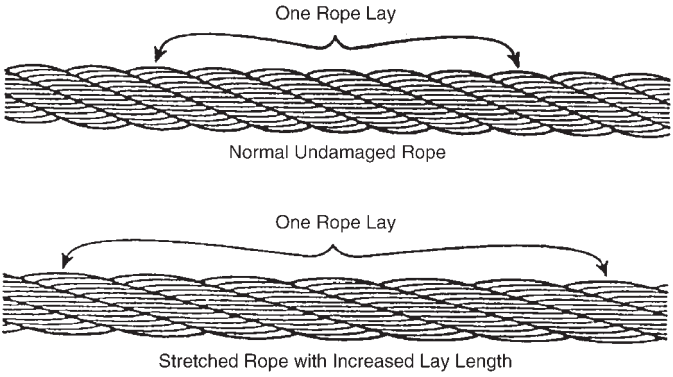
Note: The entire cross-sectional area metal loss is equal to the equivalent of five broken wires.

Case 2: Reduction in rope diameter. Rope reduction guidelines are:
3/64" for rope diameters equal to or less than 3/4"
1/16" for rope diameters between 7/8" and 1-1/8"
3/32" for rope diameters between 1-1/4" and 1-1/2"



Wire Rope Diameter Reduction

Case 3: Rope stretch where the lay length has increased in localized areas.



Wire Rope Stretching

Case 4: When the load is applied, the strands begin to unravel, separate, and spread apart. A gap forms between strands or the inner core is visible under load.

Case 5: Damage caused by exposure to heat, which results in metallic discoloration or loss of internal lubricant.

Case 6: Wire rope that has been used as a ground during welding.

Case 7: Arc strikes observed or identified on the wire rope.

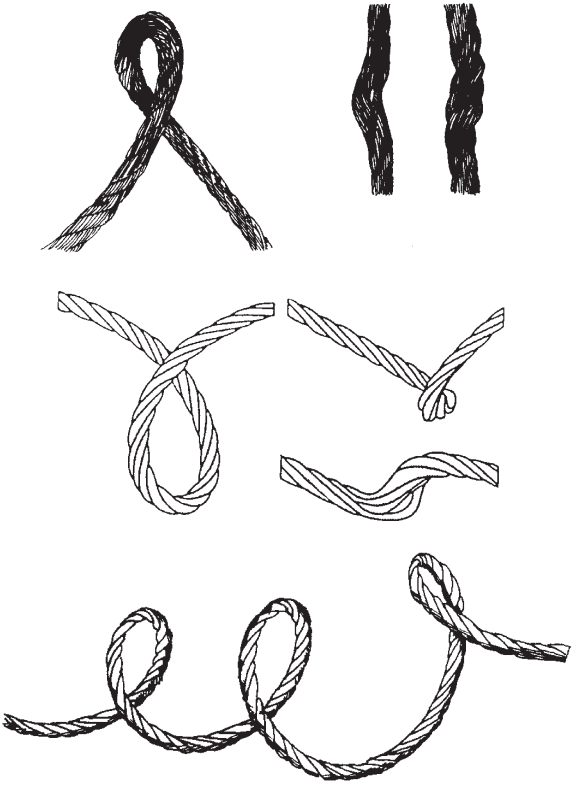
Case 8: Corrosion of the rope or end attachments, which has caused pitting or binding of wires. Note: Light surface rusting is acceptable.

Case 9: Cracked, bent, or broken end fittings.

Case 10: Correct type end fittings.

Deformation

Case 1: Wire rope kinking is the permanent deformation of the rope, which cannot be corrected and will not allow the rope to return to its original shape. Kinking is identified by sharp creases or bends, a V-shaped configuration, a pig-tail spiral in the rope, or sharp bends that prohibit the individual strands or wires from moving freely, rotating, or adjusting.



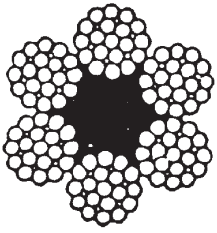
Wire Rope Kinking

Note: The wire rope condition illustrated below is not a kink but is a bend. The bend, known as a dog leg, is a set that does not prevent strand or wire movement or can be straightened without causing permanent rope damage. There is no strand kinking, crushing, flattening, or displacement and the strands can still move and adjust. Thus, wire rope that has bends or dog legs is acceptable to use.

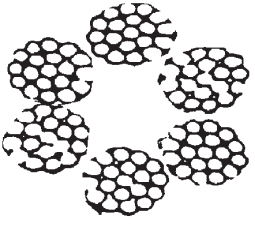
Wire Rope Dog Leg

Case 2: Crushing is the mashing of individual wires and strands, changing the shape of the rope from a circle to a rectangular shape.

Localized Crushing of Rope

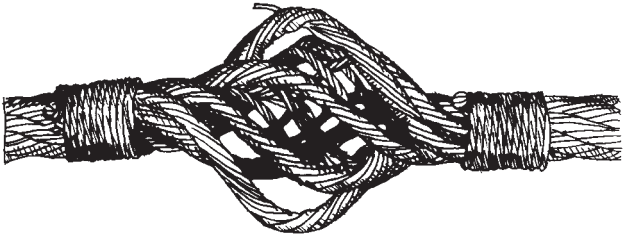


Undamaged Rope Section

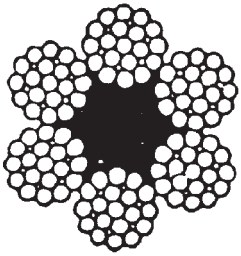


Crushed Section

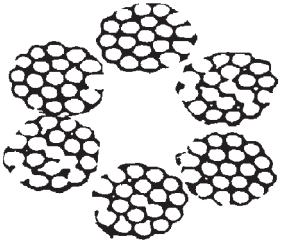
Case 3: Birdcaging is when the rope permanently unravels and all the strands separate or spread apart in a localized area.



Case 4: Flattening is similar to crushing but not as severe. Flattening of individual wires and strands resembles an oval shape. The wire rope should be discarded when flattening locks the wires and strands in place, preventing movement.



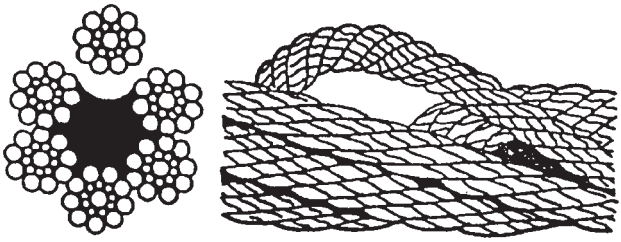
Undamaged Rope Section



Flattened Section

Unbalance/Distortion

Case 1: High stranding or unlaying of individual wires in one strand or individual strands of the rope. The individual wires or strands that separate from the rope resemble a hump. Excessive wear and crushing take place and the other strands become overloaded.



High Stranding

Case 2: Core protruding outward between separated strands.

Case 3: Individual wire or strand displacement. Wires and strands are pushed out of their original position. A gap occurs in the original shape where an individual wire or strand has been shifted or relocated.

Strand Displacement

Broken Wires

Case 1: 5 broken wires in one strand in one lay
or
10 randomly distributed broken wires in one rope lay

Case 2: Any combination of kinking, crushed, flattened, distorted/displaced, or worn individual wires that represent the equivalent of 5 broken wires in one strand in one lay or 10 randomly distributed broken wires in one rope lay.

Use the following descriptions to determine broken wire equivalent:

- Kinking (sharp creases or bends) of individual wires, which cannot be corrected, will not allow the rope to return to its original shape, and prohibits the wires from moving freely, rotating, and adjusting. Consider the wire(s) broken.
- Crushing is the mashing of individual wires, which changes the shape of the strand from a circle to an elliptical or rectangular shape. Consider the wire(s) broken.
- Flattening is similar to crushing but not as severe. Flattening of individual wires forms an oval shape of the strand. When flattening locks the wires in place, preventing movement, consider the wire(s) broken.
- Individual wire displacement. Wires are pushed out of their original position and a gap occurs in the original shape where an individual wire has been shifted or relocated. Consider the wire(s) broken.
- Wear or scraping of outside individual wires that represents equal metal loss of 5 wires in one strand of one lay or 10 wires in one lay.

Individual Wire Crushing

Broken Wires, Wear, and Distortion

Individual Wire Crushing, Flattening, and Distortion

Abrasion or Wear

Individual Wire High Stranding

Examples of Wire Rope Damage

Sling Eyes

Note: Additional conditions for eyes

Case 1: Any evidence that eye splices have slipped, tucked strands have moved, or mechanical/flemish eye splices have been damaged.

Case 2: Distortion that locks strands in the eye or flattens the rope of the eye so that strands cannot move or adjust.

Case 3: Kinks, distortion, or permanent deformation at the mechanical/flemish eye splice.

Case 4: Two broken wires or the equivalent at the mechanical/flemish eye splice.

Case 5: The width of the eye (outside edge to outside edge dimension) is less than six sling body diameters.

Case 6: Eye deformation (high stranding or strand displacement) along the curvature of the eye is acceptable as long as there are no broken wires and there is no gross distortion of the lay of the strands, crushing, or core protrusion.

Case 7: Correct type of splice/end fitting. If hand-tucked splice, ensure that there is no evidence of heat damage.

Metal Mesh Slings

All slings shall have an identification tag stating the following or be removed from service:

- Manufacturer's name or trademark
- Rated Capacity for vertical basket and choker hitch

Note: The Rated Capacity tag shall be legible. If the Rated Capacity cannot be determined from the tag for all hitches, then the sling shall be removed from service. Some manufacturer's metal mesh slings might not have a vertical hitch Rated Capacity on the tag. Check with the specific manufacturer for vertical hitch recommendations.

Inspect the sling for:

- A broken weld or brazed joint along the sling edge
- A broken wire in any part of the mesh
- Reduction in wire diameter of 25% due to abrasion or 15% due to corrosion
- Lack of flexibility due to distortion of the mesh
- Distortion of the choker fitting so that the depth of the slot is increased by more than 10%
- Distortion of either end fitting so that the width of the eye opening is decreased by more than 10%
- A 15% reduction in the original cross-sectional area of metal at any point around the hook opening of the end fitting
- Visible distortion of either end fitting out of its plane
- End fitting distortion or damage (broken welds, cracks, bend)

Kevlar Slings

All Kevlar slings shall have an identification tag stating the following or be removed from service:

- Manufacturer's name or trademark
- Rated capacity for vertical, basket, and choker hitches

Note: The Rated Capacity tag shall be legible. If the Rated Capacity cannot be determined from the tag for all hitches, then the sling shall be removed from service.

Inspect the sling for:

- Both tell-tails (stress cords) shall extend past the tag area of each sling
- Cuts, tears, holes, or punctures over the entire length of the outer cover

Note: If found, remove the sling from service and return to the manufacturer for evaluation and repair.

- End fittings for damage such as corrosion, cracks, breaks, or distortion
- Heat or chemical damage such as charring or melting
- Exposed yellow load bearing yarn

Note: Slings that receive cuts, tears, holes, or punctures to the outer cover while in use can be used to complete that lift, but shall be removed from service when the lift is completed. If the inner core load bearing yarns of a Kevlar sling are damaged during a lift, the lift must be stopped and the sling replaced. Any damaged Kevlar sling should be returned to the manufacturer for evaluation and repair.

Polyester Round Slings

Inspect the sling for:

- Legible capacity tag.
- Cuts, snags, punctures, or holes of any type over the entire length of the inner cover, which exposes the white and red load-bearing core yarns.
- Discoloration that could mean chemical damage or excessive exposure to sunlight.
- Melting or charring of any part of the sling.
- End fitting distortion or damage (broken welds, cracks, bend).
- Other visible damage that causes doubt as to the strength of the sling.
- Acid or caustic burns.

Natural and Synthetic Fiber Rope Slings

Inspect the sling for:

- Cuts, gouges, badly abraded spots.
- Seriously worn surface fiber yarns.
- Considerable filament or fiber breakage along the line where adjacent strands meet (light fuzzing is acceptable).
- Particles of broken filament or fibers inside the rope between the strands.
- Discoloration or harshness that could mean chemical damage or excessive exposure to sunlight. Inspect filaments or fibers for weakness or brittleness.
- Kinks or tangles.
- Melting or charring of any part of the sling.
- Cuts, abrasions, heat damage, chemical damage, and fitting distortion or damage (broken welds, cracks, bend) over the entire length.
- Other visible damage that causes doubt as to the strength of the sling.

Synthetic Web Slings

All synthetic slings shall be permanently labeled with the following manufacturer markings or be removed from service:

- Manufacturer's name or trademark
- Manufacturer's Code or Stock Number
- Rated Capacity for vertical, basket, and choker hitches
- Length
- Type of synthetic material and/or construction

Note: If the sling markings are not readable, return slings to the manufacturer for re-certification and tagging. If traceability of a sling is lost, the sling shall be destroyed.

Inspect the sling for:

All synthetic web slings shall be removed from service and discarded if any of the following are detected during a visual inspection of the sling:

- Scuffing of an area that is 1 inch or greater in length and covers 50% or more of the web width
- Scuffing along the sling web edge that is 4 inches or greater in length
- Scuffing of 1 inch or more along both edges of the sling web
- Scuffing of 1 inch or more along one edge of the sling web in the apex of the eye
- Any heat damage that causes melting, charring, discoloration, or hardening of the fibers
- Any acid damage that causes melting, discoloration (spotting), or hardening of the fibers
- One broken stitch in the load bearing area of the lap or splice joint
- Two broken stitches along the edge of the sling web
- Separation of webbing ply at the lap or splice joint
- The vertical, basket, or choke hitch Rated Capacity cannot be visually determined by the user
- One puncture in the midsection of any two-ply web or lap/splice joint

- Two punctures along the edge of a web sling
- Cut in the first layer of fibers across the web width (face cut)
- One cut along one edge of the sling web
- Two or more marginal conditions that exist in the same sling

Scuffing

Scuffing is the fraying of the fibers resulting in "fuzzing" with no distinct cut or separation of fibers.

Cuts

Cuts are the distinct and total separation of individual fibers such that the ends of the fibers can be identified.

Punctures

Punctures are areas where the cross-weaving fibers have been cut, allowing the longitudinal fibers along the length to become free to separate and hump similar to a birdcaging effect. Punctures usually involve cuts and fraying.

Discoloration

Discoloration is the fading of the original material color due to aging or ultraviolet rays. Fading of the original color is the judgment of the user. Indications include a light brown or gray color. Discoloration is normally detected by observing the area between webbing layers along edges or lap or splice joints.

All synthetic web slings shall be removed from service and repaired if any of the following are detected during a visual inspection of the sling:

- Defective label
- Sling web fibers ingrained with dirt, grit, metal shavings, or other abrasive foreign matter.

Note 1: The fibers or weaving in the sling web might form a wave pattern in the webbing. This is acceptable.

Note 2: The Cordura outer protective covering provided on some web slings is exempt from the visual criteria. However, the load bearing fibers underneath are subject to the inspection criteria.

Chain Slings

All alloy steel chain slings shall be permanently identified by:

- Tool Issue Tracking Number or utility-unique Identification Number
- Manufacturer
- Manufacturer Grade
- Size
- Rated Capacity and angle for which rating is based
- Length
- Number of legs

Note: If sling markings are not readable, return slings to the manufacturer for re-certification and tagging. If traceability of a sling is lost, the sling shall be destroyed.

Each chain sling will be required to have a periodic inspection by a Qualified Sling Inspector. Chain slings will be marked by color to verify the successful completion of a periodic inspection. A chain sling inspected after October 1 can be marked with the periodic inspection color code for the following year. The periodic inspection of all chain slings shall be completed by February of that color code year. Markings shall be visible or identifiable until the next periodic inspection. The user shall return any sling for which visual verification of the color code cannot be detected in a periodic inspection.

For example, the color code for 2004 might be yellow; 2005 might be green; 2006 might be blue. In 2007, the color code will start over again in sequential order of yellow, green, and blue.

Inspect the sling for:

- Wear, nicks, cracks, breaks, gouges, stretch, bends, weld splatter, arc marks, discoloration from excessive temperature, and throat opening of hooks
- Chain links and attachments should hinge freely with adjacent links
- Latches on hooks, if present, should hinge freely and seat properly without evidence of permanent distortion

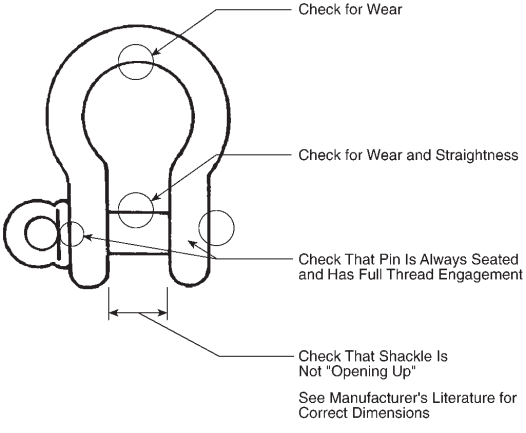
Inspection of Hardware

Hooks

- Distortion, such as bending, twisting, or increased throat opening
- Wear, cracks, nicks, or gouges
- Bending or twisting that exceeds 10° (or as recommended by the manufacturer). Distortion that causes an increase exceeding 15% (or as recommended by the manufacturer) in the throat opening
- Wear must not exceed 10% (or as recommended by the manufacturer) of the original section dimension of the hook or its load pin
- Safety latch, if present, must work correctly

Shackles

- Must be marked with capacity
- See if the pin will screw up all the way, at least flush with the outside of the bow
- Wear on the pin, arc marks, weld splatter that is not easily removed, gouges, evidence of heat damage, or excessive corrosion
- Any damage that causes doubt as to the strength of the shackle
- Spreading of bow
- Correct pin for shackle, no bolt substitution



Shackle Inspection Areas

Eyebolts

- Wear, gouges, nicks
- Arc marks, weld splatter that is not easily removed
- Evidence of heat damage
- Excessive corrosion
- Bent or stretched shaft
- Thread damage

Turnbuckles

- Wear, cracks, nicks, or gouges
- Arc marks, weld splatter that is not easily removed
- Evidence of heat damage
- Damage to the end fittings
- Thread condition
- Deformed rods or body

Wire Rope Clips

- Wear, cracks, nicks, or gouges
- Arc marks, weld splatter that is not easily removed
- Evidence of heat damage
- Thread damage
- Distortion, such as bending, twisting, spreading of the U-bolt
- Loose nuts
- Correct installation
- Correct torque

Thimbles

- Sharp edges or deformation that causes or allows cutting of the wire rope when being used under load

Lifting Clamps (Plate Dogs)

- Verify capacity and range of use
- Inspect side plates for wear, cracks, excessive corrosion, looseness
- Inspect jaws for damage and condition of serration

- Inspect eye and pins for wear or damage of any kind
- Inspect locking device, if present, for positive engagement
- If positive engagement locking device is provided or present, inspect for proper operation

Rings, Links

- Straightness, bends, cracks
- Excessive corrosion
- Wear, gouges, nicks
- Arc marks, weld splatter that is not easily removed
- Evidence of heat damage
- Any damage that causes doubt as to the strength of the rings or links

Swivel Hoist Rings

- Capacity and required torque
- Corrosion, wear, or damage
- Bail should not be bent or elongated
- Threads on the shank and receiving holes should be clean and not damaged
- Ensure free movement of bail (pivot 180° and swivel 360°)
- Bent bolts
- Condition of bolt socket head

Beam Flange Clamps

- Ensure that the clamp is marked with a unique identification number, capacity, and beam size range
- Verify capacity and range of use
- Inspect side plates for wear, cracks, excessive corrosion, looseness
- Inspect pins for condition and tightness
- Condition of adjusting screw threads
- Burrs on adjusting screw handle

Note: This inspection is to be performed before use, even if the clamp is part of an existing setup.

Blocks

- Damage to side plates
- Loose fittings
- Wear of sheave pin
- Sheave grooves
- Sheave should rotate freely
- Any evidence of overloading
- Inspect hook
- Rated Capacity
- Label

Inspection of Equipment

Hand Chain and Lever-Operated Hoists

- Current inspection tag
- Inspect chain, wire rope, or webbing
- Inspect hook and safety latch
- Bends, cracks, or other damage in handle
- Maladjustment of functional operating mechanisms interfering with operation
- Heat or chemical damage
- Loose or missing suspension housing bolts
- Any slippage under load
- Load chain, wire rope, or webbing reeving
- Labeling
  - Manufacturer
  - Model or serial number
- Rated Capacity
- Any slippage under load (during use)

Overhead Underhung Air- and Electric-Operated Hoist

- Current inspection tag
- Chain or wire rope
- Hook and safety latch
- Loose or missing suspension housing bolts
- Any slippage under load
- Operating controls for correct direction of operation
- Correct operation of upper travel limit switch
- Correct operation of lower travel limit switch when installed
- Damaged or leaking air fittings
- All functional operating mechanisms for maladjustment and unusual sounds
- Reeving of wire rope or load chain
- Labeling (Electric)
  - Manufacturer
  - Model or serial number
  - Voltage AC or DC power supply; phase and frequency of AC power supply
- Labeling (Air)
  - Manufacturer
  - Model or serial number
  - Rated Air Pressure
- Rated Capacity
- Heat or chemical damage
- Dead end anchor point

Rollers

- Verify capacity
- Check rollers for damage and lubrication
- Head swivels freely
- Head locks work properly
- Cracked or broken housing

Trolley or Carrier

- Capacity
- Wear
- Cracks
- Loose bolts
- Corrosion
- Deformation
- Wheel lubrication
- Load attachment point for wear that exceeds 15% of the original dimensions
- Wheels for fracture or cracks at the transition of flange to tread
- Current inspection tag, if part of a pre-hung system

Jacks

- Smoothness of operation
- Read all cautions, warnings, and instructions supplied by the manufacturer
- Match all components by pressure requirements
- Use clean hydraulic fluid recommended by the manufacturer
- Ensure that all components are clean and free of dust or grease
- Check hoses for damage (burns, crushing, cracks, holes, kinks, and so on)
- Inspect all hose ends, couplers, and unions
- Ensure that all connections are tight
- Make sure the gauges read zero at rest
- Verify capacity of the system

Structural and Mechanical Below-the-Hook Lifting Devices [1]

- Labels and markings
- Loose or missing guards, fasteners, covers, or stops
- Proper operation of automatic hold and release mechanisms
- Cracked welds
- Cracked or worn gears, pulleys, sheaves, sprockets, bearings, chains, or belts
- Excessive wear of friction pads, linkages, or other mechanical parts
- Excessive wear at attachment points, load support clevices, or pins
- Excessive corrosion that reduces material thickness or cross-sectional area such that the structural integrity is in question
- Structural deformation (bending or twisting of structural members or components)
- Lifting eye or attachment mechanism elongation (eye is oblong or stretched)
- Plastic flow of the lifting eye or attachment mechanism material
- Any damage that causes doubt as to the strength or Rated Capacity of the lifting device

EQUIPMENT AND HARDWARE USAGE

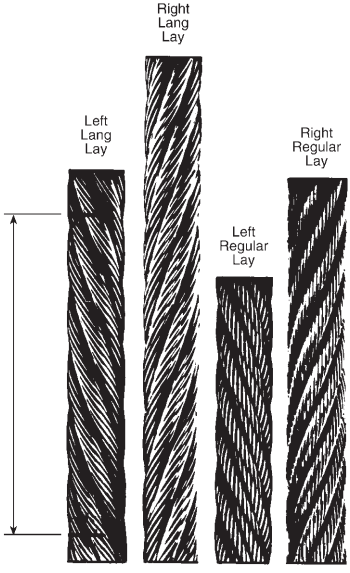
Equipment Usage

Wire Rope

Wire Rope Lay

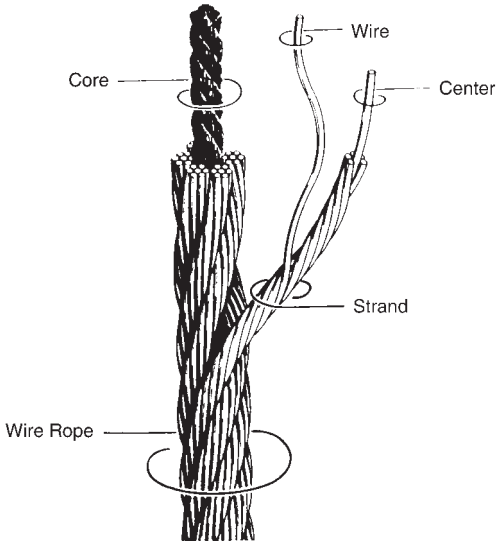
Lay refers to the direction that the wires and strands go around the core of the wire rope. If the strands and wires twist in opposite directions, then the rope is right or left regular lay. If the strands and wires turn in the same direction, the wire rope is right or left Lang lay.

Lay Length is the length along a wire rope that it takes for a single strand to make one complete turn.

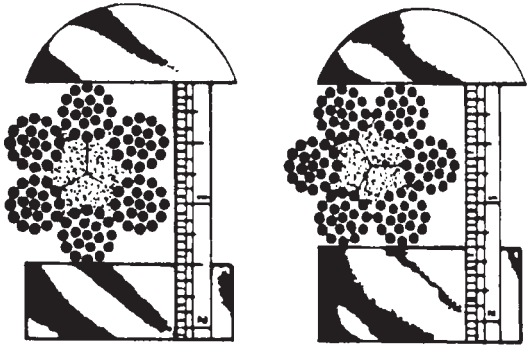


Example of Wire Rope Lay

Wire Rope Parts



How to Measure Wire Rope Diameter



Right Way

Wrong Way

Rated Capacities for Single-Leg Slings

Table 2
Rated Capacities for Single-Leg Slings for 6 x 19 and 6 x 37 Classifications, Improved Plow Steel, Fiber Core [2]

Rope Diameter (inches)	Construction	Rated Capacities, Tons (2,000 lbs.)					
		Vertical		Choker		Vertical Basket	
		HT	MS	HT	MS	HT	MS
1/4	6 x 19	0.49	0.51	0.37	0.38	0.99	1.0
5/16	6 x 19	0.76	0.79	0.57	0.59	1.5	1.6
3/8	6 x 19	1.1	1.1	0.80	0.85	2.1	2.2
7/16	6 x 19	1.4	1.5	1.1	1.1	2.9	3.0
1/2	6 x 19	1.8	2.0	1.4	1.5	3.7	3.9
9/16	6 x 19	2.3	2.5	1.7	1.9	4.6	5.0
5/8	6 x 19	2.8	3.1	2.1	2.3	5.6	6.2
3/4	6 x 19	3.9	4.4	2.9	3.3	7.8	8.8
7/8	6 x 19	5.1	5.9	3.9	4.5	10.0	12.0
1	6 x 19	6.7	7.7	5.0	5.8	13.0	15.0
1-1/8	6 x 19	8.4	9.5	6.3	7.1	17.0	19.0
1-1/4	6 x 37	9.8	11.0	7.4	8.3	20.0	22.0
1-3/8	6 x 37	12.0	13.0	8.9	10.0	24.0	27.0
1-1/2	6 x 37	14.0	16.0	10.0	12.0	28.0	32.0
1-5/8	6 x 37	16.0	18.0	12.0	14.0	33.0	37.0
1-3/4	6 x 37	19.0	21.0	14.0	16.0	38.0	43.0
2	6 x 37	25.0	28.0	18.0	21.0	49.0	55.0

HT = Hand-Tucked Splice
MS = Mechanical Splice

For all configurations:

- The shackle pin diameter used in the eye of the sling shall be equal to or greater than the wire rope diameter. For example, do not use a 1/2-inch shackle pin diameter in the eye of a 1-inch diameter wire rope sling.

For a choker hitch configuration:

- The Rated Capacities shown are for choke angles greater than or equal to 120°. For choke angles less than 120°, apply a reduction factor.

For a vertical basket configuration:

- The Rated Capacities shown only apply when the D/d ratio for slings is 25 or greater.

Rated Capacities for Single-Leg Slings

Table 3
Rated Capacities for Single-Leg Slings for 6 x 19 and 6 x 37 Classifications, Improved Plow, IWRC [2]

Rope Diameter (inches)	Construction	Rated Capacities, Tons (2,000 lbs.)					
		Vertical		Choker		Vertical Basket	
		HT	MS	HT	MS	HT	MS
1/4	6 x 19	0.53	0.56	0.40	0.42	1	1.1
5/16	6 x 19	0.81	0.87	0.61	0.65	1.6	1.7
3/8	6 x 19	1.1	1.2	0.86	0.93	2.3	2.5
7/16	6 x 19	1.5	1.7	1.2	1.3	3.1	3.4
1/2	6 x 19	2.0	2.2	1.5	1.6	3.9	4.4
9/16	6 x 19	2.5	2.7	1.8	2.1	4.9	5.5
5/8	6 x 19	3.0	3.4	2.2	2.5	6.0	6.8
3/4	6 x 19	4.2	4.9	3.1	3.6	8.4	9.7
7/8	6 x 19	5.5	6.6	4.1	4.9	11.0	13.0
1	6 x 19	7.2	8.5	5.4	6.4	14.0	17.0
1-1/8	6 x 19	9.0	10.0	6.8	7.8	18.0	21.0
1-1/4	6 x 37	10.0	12.0	7.9	9.2	21.0	24.0
1-3/8	6 x 37	13.0	15.0	9.6	11.0	25.0	29.0
1-1/2	6 x 37	15.0	17.0	11.0	13.0	30.0	35.0
1-5/8	6 x 37	18.0	20.0	13.0	15.0	35.0	41.0
1-3/4	6 x 37	20.0	24.0	15.0	18.0	41.0	47.0
2	6 x 37	26.0	30.0	20.0	23.0	53.0	61.0

HT = Hand-Tucked Splice
MS = Mechanical Splice

For all configurations:

- The shackle pin diameter used in the eye of the sling shall be equal to or greater than the wire rope diameter. For example, do not use a 1/2-inch shackle pin diameter in the eye of a 1-inch diameter wire rope sling.

For a choker hitch configuration:

- The Rated Capacities shown are for choke angles greater than or equal to 120°. For choke angles less than 120°, apply a reduction factor.

For a vertical basket configuration:

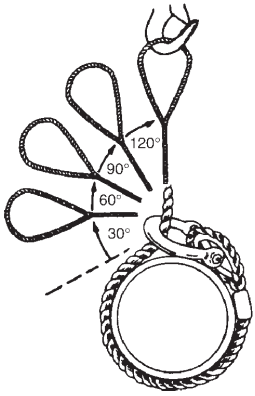
- The Rated Capacities shown only apply when the D/d ratio for slings is 25 or greater.

Choker Hitch Rated Capacity Adjustment

Table 4
Choker Hitch Rated Capacity Adjustment

Angle of Choke in Degrees	Strength Efficiency	IWRC and FC Rope Wire Rope Sling Choker Hitch Rated Capacity Multiplier
Over 120°	100%	1.00
90° to less than 120°	87%	.85
60° to less than 90°	74%	.75
30° to less than 60°	62%	.60
0° to less than 30°	49%	.50

For wire rope slings in a choker hitch when the angle of choke is less than 120°:



Example: A choker hitch is used when the angle of choke is 45°. The IWRC sling choker hitch Rated Capacity is 6.4 tons or 12,800 lbs.

Allowable Sling Load = (12,800 lbs.) x (.60) = 7,680 lbs.

When a choke is drawn down tight against a load, or a side pull is exerted, resulting in an angle-of-choke less than 120°, an adjustment must be made for further reduction of the sling-Rated Capacity, as given in the previous table. In other words, as the angle-of-choke decreases, there is a corresponding loss of sling efficiency.

Vertical Basket "D/d" Rated Capacity Adjustment

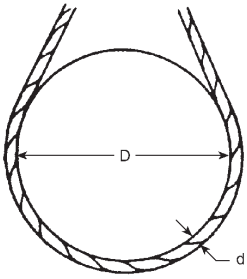
Table 5
Vertical Basket "D/d" Rated Capacity Adjustment

Ratio A (D/d)	Strength Efficiency	IWRC and FC Wire Rope Sling Rated Capacity Multiplier
25	100%	1.00
20	91%	.91
15	89%	.89
10	86%	.86
8	83%	.83
6	79%	.79
4	75%	.75
2	65%	.65
1	50%	.50

Note: This table is based on static loads only and applies to 6 x 19 and 6 x 37 class rope.

Bending wire rope reduces its strength. To account for the effect of bend radius on wire rope strength, use Table 5.

When D is 25 times the component rope diameter (d) the D/d ratio is expressed as 25/1.



D/d Ratio

Rated Capacities of a sling can be affected by the ratio of the diameter of the object around which the sling is bent to the diameter of the rope used in the sling. This is known as the D/d ratio where D is the diameter of the object and d is the diameter of the rope. As the D/d ratio becomes smaller, the capacity is reduced.

D/d Rated Capacity Adjustment Example

Ratio A = D/d = Curvature Diameter/Wire Rope Diameter

Example:

Determine the allowable load that you can apply to a 1-inch diameter IWRC mechanical splice wire rope bent around a 6-inch pipe.

Ratio A = 6 in. ÷ 1 in. = 6

Refer to the IWRC Rated Capacity table to determine the strength efficiency for a Ratio A equal to 6. The allowable load that can be applied to the sling is 79% of the vertical basket Rated Capacity.

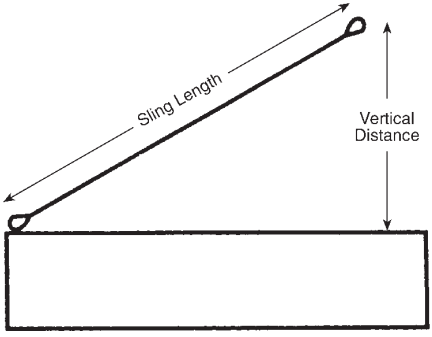
The vertical basket Rated Capacity for a 1-inch diameter IWRC wire rope is 17 tons or 34,000 lbs.

The allowable load for a 1-inch diameter IWRC Mechanical Splice Wire Rope with a D/d ratio of 6 is equal to:

Allowable Load = (34,000 lbs.) x (.79) = 26,860 lbs.

How to Determine a 30° Angle

At a 30° angle, the distance from the hook to the load will be exactly half of the sling length. As long as the vertical distance from the hook to the load is greater than or equal to half the length of the sling, the sling angle will be greater than or equal to 30°.

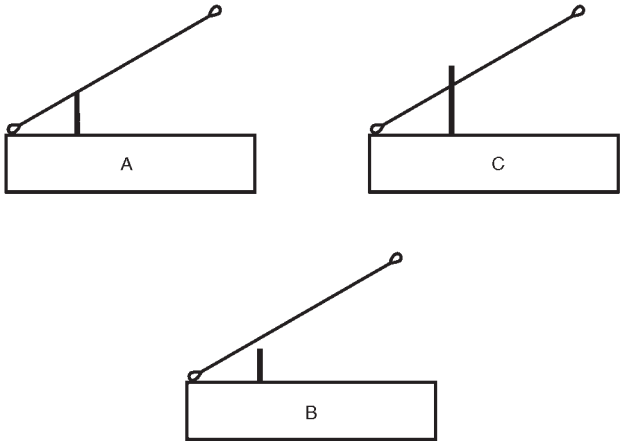


30° Lift Angle Measurement

How to Determine a 45° Angle

A 45° angle can be determined in the field by taking anything of a fixed length (such as a stick, rule, piece of pipe or string) and using it as a guide.

1. Tension the slings
2. Hold the guide level with one end touching where the sling contacts the load. Hold the other end against the load and swing the guide up until it is plumb.
3. If the guide just touches the sling (A), then the sling angle is 45°. If the guide will not touch the sling (B), then the angle is greater than 45°. If the guide extends past the sling (C), then the angle is less than 45°.



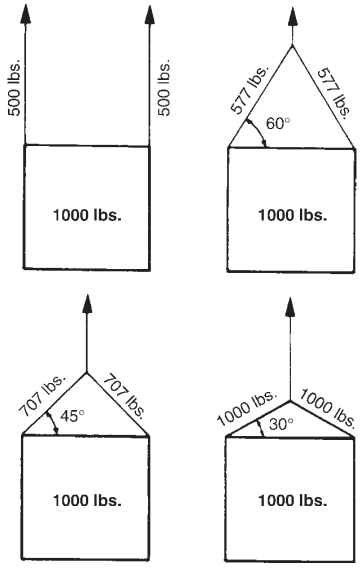
45° Lift Angle Measurement

How Sling Angles Affect Sling Loads

In the field, it is hard to measure angles but distance can be measured. If the length of the sling and the vertical distance from the load to the load hook is known, the stress load can be determined. Stress load will increase as the angles of the slings decrease relative to the horizon. Looking at the formula below should help to illustrate this.

$$\text{Stress Load Per Sling} = \frac{\dfrac{\text{Sling Length}}{\text{Vertical Distance}} \text{ X Load Weight}}{2}$$

As the formula shows, the sling length is divided by the vertical distance from hook to load. Load weight is then multiplied by this number. The result will be divided by two. If more than two slings are being used to lift the load, the result will still be divided by two. There is a danger that the entire load weight will be carried by two of the slings. This can happen because slings are not exactly the same length, and it occurs if two slings a little shorter than each other are used on opposite corners.



Sling Angle vs. Load Effects

Rule of Thumb: Riggers shall not lift loads when the angle from the horizontal is less than 30°. Advanced Riggers shall not lift loads when the angle from the horizontal is less than 10°.

Sling Angle Determinations and Sling Load Multipliers

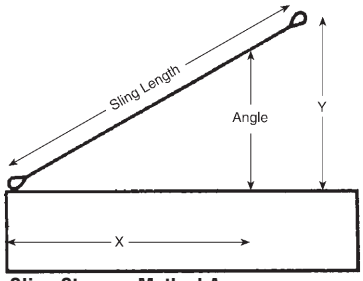
Table 6

Sling Angle Determinations and Sling Load Multipliers

Smallest Sling Angle	Horizontal Distance X - inches	Vertical Distance Y - inches	d/L	D/L	Sling Load Multiplier (Two-, Three-, or Four-Point Pick)
90°	0	-	-	-	.50
85°	3	34	.09	.18	.50
80°	3	17	.18	.35	.51
75°	3	11	.26	.52	.52
70°	3	8	.34	.68	.54
65°	3	6.5	.42	.85	.56
60°	3	5	.50	1.00	.58
55°	3	4	.57	1.15	.61
50°	6	7	.64	1.29	.66
45°	6	6	.71	1.42	.71
40°	6	5	.77	1.54	.78
35°	6	4	.82	1.64	.88
30°	6	3.5	.87	1.73	1.00
25°	12	5.5	.91	1.81	1.19
20°	12	4.5	.94	1.88	1.47
15°	12	3	.97	1.94	1.93
10°	12	2	.98	1.97	2.88
5°	12	1	1.0	2.00	5.75

Using Table 6, the sling angle from the horizontal can be determined by measuring the horizontal and vertical distances. In addition, the stress (applied load or tension) for each sling leg can be calculated by multiplying the load by the Sling Load Multiplier.

Sling Load Multiplier Examples



Calculating Sling Stress – Method A

1. Determine the horizontal distance "X" (3 in., 6 in., or 12 in.) location.
2. Measure the vertical distance "Y" from the "X" location to the sling.
3. Locate "X" value on the chart. Locate the measured vertical distance "Y" or the next smaller value in the chart. Go over to the Sling Load Multiplier column. The value in the same row is the multiplier.
4. Multiply the Load Weight by the multiplier to determine the sling stress.

Example:
Load Weight = 1000 lbs.
X = 6 inches
Y = 3.75 inches
Use Y = 3.5
Load Multiplier = 1.0
Sling Stress = Load Weight x 1.0 = 1000 lbs.

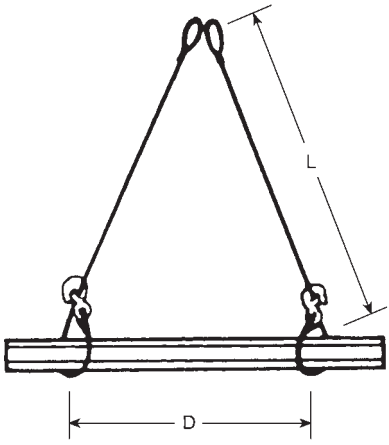
Calculating Sling Stress – Method B

1. The sling angle is known.
2. Locate the sling angle value in the table. Go over to the Sling Load Multiplier column. The value in the same row is the multiplier.
3. Multiply the Load Weight by the multiplier to determine the sling stress.

Example:
Load Weight = 1000 lbs.
Sling Angle = 65°
Three-Point Pick
Load Multiplier = .56
Sling Stress = Load Weight x .56 = 560 lbs.

Example:
Load Weight = 1000 lbs.
Sling Angle = 35°
Four-Point Pick
Load Multiplier = .88
Sling Stress = Load Weight x .88 = 880 lbs.

Sling Load Multiplier Examples



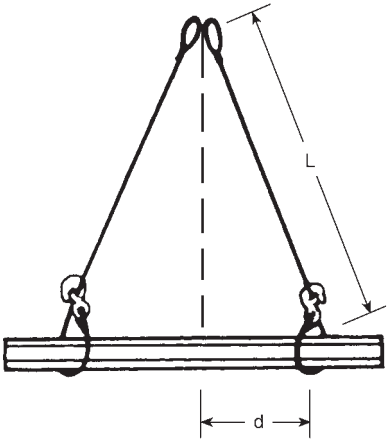
Calculating Sling Stress – Method C

1. Divide the distance D by the sling length L.
2. Calculate D ÷ L.
3. Locate the D/L value or the next larger value in the chart.
4. Locate the D/L value in the table. Go over to the Sling Load Multiplier column. The value in the same row is the multiplier.
5. Multiply the Load Weight by the multiplier to determine the sling stress.

Example:
Load Weight = 1000 lbs.
D = 10 feet
L = 16 feet
D ÷ L = 10 ÷ 16 = .625
Use D/L = .68
Load Multiplier = .54
Sling Stress = Load Weight x .54 = 540 lbs.

Example:
Load Weight = 1000 lbs.
D = 22 feet
L = 12 feet
D ÷ L = 22 ÷ 12 = 1.833
Use D/L = .68
Load Multiplier = 1.47
Sling Stress = Load Weight x 1.47 = 1470 lbs.

Sling Load Multiplier Examples



Calculating Sling Stress – Method D

1. Divide the distance d by the sling length L.
2. Calculate d ÷ L.
3. Locate the d/L value or the next larger value in the chart.
4. Locate the d/L value in the table. Go over to the Sling Load Multiplier column. The value is in the same row as the multiplier.
5. Multiply the Load Weight by the multiplier to determine the sling stress.

Example:
Load Weight = 1000 lbs.
d = 10 feet
L = 16 feet
d ÷ L = 10 ÷ 16 = .625
Use d/L = .64
Load Multiplier = .66
Sling Stress = Load Weight x .66 = 660 lbs.

Example:
Load Weight = 1000 lbs.
d = 8 feet
L = 10 feet
d ÷ L = 8 ÷ 10 = .80
Use d/L = .82
Load Multiplier = .88
Sling Stress = Load Weight x .88 = 880 lbs.

Choker Hitches

Good
No Cutting Action on Running Line

Bad
Shackle Pin Will Unscrew

Bad
Cutting Action of Wire Rope Sling Eye on Running Line

Acceptable for Kevlar, Polyester, Round, and Synthetic Slings

Below-the-Hook Lifting Devices

A Below-the-Hook Lifting Device is any fabricated assembly designed to attach and secure a load to a hoisting mechanism that is being used to raise, suspend, move, transport, or lower the load. Slings and hooks furnished by a manufacturer are excluded because these items are governed by ASME/ANSI B30.9 and ASME/ANSI B30.10.

In accordance with OSHA 29CFR Parts 1910.184 and 1926.251, makeshift or homemade fasteners, hooks, or links formed from bolts, rods, etc., or other such attachments shall not be used. Non-standard end fittings, attachments, and lifting devices designed by a Qualified Engineer can be used. Special or modified eye bolts, special custom design grabs, hooks, clamps, lifting beams, spreader beams, lift rigs, or other special custom-fabricated lifting devices or attachments shall be engineered, fabricated, inspected, and proof-tested in accordance with OSHA 29CFR Parts 1910.184 and 1926.251 or ASME/ANSI B30.20 requirements.

Below-the-hook lifting devices are categorized as

- Rigging hardware
- Fabricated lifting devices
- Special custom-designed fabricated devices or attachments

Rigging hardware (shackles, turnbuckles, eyebolts, swivel eyes, hoist rings, lifting clamps, etc.) are purchased items furnished by a manufacturer that attach directly to the load or lifting device.

Note: Eyebolts that have been shortened by removing a section of the threaded portion of the bolt to accommodate installation shall be approved by Engineering and labeled to identify reduced Rated Capacity and intended use.

Fabricated lifting devices (spreader beams, lifting beams, lift rigs, lifting clamps, pallet lifter, coil grab, bar tong, rotator, turner, vacuum lifter, magnetic lifter, etc.) [1] are either purchased items furnished by a manufacturer, or engineered and fabricated within the utility. Fabricated lifting devices are required to raise, suspend, move, transport, or lower loads that cannot be performed using standard rigging hardware. These fabricated lifting devices are designed with specific rigging configurations resulting in defined loading combinations.

Special custom-designed fabricated lifting devices and attachments are those items that are usually not general purpose items but have a specific intended purpose that either provides a safer and more economical means to perform the activity or cannot be accomplished by using standard rigging hardware or lifting devices. These items might be similar to rigging hardware or lifting devices in application.

As an example, structural plates, lugs, trunions etc., which are either welded or bolted to the load to be used as lifting attachments, might be exempted from the proof test requirements when the proof test is not feasible or is impractical to perform. However, to exercise this exemption, the design of the attachment shall include a factor of three (3) on the yield strength, and a factor of five (5) on the ultimate strength of the weakest material being used. In addition, a visual inspection (structural, mechanical, welds) and PT non-destructive examination of the load-bearing welds shall be performed and the results documented. This applies to lifting lugs welded to structural members used as attachment points for lifting loads.

All small fabricated lifting devices and special custom-designed fabricated lifting devices and attachments (modified eye bolts, grabs, hooks, beam clamps, wrenches, etc.) are to be permanently identified by labeling as follows:

- Utility-specific site designation
- Component piece number, Drawing Number, or intended use
- Rated Capacity

All fabricated lifting devices and special custom-designed fabricated lifting devices and attachments that require periodic documented inspection, or whose weight exceeds 100 pounds, shall be permanently identified by labeling as follows:

- Utility-specific site designation
- Tool Issue Tracking Number
  or
  Manufacturer's name and serial number (if applicable)
  or
  Utility/Licensee Drawing Number
  or

  Utility/Licensee Calculation Number with sketch identification
- Rated Capacity
- Intended Use (might include a drawing)
- Weight (when greater than 100 pounds)

Note 1: Drawing should describe use and rigging configuration restrictions.

Note 2: Etching label information on stainless steel plates and welding to lifting devices should be considered.

All lifting devices and special custom-designed fabricated lifting devices shall be visually inspected prior to use. All discrepancies shall be reported to the Lifting Coordinator or Engineer responsible for the design or fabrication prior to use.

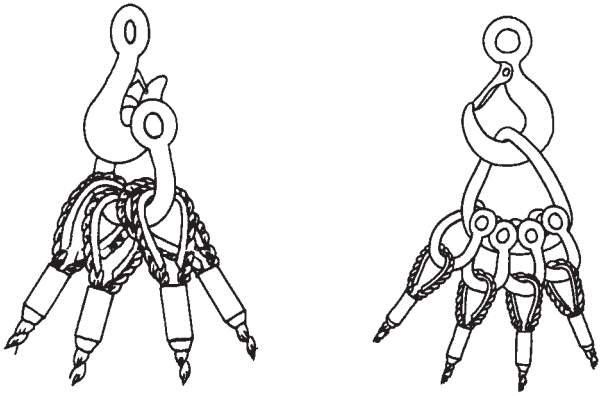
All lifting devices associated with NUREG-0612 or ASME ANSI N14.6 shall be visually inspected prior to use and once every 12 months. The periodic inspection (12 months) shall be performed in accordance with ANSI N14.6 requirements and inspection findings recorded and retained on file by the site.

Note: All assembly parts of a below-the-hook lifting device shall be kept with the device or storage location so that the parts are readily available and easily retrievable to ensure that assembly of the device is not impeded by the inability to locate assembly parts. In addition, parts that might require lubrication (pins, bearings, etc.) should be stored in such a manner as to minimize degradation.

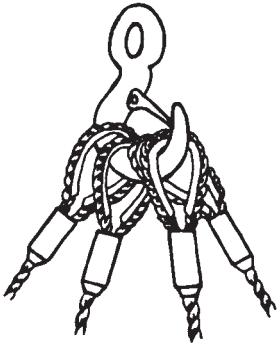
Structural and mechanical below-the-hook lifting device inspections shall include [1]:

- Labels and markings
- Loose or missing guards, fasteners, covers, or stops
- Proper operation of automatic hold and release mechanisms
- Cracked welds
- Cracked or worn gears, pulleys, sheaves, sprockets, bearings, chains, or belts
- Excessive wear of friction pads, linkages, or other mechanical parts
- Excessive wear at attachment points, load support clevices, or pins
- Excessive corrosion that reduces material thickness or cross-sectional area such that the structural integrity is in question
- Structural deformation (bending or twisting of structural members or components)
- Lifting eye or attachment mechanism elongation (eye is oblong or stretched)
- Plastic flow of the lifting eye or attachment mechanism material
- Any damage that causes doubt as to the strength or Rated Capacity of the lifting device

Using More Than Two Sling Eyes with a Hook

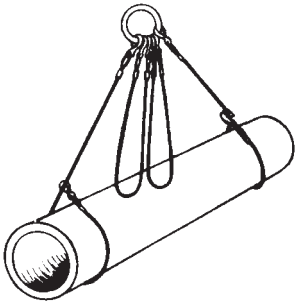


Good
Shackles Used to Join Sling Eyes

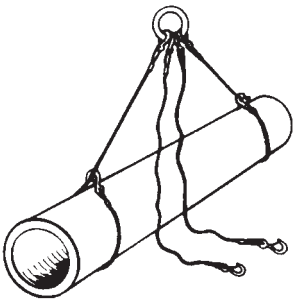


Caution
Do not point load hook.
Use master links or shackles to
avoid point loading the hook.

Secure Unused Sling Legs

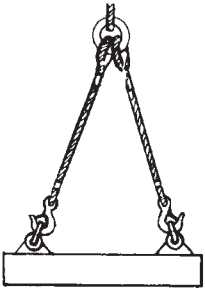


Good
Unused Sling Legs Secured



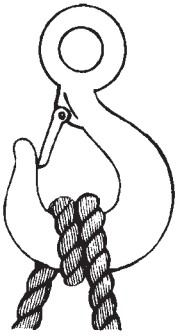
Bad
Loose Sling Legs

Slings with Hooks



Good
Hooks Are Turned Out

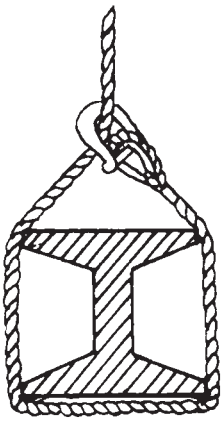
Bad
Hooks Are Turned In



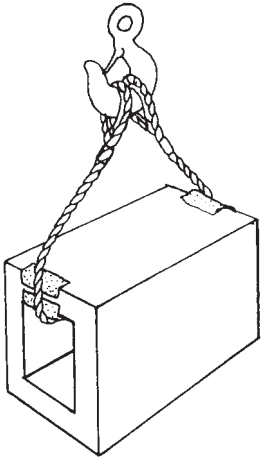
Bad
Never Wrap a Rope
Around a Hook

Lifting Sharp-Edged Loads

Good
Softeners Used



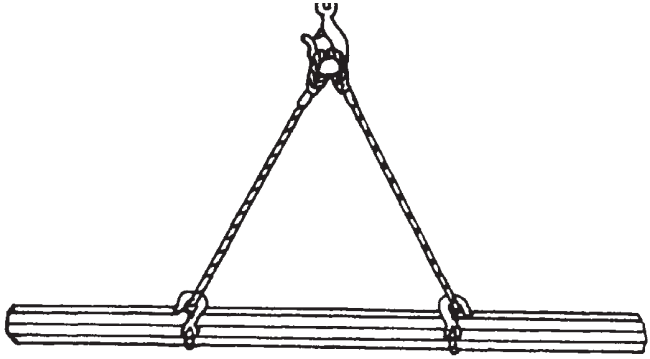
Bad
No Softeners



Good
Softeners Used

Do not use softeners that could be cut by sharp edges (for example, rubber that is too thin or not properly reinforced).

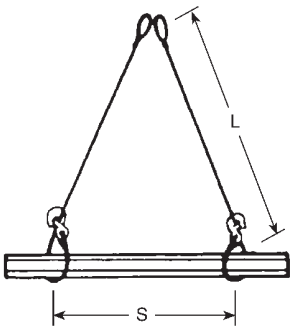
Lifting Loads with a Single Wrap Choker Hitch



Good

Bad

Use Double Slings to Lift a Load



Check Sling Angle

Rule of Thumb:

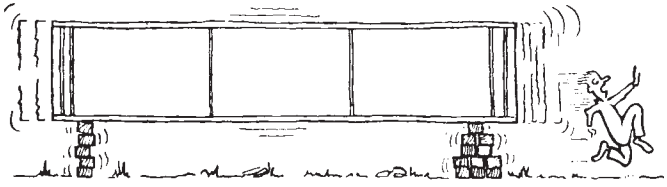
- If L is greater than S, sling angle is OK.
- If S is greater than L, use a double wrap choker hitch.
- If S is greater than L and L is greater than 12 feet, DO NOT LIFT.

Table 7
Rated Capacity Chart Carbon Steel and Stainless Steel Metal Mesh Slings (horizontal angles shown in parentheses) [3]

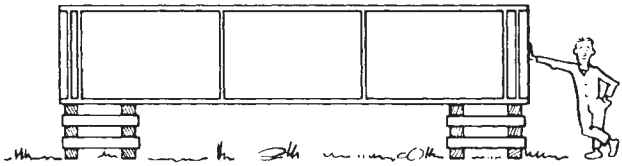
Sling Width (inches)	Vertical or Choker	Vertical Basket	Effect of Angle on Rated Capacities in Basket Hitch		
			30° (60°)	45° (45°)	60° (30°)
Heavy Duty — 10 Ga 35 Spirals/Ft of Sling Width					
2	1,500	3,000	2,600	2,100	1,500
3	2,700	5,400	4,700	3,800	2,700
4	4,000	8,000	6,900	5,600	4,000
6	6,000	12,000	10,400	8,400	6,000
8	8,000	16,000	13,800	11,300	8,000
10	10,000	20,000	17,000	14,100	10,000
12	12,000	24,000	20,700	16,900	12,000
14	14,000	28,000	24,200	19,700	14,000
16	16,000	32,000	27,700	22,600	16,000
18	18,000	36,000	31,100	25,400	18,000
20	20,000	40,000	34,600	28,200	20,000
Medium Duty — 12 Ga 43 Spirals/Ft of Sling Width					
2	1,350	2,700	2,300	1,900	1,400
3	2,000	4,000	3,500	2,800	2,000
4	2,700	5,400	4,700	3,800	2,700
6	4,500	9,000	7,800	6,400	4,500
8	6,000	12,000	10,400	8,500	6,000
10	7,500	15,000	13,000	10,600	7,500
12	9,000	18,000	15,600	12,700	9,000
14	10,500	21,000	18,200	14,800	10,500
16	12,000	24,000	20,800	17,000	12,000
18	13,500	27,000	23,400	19,100	13,500
20	15,000	30,000	26,000	21,200	15,000
Light Duty — 14 Ga 59 Spirals/Ft of Sling Width					
2	900	1,800	1,600	1,300	900
3	1,400	2,800	2,400	2,000	1,400
4	2,000	4,000	3,500	2,800	2,000
6	3,000	6,000	5,200	4,200	3,000
8	4,000	8,000	6,900	5,700	4,000
10	5,000	10,000	8,600	7,100	5,000
12	6,000	12,000	10,400	8,500	6,000
14	7,000	14,000	12,100	9,900	7,000
16	8,000	16,000	13,900	11,300	8,000
18	9,000	18,000	15,600	12,700	9,000
20	10,000	20,000	17,300	14,100	10,000

Note: Some manufacturer's metal mesh slings might not have a vertical hitch Rated Capacity on the tag. Check with the specific manufacturer for vertical hitch recommendations.

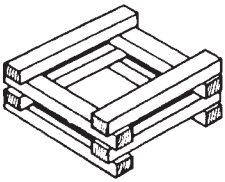
Proper Use of Cribbing



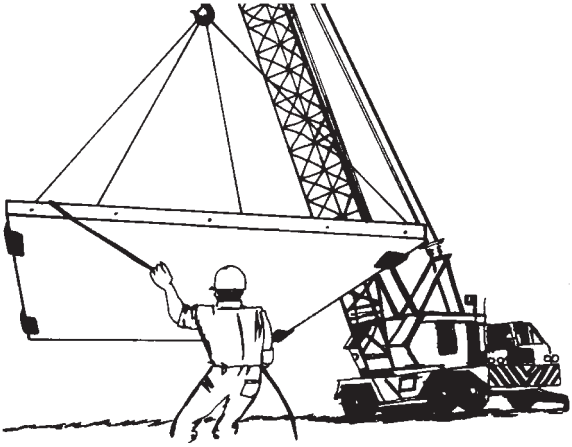
Incorrect



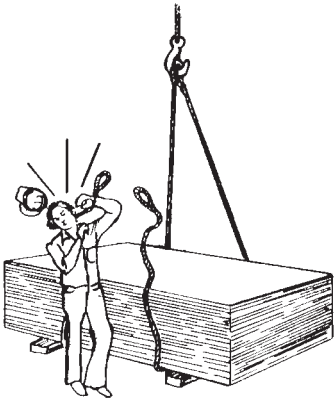
Correct



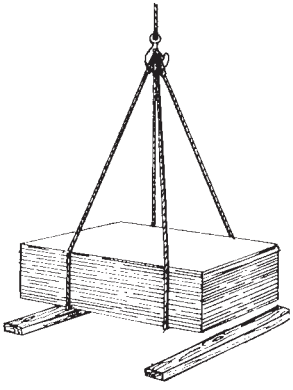
Tag Lines



Unloading Material



Slings should never be pulled out from under loads with a crane or other lifting device.



Always set loads on shoring.

Personnel Basket Lifting Requirements

All lifts must comply with the site-specific utility Lifting Program. Requirements are summarized as follows:

- The Supervisor or Designee shall document the scope of work, duration, and need for the use of a personnel basket on the Personnel Basket Lift Plan Form.
- The Supervisor or Designee shall select the Personnel Basket Lift Team Members.
- Ensure that personnel baskets are designed by a Qualified Civil or Structural Engineer.
- Visually inspect personnel baskets and rigging prior to lift. Proof test to 125% Rated Capacity.
- Complete the Personnel Basket Lift Plan Form in Lifting Program prior to each lift.
- Conduct lift planning meeting to be attended by Supervisor or Designee, Crane Operator, Flagger, and personnel to be lifted.
- Evaluate existing conditions and determine equipment necessary to conduct safe lift.
- Determine weights and verify that total weight of leaded basket does not exceed 50% Rated Capacity of crane.
- Inspect crane and rigging equipment prior to use. Ensure that crane's periodic inspections are current.
- Rig basket to the crane as described in Lifting Program.
- Prior to the lift:
  - Conduct pre-lift meeting.
  - Conduct trial lift immediately prior to lifting individuals.
  - Inspect equipment again.
  - Crane Operator and Flagger verify that everyone is wearing fall protection and is tied off.
  - While lift is in progress, follow the appropriate safe work practices described in the licensee's Lifting Program.

Hardware Usage

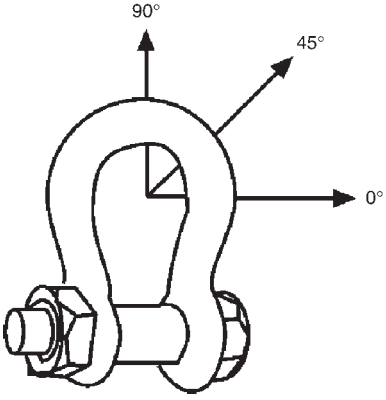
Shackles

Side Loading Reduction and Strength Efficiency Values (For Screw Pin and Bolt-Type Shackles Only) [4]

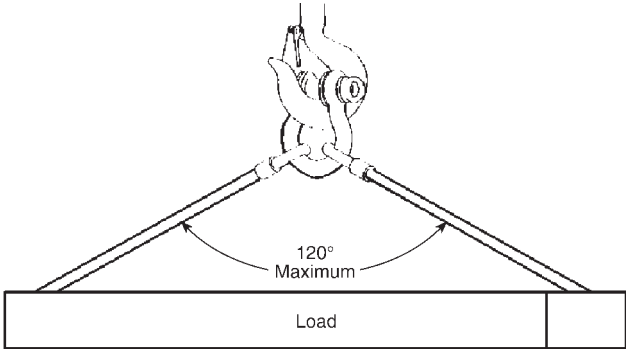
Table 8
Shackle Angular Loading Capacity

Angles From Horizontal	Reductions in Rated Capacity	Shackle Rated Capacity Multiplier
0º to 19º	50%	.50
20º to 34º	45%	.55
35º to 44º	40%	.60
45º to 59º	35%	.65
60º to 69º	25%	.75
70º to 79º	15%	.85
80º to 90º	0%	1.00

Note: Do not side load round pin shackles.



Symmetrically Loaded Shackles



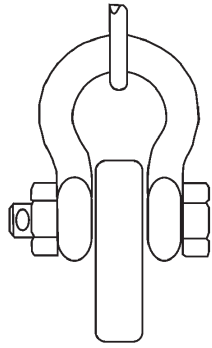
- Shackles symmetrically loaded with two leg slings having a maximum included angle of 120° can be loaded to Rated Capacity.
- Use Bolt-type and Screw Pin shackles only.
- **Riggers do not exceed 120° included angle.**
- **Advanced Riggers do not exceed 160° included angle.**

Note: The allowable applied load is 50% of the Rated Capacity for an included angle between 120° and 160° or for sling angles between 10° and 30° from the horizontal.

Working Load Limit for Shackles 85 Tons and Larger

Reduces Working Load Limits When Pad Eye Less Than 80% of the Shackle Opening

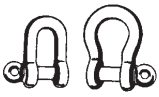
- Pad eye 60% of the shackle opening:
  Allowable Load = .87 X catalog Rated Capacity
- Pad eye 40% of the shackle opening:
  Allowable Load = .80 X catalog Rated Capacity
- Pad eye 25% of the shackle opening:
  Allowable Load = .70 X catalog Rated Capacity



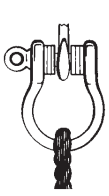
Shackles (All Types)

Table 9
Shackle Capacities (All Types) [5]

Stock Diameter (inches)	Inside Width at Pin (inches)	Maximum Safe Working Load Single Vertical Pull (pounds)
3/16	3/8	665
1/4	15/32	1000
5/16	17/32	1500
3/8	21/32	2000
7/16	24/32	3000
1/2	13/16	4000
5/8	1-1/16	6500
3/4	1-1/4	9500
7/8	1-7/16	13,000
1	1-11/16	17,000
1-1/8	1-13/16	19,000
1-1/4	2-1/32	24,000
1-3/8	2-1/4	27,000
1-1/2	2-3/8	34,000
1-3/4	2-7/8	50,000
2	3-1/4	70,000
2-1/2	4-1/8	100,000
3	5	150,000
3-1/2	5-3/4	200,000
4	6-1/2	260,000

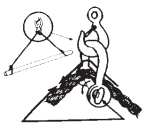


Rule of Thumb: Whenever possible, use a shackle with a stock diameter at least one size larger than the diameter of the wire rope you are using.



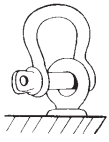
Good
Washers or Spool Center the Hook

Bad
Shackle Pulled at Angle



Bad
Shackle Pin on Running Line Can Work Loose

Bad



Good
However, Use Washers or Plate to Center Eye on Shackle

Shouldered Eyebolts Capacities

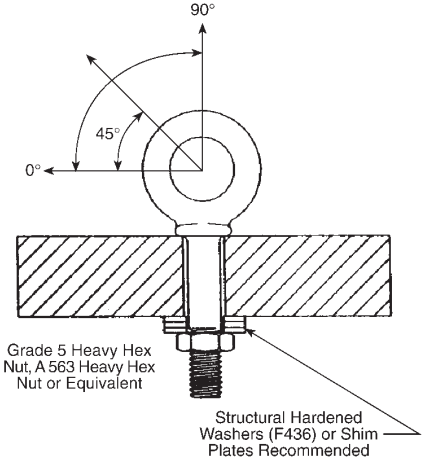
Table 10

Shouldered Eyebolts Capacities [6]

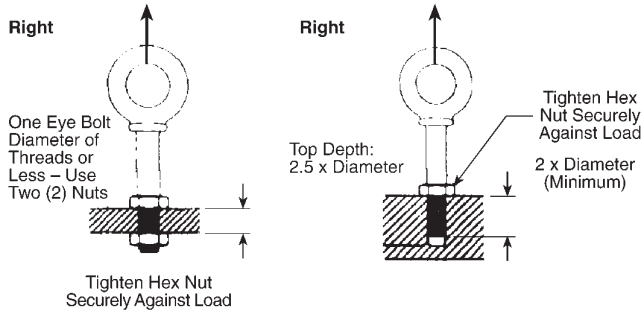
Stock Diameter (inches)	At 90º (In-line or Vertical)	75º to < 90º	60º to < 75º	45º to < 60º
1/4	500	275	175	125
5/16	800	440	280	200
3/8	1200	660	420	300
1/2	2200	1210	770	550
5/8	3500	1925	1225	875
3/4	5200	2860	1820	1300
7/8	7200	3960	2520	1800
1	10,000	5500	3500	2500
1-1/8	15,200	8360	5320	3800
1-1/4	21,400	11770	7490	5350

Notes:

- Maximum safe working load is in pounds.
- Applies to forged steel eyebolts only.
- Can use higher values if using manufacturer's literature.
- Less than 45° angle of pull not recommended.



Shouldered Eyebolt Left Angles

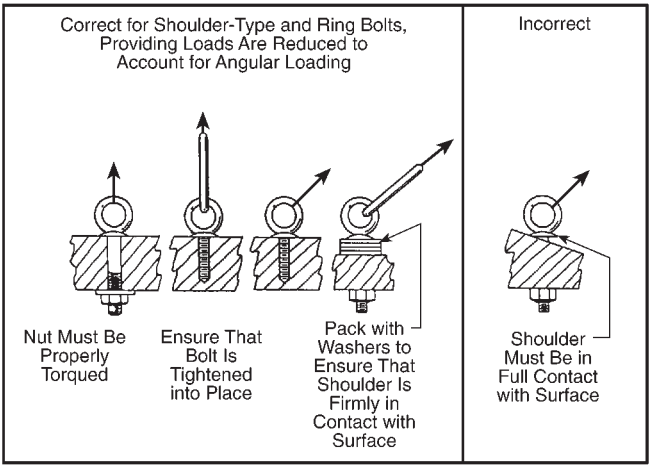


Proper Eyebolt Installed

Note 1: Thread engagement in tapped holes of 2 times diameter required for dynamic effects during lifting.

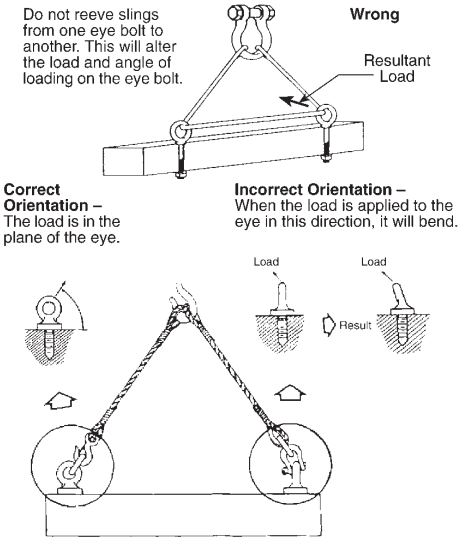
Note 2: Secure heavy hex nut by finger tight plus 1/4 turn.

Installation for Angular Loading



Note 1: Can use beveled washers on inclines to provide firm surface contact.

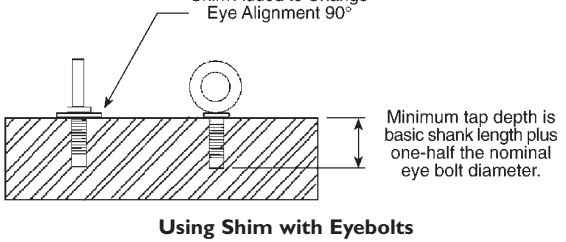
Note 2: For cyclic or repetitive loading, torque heavy hex nut to grade 5 bolt requirements.



Correct/Incorrect Rigging of Eyebolts

Table 11
Eyebolt Size Versus Shim Thickness [7]

Eye Bolt Size (inches)	Shim Thickness Required to Change Rotation 90° (inches)
1/4	.0125
5/16	.0139
3/8	.0156
1/2	.0192
5/8	.0227
3/4	.0250
7/8	.0278
1	.0312
1-1/4	.0357
1-1/2	.0417



Using Shim with Eyebolts

Shoulderless Eye Bolts

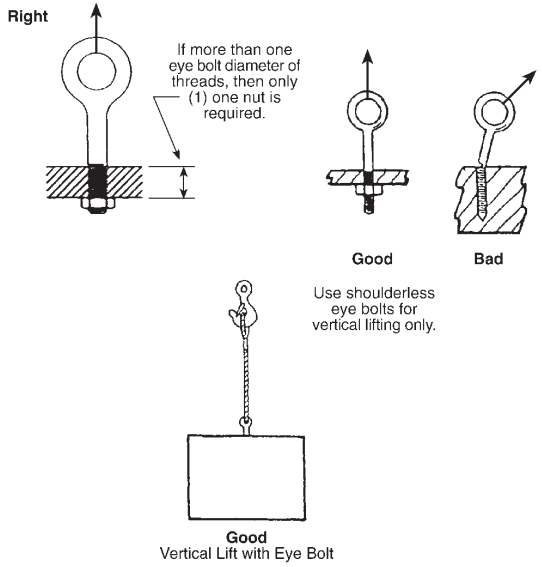


Table 12
Shoulderless Eyebolt Diameter Versus Vertical Lifting [6]

Stock Diameter (inches)	Vertical
1/4	500
5/16	800
3/8	1200
1/2	2200
5/8	3500
3/4	5200
7/8	7200
1	10,000
1 1/8	15,200
1 1/4	21,400

Note 1: Shoulderless eye bolts shall not be pulled at an angle.
Note 2: Can use higher values if using manufacturer's literature.
Note 3: Applies to forged steel only.

Weldless Rings Capacities

Table 13
Weldless Rings Capacities

Stock Diameter (inches)	Inside Diameter (inches)	Maximum Safe Working Load (pounds)
7/8	4	7200
7/8	5-1/2	5600
1	4	10,800
1-1/8	6	10,400
1-1/4	5	17,000
1-3/8	6	19,000

Weldless End Links Capacities

Table 14
Weldless End Links Capacities [5]

Stock Diameter (inches)	Inside Diameter (inches)	Maximum Safe Working Load (pounds)
5/16	1/2	2500
3/8	9/16	3800
1/2	3/4	6500
5/8	1	9300
3/4	1-1/8	14,000
7/8	2	12,000
1	2-1/4	15,200
1-1/4	2-1/2	26,400
1-3/8	2-3/4	30,000

Note: Correct use of rings, end links, and master links improves hook loading and equal distribution of load on the slings.

Weldless Sling Links Capacities

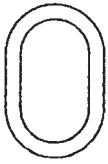
Table 15
Weldless Sling Links Capacities [5]

Size (inches)	Working Load Limit Single Pull (pounds)
3/8	1800
1/2	2900
5/8	4200
3/4	6000
7/8	8300
1	10,800
1-1/4	16,750
1-3/8	20,500

Master Link Capacities

Table 16
Master Link Capacities [8]

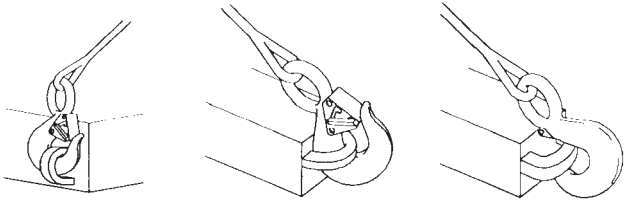
Size (inches)	Working Load Limit Single Pull (pounds)
1/2	4920
5/8	6600
3/4	10,320
1	24,360
1-1/4	35,160
1-1/2	47,880
1-3/4	62,520
2	97,680
2-1/4	119,400
2-1/2	147,300
2-3/4	178,200
3	228,000
3-1/4	262,200
3-1/2	279,000
3-3/4	336,000
4	373,000
4-1/4	354,000
4-1/2	399,000
4-3/4	389,000
5	395,000



Note: Correct use of rings, end links, and master links improves hook loading and equal distribution of load on the slings.

Eye Hooks

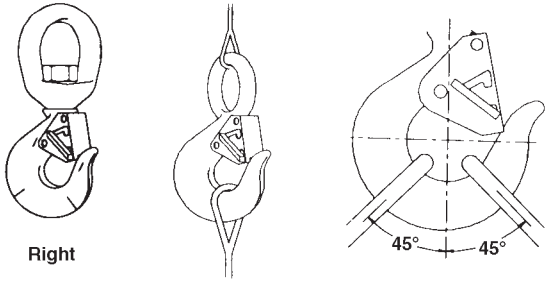
Incorrect Use of an Eye Hook



Wrong

Do not side load, back load, or tip load a hook.

Correct Use of an Eye Hook



When placing two slings on the hook, the sling angle measured from the horizontal shall be equal to or greater than 45°. For sling angles less than 45°, a master link, pear link, bolt-type shackle, or screw pin shackle should be used to attach the slings to the hook.

Note 1: Forged swivels and swivel hooks with bronze bushings are to be used for positioning prior to lifting a load. DO NOT rotate under load. Only swivels or swivel hooks with Teflon bushings (Shur-Loc S-326 A) can be used to rotate under load.

Note 2: DO NOT overcrowd the hook.

DO NOT swivel the hook while it is supporting a load.

Turnbuckle Capacities

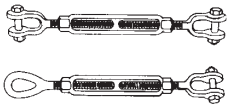


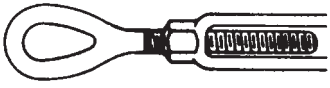
Table 17
Turnbuckle Capacities [5]

End Fitting, Stock Diameter (inches)	Any Combination of Jaw-End Fittings, Eye-End Fittings, and Stub-End Fittings (pounds)	Any Turnbuckle Having a Hook-End Fitting (pounds)
1/4	500	400
5/16	800	700
3/8	1200	1000
1/2	2200	1500
5/8	3500	2250
3/4	5200	3000
7/8	7200	4000
1	10,000	5000
1-1/4	15,200	5000
1-1/2	21,400	7500
1-3/4	28,000	—
2	37,000	—
2-1/2	60,000	—
2-3/4	75,000	—

Securing Turnbuckles

Note: When twisting of the turnbuckle might occur, use a lock wire to prevent rotation of the turnbuckle.

Good
Lock Wire Used

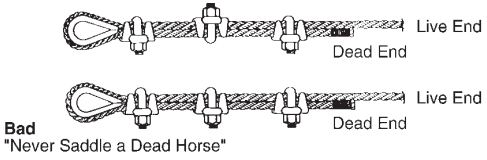


Bad
No Lock Wire

Installing Wire Rope Clips

The correct way to attach U-bolts is shown at the top; the U section is in contact with the dead end of the rope and is clear of the thimble.

Note: It is recommended that thimbles be used when pin sizes are small. Large eyes are also acceptable.



Recommended Method of Applying Clips to Get Maximum Holding Power from the Clip

The following is based on the use of properly sized U-Bolt clips on new rope.

1. Turn back specified amount of rope from thimble or loop. Apply first clip one base width from dead end of rope. (Apply U-Bolt over dead end of wire rope with live end resting in saddle.) Tighten nuts evenly, alternating from one nut to the other until the recommended torque is reached.
2. When two clips are required, apply the second clip as near to the loop or thimble as possible. Tighten nuts evenly, alternating until the recommended torque is reached. When more than two clips are required, apply the second clip as near to the loop as possible. Turn nuts on second clip firmly but do not tighten. Proceed to Step 3.
3. When three or more clips are required, space additional clips equally between first two. Take up rope slack. Tighten nuts on each U-Bolt evenly, alternating from one nut to the other until the recommended torque is reached.
4. Apply first load to test assembly. This load should be of equal or greater weight than loads expected in use. Next, check and retighten nuts to recommended torque.

CAUTION: DO NOT fabricate slings using wire rope clips.

Installation of U-Bolt Clips

Table 18
Installation of U-Bolt Clips [5]

Clip Size (inches)	Rope Size (inches)	Minimum Number of Clips	Amount of Rope Back in Inches from the Thimble	Torque (ft-lbs)
1/8	1/8	2	3-1/4	4.5
3/16	3/16	2	3-3/4	7.5
1/4	1/4	2	4-3/4	15
5/16	5/16	2	5-1/2	30
3/8	3/8	2	6-1/2	45
7/16	7/16	2	7	65
1/2	1/2	3	11-1/2	65
9/16	9/16	3	12	95
5/8	5/8	3	12	95
3/4	3/4	4	18	130
7/8	7/8	4	19	225
1	1	5	26	225
1-1/8	1-1/8	6	34	225
1-1/4	1-1/4	7	44	360
1-3/8	1-3/8	7	44	360
1-1/2	1-1/2	8	54	360
1-5/8	1-5/8	8	58	430
1-3/4	1-3/4	8	61	590
2	2	8	71	750
2-1/4	2-1/4	8	73	750
2-1/2	2-1/2	9	84	750
2-3/4	2-3/4	10	100	750
3	3	10	106	1200
3-1/2	3-1/2	12	149	1200

Rule of Thumb: Space U-bolt clips a lay length apart.

- If a greater number of clips are used than shown in the table, the amount of turn back should be increased proportionately.
- The tightening torque values shown are based on the threads being clean, dry, and free of lubrication.
- Above values do not apply to plastic-coated wire rope.
- Correctly installed wire rope clips reduce the wire rope Rated Capacity by 20%.
- **Only forged clips shall be used.**
- **U-Bolt clips shall not be used in personnel hoist or scaffold applications.**

CAUTION: DO NOT fabricate slings using wire rope clips.

Installation of Double-Saddle Clips

Table 19
Installation of Double-Saddle Clips [5]

Clip Size (inches)	Rope Size (inches)	Minimum Number of Clips	Amount of Rope Back in Inches from the Thimble	Torque (ft-lbs)
3/16	3/16	2	4	30
1/4	1/4	2	4	30
5/16	5/16	2	5	30
3/8	3/8	2	5-1/4	45
7/16	7/16	2	6-1/2	65
1/2	1/2	3	11	65
9/16	9/16	3	12-3/4	130
5/8	5/8	3	13-1/2	130
3/4	3/4	3	16	225
7/8	7/8	4	26	225
1	1	5	37	225
1-1/8	1-1/8	5	41	360
1-1/4	1-1/4	6	55	360
1-3/8	1-3/8	6	62	500
1-1/2	1-1/2	7	78	500

Rule of Thumb: Space double-saddle clips a lay length apart.

- If a greater number of clips are used than shown in the table, the amount of turn back should be increased proportionately.
- The tightening torque values shown are based on the threads being clean, dry, and free of lubrication.
- Above values do not apply to plastic-coated wire rope.
- Correctly installed wire rope clips reduce the wire rope Rated Capacity by 20%.
- **Only forged clips shall be used.**

CAUTION: DO NOT fabricate slings using wire rope clips.

REFERENCE DATA

Come-a-Long/Chain Fall Data

Table 20
Come-a-Long Specifications

Typical Come-a-Long Specifications				
	3/4 Ton	**1-1/2 Ton**	**3 Ton**	**6 Ton**
Maximum Capacity (tons)	3/4	1-1/2	3	6
Standard Lift (Ft.)	5	5	5	5
Pull On Standard Lever to Lift Full Load (Lbs.)	58	83	95	96
Net Weight (Lbs.)	14	24	34	65
Minimum Distance Between Hooks (In.)	10-3/4	14-1/4	17	21-3/8
Lever Length (In.)	21-1/4	21-1/4	21-1/4	21-1/4
Standard Length of Chain	5'6"	5'6"	11'3"	22'9"
Chain Size	1/4	5/16	5/16	5/16

Table 21
Chain Fall Data Specifications [6]

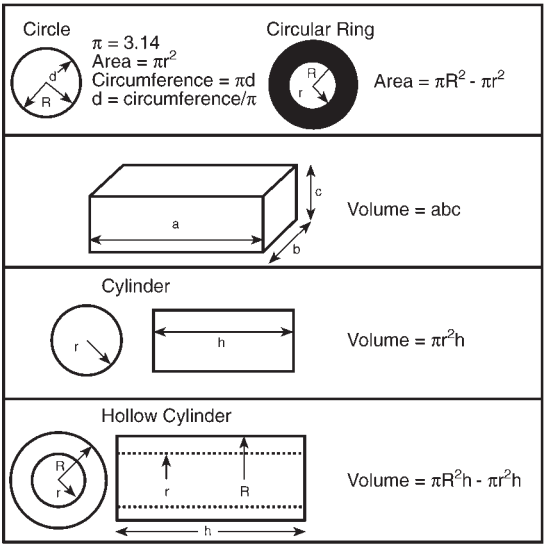
Typical Chain Fall Specifications										
Maximum Capacity (Tons)	1/2	1	1-1/2	2	3	4	5	6	8	10
Standard Lift (Ft.)	8	8	8	8	8	8	8	8	8	8
Net Weight (Lbs.)	33	36	59	60	84	91	122	127	207	219
Shortest Distance Between Hooks (In.)	12-7/8	14	17-3/8	17-3/8	21-1/2	21-1/2	24-1/4	25-1/4	34-1/2	35-1/2
Chain Overhauled to Lift Load One Foot (Ft.)	22-1/2	30	40-1/2	52	81	104	156	156	208	260
Chain Pull to Lift Full Load (Lbs)	46	69	80	83	85	88	75	90	89	95

As indicated in the previous table, a load at Rated Capacity takes less than a 100-pound pull by the operator to lift a Rated Capacity load. See manufacturer's literature for specific product data.

To avoid overloading the hoist mechanisms, never use a cheater bar. Never allow more than one person to operate the lever or the load chain.

Calculating Areas and Volumes

Common Formulas and Definitions



- Area of a circle = π x r^2
- Volume of a right circular cylinder = π x r^2 x h
  - π = 3.14
- The radius is equal to 1/2 of the diameter
  - r = 1/2 d
- The diameter of a circle is the distance across the circle through the center.
- The circumference is the distance around the circle.
- To find the diameter when the circumference is known, divide the circumference by 3.14.
  - C/3.14 = Diameter

To find the area of a rectangle or square, multiply the length by the width.

- Area = L x W
- To find the volume of a rectangular solid, multiply the length times the width times the height.
- Volume = L x W x H
- Remember: when finding area or volume, use the same increments of measurement, in either inches or feet. Most of the time, it is easier to convert to feet or parts of a foot before starting the multiplication process. This is accomplished by dividing inches by 12.
  - 12 inches = 1 foot
  - Example: 36 inches divided by 12 inches/foot = 3 feet
  - Example: 80 inches divided by 12 inches/foot = 6-2/3 feet
- If a volume problem is in inches, then it must be converted to cubic feet. That is accomplished by dividing cubic inches by 1728. There are 1728 cubic inches in a cubic foot.
- When a calculation is used to determine load weight, it is necessary to remember that, if a mistake is made, it needs to be on the high side. All rounding off should be up and not down.
- Once the volume of an object is known, multiply the volume by the weight per cubic foot.

Load weight = Volume in cubic feet x weight per cubic foot

Material Weights

Table 22
Material Weights

Material	Approximate Weight Per Cubic Foot (pounds)
Aluminum	166
Ashes	43
Asphalt	81
Brass	534
Brick (common)	120
Brick (fire)	145
Bronze	509
Concrete, stone, sand	144
Concrete, slag	130
Concrete, cinder	100
Copper	556
Earth, dry (loose)	76
Earth, dry (packed)	95
Earth, moist (loose)	78
Earth, moist (packed)	96
Earth, mud (packed)	115
Granite	179
Iron (casting)	450
Lead	710
Lumber (fir)	32
Lumber (oak)	62
Marble	168
Masonry Rubble	130
Mortar	103
Portland Cement (loose)	90
Portland Cement (set)	183
Rip rap, limestone	85
Rip rap, sandstone	90
Rip rap, shale	105
Sand, gravel, dry (loose)	105
Sand, gravel, dry (packed)	120
Sand, gravel, dry (wet)	120
Steel	490
Tar	115
Water	63
Zinc	440

Formula for figuring load weight:
L x W x H = Cubic Feet
Cubic Feet x Material Weight Per Cubic Foot = Load Weight

Pipeweights Per Foot

Table 23
Pipeweights Per Foot

Nominal Pipe Size (inches)	American Steel Association (ASA) Schedule					
	40	60	80	100	120	160
1/8	.24		.31			
1/4	.42		.54			
3/8	.57		.74			
1/2	.85		1.09			1.31
3/4	1.13		1.47			1.94
1	1.68		2.17			2.34
1-1/4	2.27		3.00			3.76
1-1/2	2.72		3.63			4.36
2	3.65		5.02			7.46
2-1/2	5.79		7.66			10.01
3	7.58		10.25			14.31
3-1/2	9.11		12.51			
4	10.79		14.98		18.98	22.52
5	14.62		20.78		27.04	32.96
6	18.97		28.57		36.42	45.34
8	28.55	35.66	43.39	50.93	60.69	74.71
10	40.48	54.74	64.40	77.00	89.27	115.65
12	53.56	73.22	88.57	107.29	125.49	160.33
14	63.37	85.01	106.13	130.79	150.76	189.15
16	82.77	107.54	136.58	164.86	192.40	245.22
18	104.76	138.17	170.84	208.00	244.14	308.55
20	123.06	166.50	208.52	256.15	296.37	379.14
22		197.42	250.82	302.88	353.61	451.07
24	171.17	238.29	296.53	367.45	429.50	542.09

Note 1: Forged swivels and swivel hooks with bronze bushings are to be used for positioning prior to lifting a load. DO NOT rotate under load. Only swivels or swivel hooks with Teflon bushings (Shur-Loc S-326 A) can be used to rotate under load.

Note 2: Do not overcrowd the hook.

DO NOT swivel the hook while it is supporting a load.

Rebar Weights Per Foot

Table 24
Rebar Weights Per Foot

Bar No.	Diameter (inches)	Weight per Foot (pounds)
3	0.375	0.376
4	0.500	0.668
5	0.625	1.043
6	0.750	1.502
7	0.875	2.044
8	1.000	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313
14	1.693	7.650
18	2.257	13.600

Fractions of Inches and Inches Converted to Decimals

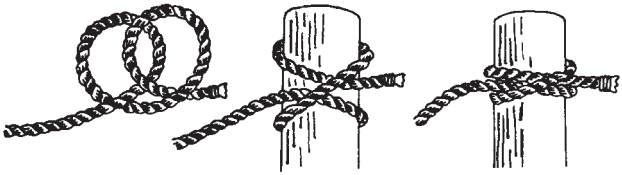
Table 25
Fractions of Inches and Inches Converted to Decimals

Inches	Decimals of Inch	Decimals of Foot
1/16	.062	.005
1/8	.125	.01
3/16	.187	.015
1/4	.25	.02
5/16	.312	.026
3/8	.375	.031
7/16	.437	.036
1/2	.50	.041
9/16	.562	.047
5/8	.625	.052
11/16	.6875	.057
3/4	.75	.062
13/16	.8125	.068
7/8	.875	.072
15/16	.9375	.078
1		.083
2		.166
3		.25
4		.33
5		.416
6		.5
7		.583
8		.66
9		.75
10		.833
11		.916
12		1.0

Knots

How to Tie a Bowline Knot

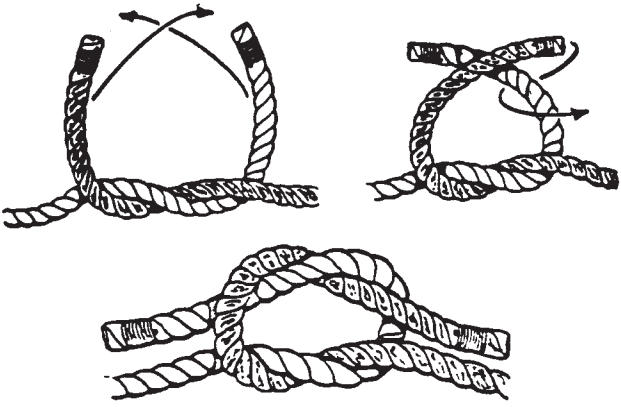
How to Tie a Clove Hitch



Note: These knots can be used to attach tag lines.

How to Tie a Sheet Bend

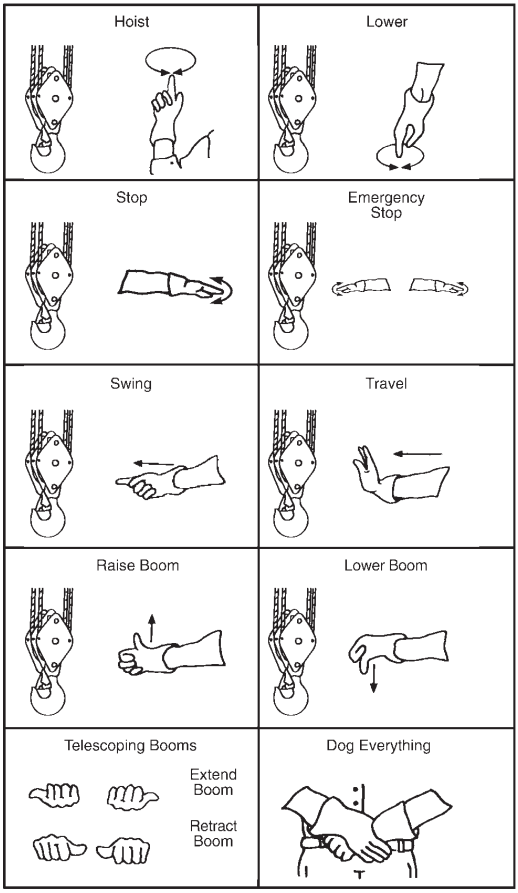
How to Tie a Square Knot



Caution: For tag line use

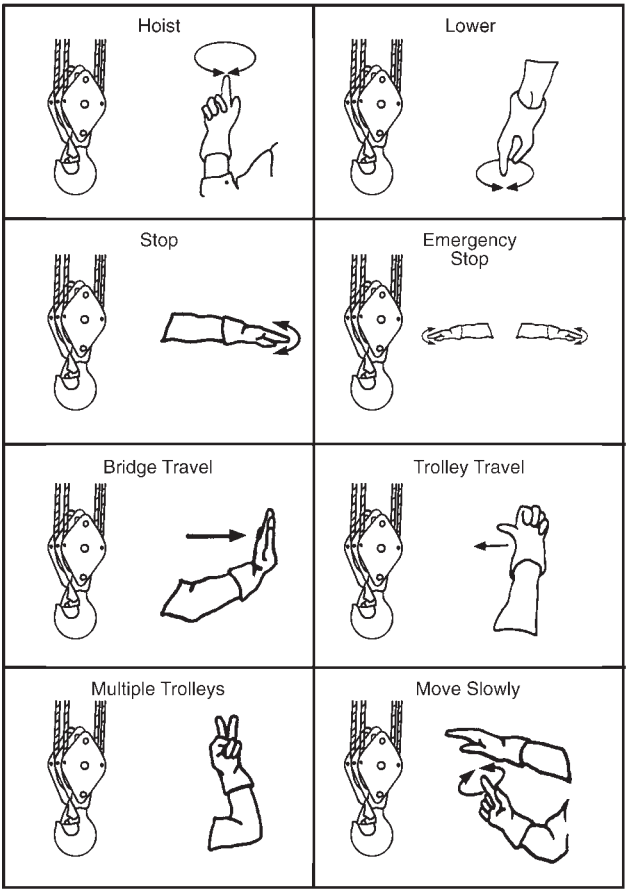
SIGNALING AND COMMUNICATION

Hand Signals (Mobile Crane)



Note:
For other crane hand signals, refer to the signals posted in the crane cab.

Hand Signals (Overhead Crane)



Note 1:
For other crane hand signals, refer to the signals posted in the crane cab.

Note 2:
When signaling for more than one block, use one finger to indicate block marked #1, two fingers to indicate block marked #2, and so on.

Communication Technique Using Radios

To provide consistency, Crane Operator and Flagger communications should follow the process described below when using radios. This three-step process should be used when there is a change in direction of movement of the crane. Once the direction of movement has been given to the Crane Operator, acknowledged by the Crane Operator, and confirmed by the Flagger, the movement may begin. While the crane is in motion, the Flagger should keep in constant communication with the Crane Operator. If this constant confirmation of the movement stops, the Crane Operator must stop all crane movement.

Message Format

The basic message consists of three parts in the following order:

1. Name or responsibility of the called individual
2. Title or responsibility of the calling individual
3. Message Text

Example:

1. "Crane Operator name."
2. "This is the Flagger."
3. "Raise load approximately 4 inches off the floor and hold."

Acknowledgment

The basic acknowledgment consists of three parts in the following order:

1. Originating individual's name or responsibility
2. Calling individual's name or responsibility
3. Paraphrase or explanation of the instructions or message received

Example:

1. "Flagger name."
2. "This is the Crane Operator."
3. "Raise the load 4 inches off the floor and hold."

Confirmation

Acknowledgment from the originating individual.

Example:

1. "Crane Operator."
2. "This is the Flagger."
3. "That is correct."

The absence of the confirmation step may result in miscommunications. The Crane Operator might misunderstand the information, acknowledge the miscommunication, and then proceed in performing the wrong movement. A lack of response by the originator shall be an indication to stop until the message is confirmed or repeated. Listening to the repeated message is very important because studies have shown that people hear what they want and expect to hear, and frequently do NOT hear what is said.

If the recipient (Crane Operator) does NOT understand the message, he should ask the originator to repeat or rephrase the message. If the recipient (Crane Operator) repeats or rephrases the message incorrectly, the originator (Flagger) should immediately correct the recipient (Crane Operator) by saying "wrong," and repeat the message.

REFERENCES

1. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30.20-1999. Below-the-Hook Lifting Devices.
2. U.S. Department of Labor. Occupational Safety & Health Administration (OSHA) 29 CFR 1926.251. Rigging Equipment for Material Handling.
3. U.S. Department of Labor. Occupational Safety & Health Administration (OSHA) 1910.184 Slings. General Industry Standards, Material Handling and Storage, March 7, 1996.
4. Private Communication from The Crosby Group to the Operating Engineers Institute of Ontario, 1992.
5. *The Crosby Group Catalog,* The Crosby Group, Inc., 1998.
6. Ronald Garby. *IPT's Crane and Rigging Handbook: Mobile – EOT – Tower Cranes*. IPT Publishing and Training, Ltd., 1991, p. 68.
7. *The Crosby Group Catalog,* The Crosby Group, Inc., 2000.
8. *The Crosby Group Catalog,* The Crosby Group, Inc., 1997.

NOTES

LIFTING PROCESS CHECKLIST

Planning a lift can be accomplished in as little as five minutes or as long as several days according to the complexity of the lift. After the work scope has been identified and the appropriate individuals selected to perform the associated lifting tasks, the lifting team members should review the following Lifting Process steps and perform their individual responsibilities:

- The Lift Plan Checklist is to be used as a tool or a job aid by an individual who successfully completed either the Rigger Lifting Process or Advanced Rigger training, or by a Lifting Coordinator or Engineer. The Lift Plan Checklist will help in determining:
  - If the lift is a common or complex lift
  - When a verbal discussion of the lift plan is sufficient
  - When to develop a Lift Plan
  - When to document a Lift Plan
- A Lift Plan is developed by a Qualified Rigger, Advanced Rigger, Lifting Coordinator or Engineer, and a Qualified Crane or Equipment Operator (if applicable).
- Conduct a pre-lift briefing to ensure that roles and responsibilities are clearly understood; review the Lift Plan.
- Obtain rigging hardware from tool issue. Ensure that a copy of this handbook and the Crane Operator's guidebooks (as applicable) are available for reference.
- Perform frequent inspection of all rigging hardware in accordance with appropriate licensee inspection requirements.
- Verify hoist or crane Rated Capacity.
- Perform pre-operational crane inspection as applicable.
- When using a mobile crane, verify that mobile crane setup is correct.
- For outdoor lifts, determine if weather conditions are acceptable.
- Verify rigging hardware for appropriate size and type. Correctly attach rigging hardware to the load and to the hoist or crane hook. Use softeners and tag lines as required.
- Verify that the load travel path is clear. Rope off the load travel path as required.
- Notify individuals that are located near or (when necessary) at elevations below the travel path that the lift is in progress.

Note: When transporting a load that is heavy enough to damage the floor or that might pass over hatchways or openings in the floor, rope off the load travel path at the affected lower elevations and/or notify individuals in nearby areas prior to making the lift.

- Verify that the set point location will support the load weight. As required, place or erect cribbing in the lay down or set point location.
- Establish and verify communications between the Crane Operator and the Flagger.
- Tension the slings and rigging hardware to a taut condition. Secure the load by:
  - Visually inspecting the rigging hardware for safe configuration, correct installation, and any deficiencies.
  - Make any necessary adjustments.
  - Verify that the hook is located over the center of gravity of the material or equipment.
- Raise or lift the load to verify the center of gravity. If the load shifts and it appears that the load is not secure or is in an unbalanced condition, stop the lift. Make adjustments as necessary to balance and secure the load.
- Raise or lift the load just enough to clear the support mechanism (floor, pedestal, trailer, and so on). Verify safe lifting configuration.
- Raise or lift the load no higher than necessary. Transport or move the load. Avoid travel over individuals. Keep individuals clear of the load path. Stop movement of the load if individuals enter the load path area. Follow the travel path to the set point location.
- Lower or set the load on the predetermined location or on cribbing so that the rigging hardware can be removed safely.
- Ensure stability of the load prior to de-coupling the rigging hardware.
- Remove the rigging hardware and inspect each component. If a component is defective, tag and document the deficiency on the tag.

LIFT PLAN CHECKLIST

Notes:

The Lift Plan Checklist should be used as a tool by the Rigger, Advanced Rigger, or Crane Operator to assist in the planning of a lift. The Lift Plan Checklist is intended to be used as a guide to help the individual identify the following:

- Whether a lift is Common or Complex.
- When a Lift Plan **should** be developed and recorded, either on paper or on the laminated sheets in the back of this handbook.
- When a documented Lift Plan **shall** be developed and retained on file.

To use this checklist effectively, the Rigger, Advanced Rigger, or Crane Operator should answer all of the questions.

A blank under both the Common Lift and Complex Lift columns indicates that answers to other questions will determine whether a lift is Common or Complex.

One YES in the Common Lift column indicates the lift to be a *Common* lift.

One YES in the Complex Lift column indicates the lift to be a *Complex* lift.

One YES in the Develop Lift Plan column indicates that a Lift Plan **should** be developed.

One YES in the Document Lift Plan column indicates the requirement that a Lift Plan **shall** be developed, documented, and filed.

Table 26
Lift Plan Checklist

Question/Condition	Common Lift	Complex Lift	Develop Lift Plan	Document Lift Plan
If a lift requires that a Lift Plan be developed and the lift is repetitive, will a documented Lift Plan reduce labor time or benefit the Rigger and/or Crane Operator the next time the lift will be performed?				YES
Will there be multiple lifts for disassembly or assembly of major equipment (such as turbines) where more than one set of rigging hardware is required and these lifts are repetitive?			YES	YES
Does the lift require procedural controls to perform the lift?			YES	YES
Is the lift a special over-rated load lift that exceeds the Rated Capacity of the crane or hoist (requires Lifting Coordinator involvement)?		YES	YES	YES
During the lift, could uncontrolled movement or loss of load adversely affect safety-related systems, decay heat removal systems, or result in potential off-site radiation exposure in excess of 10CFR100 limits?		YES	YES	YES
Will the lift being performed require use of a mobile crane on a barge?		YES	YES	YES
Lifting personnel?			YES	YES
Is this a specialized lifting task; in other words, steam generator or reheat tube replacement?		YES	YES	YES
Will the lift involve rotating, flipping, upending, or lowering shells, tanks vessels, or similar loads?		YES	YES	YES
Will the lift involve side loading or a bridge or gantry crane hoist drum?		YES	YES	YES
Will an equalizer beam be used to equally distribute loads or for load balancing and stabilization?		YES	YES	

Table 26 (cont.)
Lift Plan Checklist

Question/Condition	Common Lift	Complex Lift	Develop Lift Plan	Document Lift Plan
Will the lift be a tandem lift requiring the use of more than one overhead gantry or mobile crane, **or** more than one hook on the same overhead or gantry crane?		YES	YES	
Is the known center of gravity of the load to be lifted more than 12 inches from the geometrical center of the load?		YES	YES	
Is the center of gravity of the load unknown?		YES	YES	
Are sling angles less than 30° from the horizontal?		YES	YES	
Is the load difficult to balance and secure?		YES	YES	
Are the lift attachment points (lugs, shackle location) located below the center of gravity on the load? Note: A load in a basket hitch does not apply.		YES	YES	
Will the lift be performed outdoors during adverse weather conditions or under a weather advisory caution, which might cause instability of the load or difficulty in load control?		YES	YES	
Will the lift being performed require High Lining? Note: The use of high lines is not recommended and should be avoided whenever possible.		YES	YES	
Will the lift be performed without the use of a previously documented Lift Plan performed by an Advanced Rigger using snatch blocks or base-mounted drum hoists?		YES	YES	
Would the failure of the lift cause damage to a high-value, long lead time procurement item or significantly impact plant operations, shutdown, or equipment?			YES	

Table 26 (cont.)
Lift Plan Checklist

Question/Condition	Common Lift	Complex Lift	Develop Lift Plan	Document Lift Plan
Will the load to be lifted exceed 90% of the Rated Capacity of the overhead crane, gantry crane, monorail, other similar crane, hoist, or rigging hardware?			YES	
Will the load to be lifted exceed 75% of the Rated Capacity of the boom configuration, boom radius, job boom extension, setup etc., for mobile cranes?			YES	
Will the Flagger use a remote monitoring screen to monitor the lift and use radios as the method of communication?			YES	
When using a mobile crane, will the lift being performed be within 10 feet of energized equipment (that is, switchgear, exposed conductive components, batteries, conductor bus bar, and so on)? Note: Cable tray, enclosed motors, electrical conduit, etc. are excluded.			YES	
When using a mobile crane, will the lift being performed be within 50 feet of electrical power lines?			YES	
Will travel path interferences require roped off areas?			YES	
Will the lift be performed or travel over operating equipment?			YES	
Is visibility poor?			YES	
Will more than one Flagger be required to perform the lift?			YES	
Will the lift require the use of a mobile crane using the “On Rubber” load chart?			YES	
Will a load that could punch through the floor be carried over personnel located at lower floor elevations?			YES	
Will the load be carried over open hatchways in the floor?			YES	

Table 26 (cont.)
Lift Plan Checklist

Question/Condition	Common Lift	Complex Lift	Develop Lift Plan	Document Lift Plan
Will two hoists be used on the same monorail to lift a common load where each hoist is located at the same distance from the center of gravity of the load?	YES			
Will two hoists be used on the same monorail to lift a common load where 1) each hoist is located at the same distance from the center of the load, 2) the center of gravity of the load is within 12 inches of the load center, and 3) the Rated Capacity of each hoist is at least .75 times the load weight?	YES			
Will the Common Load to be lifted using two or more hoists that are both attached to the same attachment point on the load always have load line angles equal to or greater than 30° from the horizontal (the angle between a horizontal line at the load attachment point and the hoist hook) at all times throughout the lift? Will the Rated Capacity of each hoist be at least equal to the load weight?	YES			
Will the Common Load to be lifted using two or more hoists that are attached to different attachment points on the loads always have load line angles equal to or greater than 30° from the horizontal (the angle between a horizontal line at the load attachment point and the hoist hook) at all times throughout the lift? Will the Rated Capacity of each hoist be at least 1.5 times the load weight?	YES			

DOCUMENTED LIFT PLAN COVER SHEET

Station or Facility _____

Lift Plan Task Number _____

Lift Plan Scope _____

_____

_____

_____

_____

_____

Common Lift?	YES	NO
Complex Lift?	YES	NO
Advanced Rigger required to perform FIRST time?	YES	NO
Advanced Rigger required to perform EACH time?	YES	NO
Advanced Rigger required to be present each time during execution?	YES	NO
Can any Qualified Rigger execute this Lift Plan independently?	YES	NO
Can a Qualified Rigger execute the Lift Plan independently?		
Any Rigger?	YES	NO
Specific Rigger or team? Name:_____	YES	NO

Lift Plan Prepared
and Approved by:_____Date_____

Note: A Common Lift requires the signature of a Qualified Rigger, Advanced Rigger, Crane Operator, Lifting Coordinator or Engineer.

A Complex Lift requires the signature of a Qualified Advanced Rigger, Crane Operator, Lifting Coordinator or Engineer.

Exemptions, if needed:

Lift Plans are to be performed by trained and Qualified Riggers, Advanced Riggers, or Crane Operators unless training and qualifications are exempted and approved by the Lifting Coordinator.

Can a Non-Qualified Rigger be specifically trained to perform the Lift Plan?	YES	NO
Qualifications exempted?	YES	NO

Exemptions
Approved by:_____Date_____

LIFT PLAN FORM

Work Order Number_____Task Number_____

Equipment ID No._____

Lift Plan Performed by:_____Date_____

Drawings, sketches, diagrams, pictures, etc. attached or referenced in comments YES NO

1. Determine Team Responsibilities

   Crane/Lifting Equipment Operator_____

   Rigger_____

   Advanced Rigger_____

   Flagger_____

   Additional Support Individuals_____

   Required Engineering Support_____

Note: The rigging hardware and lifting equipment Operator, Rigger, and Flagger can be the same individual.

2. Determine material/equipment weight, shape, height, width, length, center of gravity, and rigging attachment points.

   Verified material/equipment shape, height, width, length _____

   Verified or determined material/equipment center of gravity _____

   Verified acceptable rigging attachment points or obtained Engineering approval _____

   Determined material/equipment weight to be one of the following:

   Manufacturer or licensee drawings _____

   Weighing of the material or equipment _____

   Work control _____

   Engineering or Lift Coordinator _____

   Conservative calculation _____

3. Location of material/equipment center of gravity:

   Center of gravity is 12 inches or less from center

   (Rigger Qualification Required) _____

   Center of gravity is greater than 12 inches from center

   (Advanced Rigger Qualification Required) _____

   Labeled/marked center of gravity for visual reference _____

4. Perform a field survey to observe, evaluate, and identify:

____	Lifting Conditions	____	Surroundings
____	Building or structural attachment points	____	Lift lugs
____	Handling of loose parts	____	Pick points
____	Travel path	____	Interferences
____	Set point location	____	Laydown area
____	Roped-off area identification		
____	Fabricated lifting devices needed		
____	Individuals or work in progress in the area		
____	Specialized rigging task		

5. Select Crane Hoist Equipment

Mobile Crane Type	Rated Capacity	Number of Boom Sections	Number of Parts in Line	Size Block/ Ball	Jib Boom
Mobile Lattice Boom Crane					
Crawler _____	_____	_____	_____	_____	Y__
Truck _____	_____	_____	_____	_____	N__
Other _____	_____	_____	_____	_____	
Mobile Hydraulic Boom Crane					
Rough Terrain _____	_____	_____	_____	_____	Y__
Truck _____	_____	_____	_____	_____	N__
Barge_____	_____	_____	_____	_____	
Other _____	_____	_____	_____	_____	
Boom Truck Crane	_____	_____	_____	_____	_____
Other _____	_____	_____	_____	_____	_____

Overhead Traveling Crane Type	Crane Rated Capacity	Main Hoist Rated Capacity	Auxiliary Hoist Rated Capacity	Sister Hook	J Hook
Cab-Operated Bridge Crane				Y___	Y___
Trolley #1				N___	N___
Cab-Operated Bridge Crane				Y___	Y___
Trolley #2				N___	N___
Floor-Operated Bridge Crane				Y___	Y___
Trolley #1				N___	N___
Floor-Operated Bridge Crane				Y___	Y___
Trolley #2				N___	N___
Cab-Operated Gantry Crane				Y___	Y___
Trolley #1				N___	N___
Cab-Operated Gantry Crane				Y___	Y___
Trolley #2				N___	N___
Floor-Operated Gantry Crane				Y___	Y___
Trolley #1				N___	N___
Floor-Operated Gantry Crane				Y___	Y___
Trolley #2				N___	N___

Hoist	Rated Capacity	Required Lift/Reach	Chain or Wire Rope Length	Load Stress at Load Angle
Lever Operated				
1. _____	_____	_____	_____	_____
2. _____	_____	_____	_____	_____
3. _____	_____	_____	_____	_____
4. _____	_____	_____	_____	_____
Hand Chain Operated				
1. _____	_____	_____	_____	_____
2. _____	_____	_____	_____	_____
3. _____	_____	_____	_____	_____
4. _____	_____	_____	_____	_____
Air Operated				
1. _____	_____	_____	_____	_____
2. _____	_____	_____	_____	_____
3. _____	_____	_____	_____	_____
4. _____	_____	_____	_____	_____
Electric Operated				
1. _____	_____	_____	_____	_____
2. _____	_____	_____	_____	_____
3. _____	_____	_____	_____	_____
4. _____	_____	_____	_____	_____
Base-Mounted Drum Hoist				
1. _____	_____	_____	_____	_____
2. _____	_____	_____	_____	_____
3. _____	_____	_____	_____	_____
4. _____	_____	_____	_____	_____
Other				
1. _____	_____	_____	_____	_____
2. _____	_____	_____	_____	_____
3. _____	_____	_____	_____	_____
4. _____	_____	_____	_____	_____

6. Verify that the set point location can withstand the applied load or weight of the load. YES NO

7. Determine the rigging configuration, rigging hardware, containers, fabricated lifting devices, and lift beams to be used. Determine size and type of rigging hardware to be used according to the weight of the load and rigging configuration.

Note: Refer to load charts as applicable.

Sling Leg	Sling Leg Length (L)	Distance (D)	Distance (d)	Sling Angle (degrees)	Multiplication Factor	Load Weight (lbs.)	Sling Stress Load (lbs.)
1							
2							
3							
4							
5							
6							

Request the aid of an Advanced Rigger as needed (for example, for sling angles less than 30° from the horizontal).

CALCULATIONS:

Select Rigging Hardware:

Type	Kevlar	Synthetic Web/Round	Wire Rope	Chain
Material Construction		Web__ Round__ Web__ Round__ Web__ Round__ Web__ Round__	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____
Rope or Link Diameter			1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____
Vertical Rated Capacity	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____
Length	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____

Rigging Hardware	Quantity	Rated Capacity	Size
Shackle	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Shackle	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Hoist Ring	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Turnbuckles	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Link	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Beam Clamp	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Shouldered Eyebolt	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Shoulderless Eyebolt	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Swivel Eyes	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Plate Dogs	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Jacks	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Pumps	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Rollers	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Air Pallets	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Wire Rope Clips	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Snatch Block	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.
Other	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.	1. 3. 5. 2. 4. 6.

Softeners	Size(s)			Quantity		
Rubber Pad	1. 2.	3. 4.	5. 6.	1. 2.	3. 4.	5. 6.
Conveyor Belt	1. 2.	3. 4.	5. 6.	1. 2.	3. 4.	5. 6.
Split Pipe	1. 2.	3. 4.	5. 6.	1. 2.	3. 4.	5. 6.
Wooden Blocks	1. 2.	3. 4.	5. 6.	1. 2.	3. 4.	5. 6.
Kevlar Pads	1. 2.	3. 4.	5. 6.	1. 2.	3. 4.	5. 6.
Fire Hose	1. 2.	3. 4.	5. 6.	1. 2.	3. 4.	5. 6.
Other	1. 2.	3. 4.	5. 6.	1. 2.	3. 4.	5. 6.
Other	1. 2.	3. 4.	5. 6.	1. 2.	3. 4.	5. 6.

Lifting Devices	Identification Number	Storage Location	Rated Capacity
Lift Rig	1. 2.	1. 2.	1. 2.
Lift Beam	1. 2.	1. 2.	1. 2.
Spreader Beam	1. 2.	1. 2.	1. 2.
Special Lifting Device	1. 2.	1. 2.	1. 2.
Personnel Basket	1. 2.	1. 2.	1. 2.
Fabricated Lifting Device	1. 2.	1. 2.	1. 2.
Other	1. 2.	1. 2.	1. 2.

8. Verify that the Maximum Applied Load is less than the Rated Capacity of all rigging hardware and hoists, or within the load chart rating of the crane being used.

YES NO

9. Determine the load travel path.

Minimizes interferences?	YES	NO
Minimizes the number of direction movements?	YES	NO
Complies with NUREG-0612 requirements?	YES	NO
Avoids carrying the load over individuals' work in progress?	YES	NO
Avoids carrying the load over operating or essential equipment?	YES	NO
Complies with the minimum distance requirements for energized equipment or power lines?	YES	NO
Is the shortest direct travel path used to ensure a safe lifting process?	YES	NO

Describe the load travel path:

Identify interferences:

List areas that require barricades:

10.	Drawings, sketches, or job aids required?	YES	NO
11.	Determine communications between the Crane Operator and the Flagger:		
	Radio	YES	NO
	Hand Signals	YES	NO
	Video Camera with Radio	YES	NO

Comments:

Comments (continued):

About EPRI

Program:
Nuclear Power

EPRI creates science and technology solutions for the global energy and energy services industry. U.S. electric utilities established the Electric Power Research Institute in 1973 as a nonprofit research consortium for the benefit of utility members, their customers, and society. Now known simply as EPRI, the company provides a wide range of innovative products and services to more than 1000 energy-related organizations in 40 countries. EPRI's multidisciplinary team of scientists and engineers draws on a worldwide network of technical and business expertise to help solve today's toughest energy and environmental problems.

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