

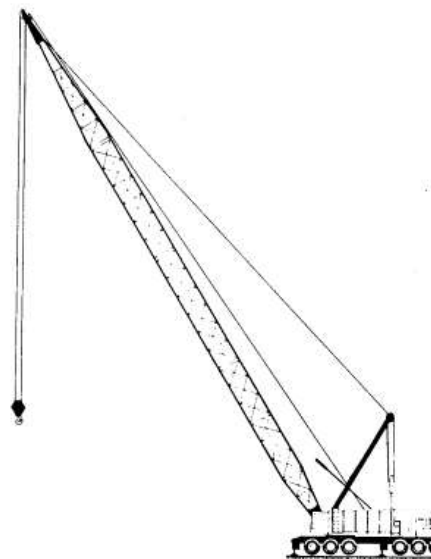
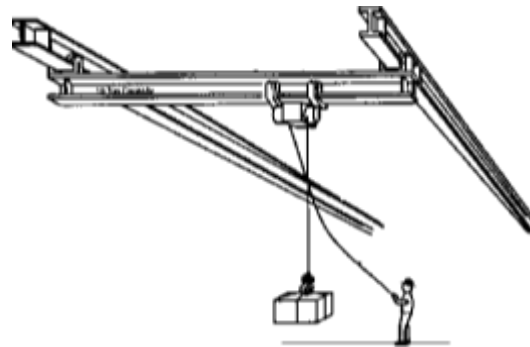
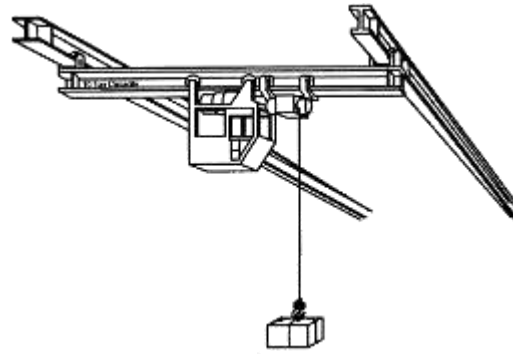


An Annex to:

AEDC Safety Health & Environmental Standard

D5, Hoisting Devices

AEDC HOISTING & RIGGING HANDBOOK



AEDC Operations

Arnold Air Force Base, TN 37389

7th Edition – June 2014

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Record of Review/Revision

Date/POC	Description
July 2013 – June 2014 C. Bidmead E. Robinson	7th Edition. Incorporated Change #1, Jan 2011. Added definitions and modified duty position titles throughout document for clarity and consistency with OSHA and ASME, and as a result of in depth crane program review. Corrected exhibit numbers throughout document to reflect unique number for each exhibit. Added Rigger, Signal Person and Dedicated Spotter training and qualification changes to Chapter 6 and changed operating near power line requirements to be consistent with latest OSHA 1926 Subpart CC mandatory requirements. Incorporated changes requested by AEDC Crane System Engineer. Deleted chapter 15 to reduce redundancy with chapter 9. Reformatted entire document for consistency and e-document use. Reduced number of entries on Table of Contents and added hyperlinks for easier e-document navigation. Corrected errors and made minor clerical changes throughout.
May 2013 R. Roosa	6 th Ed.: Added stability analysis and explosives handling information to critical lift requirements. Added definition of Stability Equilibrium, Changed/added: Paragraphs 2.1.1.2; 2.1.1.7; 2.1.1.2. 8; 2.2.1.2.1; 2.2.1.2.3.9; Exhibit 2.1; Exhibit 2.2; added new Exhibit 2.6 Stability Analysis Methodology.
Oct 2010 R.Eichel	5 th Ed.: Updated to reflect new OSHA requirements for mobile crane operations.

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HISTORY AND BACKGROUND

In 2002, AEDC established a crane safety committee to develop an AEDC Hoisting and Rigging Program. The Committee reviewed existing hoisting and rigging codes, standards, and regulations, such as the Occupational Safety and Health Administration (OSHA) 29 CFR 1910, the American Society of Mechanical Engineers (ASME) B-30 series, and others. The Committee determined that these documents, while adequate as minimum general industry standards, did not contain the details for the unique hoisting and rigging operations being performed at AEDC. Due to the risky operations at AEDC, it was determined that an AEDC Hoisting and Rigging (H&R) handbook was necessary.

Preliminary work on the handbook was begun in June 2002. The first handbook developed incorporated the minimum requirements of OSHA, ASME, similar documents and included additional requirements to control hoisting and rigging work processes at AEDC. The handbook was reviewed by AF and base operating contractor personnel. A final draft was completed in December 2002 and implemented in May 2003.

This handbook is a safety, not a design, document and is intended for use by safety professionals, managers, supervisors, riggers, and operators. In keeping with this philosophy, only those portions of standards and regulations dealing with safety have been included. In that, the target audience for this document is safety professionals, managers and supervisors, riggers, and operators rather than hoisting and rigging equipment designers, the design references cited within Chapter 17 of this handbook (References) should be consulted for specific design, fabrication, and other performance criteria. Readers are strongly encouraged to review each of them to have a full description of the subject area covered.

This Handbook supports the objectives of AEDC by controlling hoisting and rigging activities in a safe and cost-effective manner. It is intended to be a user's guide to requirements, codes, laws, regulations, standards, and practices that apply to AEDC operations. This Handbook, or any part of this Handbook, is applicable to all contractors and subcontractors (offsite or onsite) performing work at/for AEDC.

This Handbook is generally invoked via contract. All contractors performing work involving critical lifts shall follow this Handbook. As a minimum, acceptability of equipment and rigging should be verified by the AEDC Crane System Engineer and critical lift procedures shall be reviewed and approved by Person-In-charge (PIC) or another qualified person designated by the PIC.

This is the seventh edition. This revision incorporates the recent OSHA and ANSI B-30 changes.

ACKNOWLEDGMENTS

AEDC acknowledges the many organizations whose documents provided important source material for the handbook. They include:

American Society of Mechanical Engineers

Construction Safety Association (CSA) of Ontario

Society of Automotive Engineers, Inc. (SAE)

Permission to reprint specific figures and illustrations was obtained from CSA and SAE.

The Department of Energy (DOE)

Applicable sections of 29 CFR 1910, "Occupational Safety and Health Standards for General Industry," and 29 CFR 1926, "Occupational Safety and Health Regulations for Construction," have been paraphrased or reproduced verbatim throughout. The contributions of AEDC's Hoisting and Rigging Committee are also recognized. Without their time and talent, which has been provided gratuitously, there would be no handbook.

INTRODUCTION

The AEDC *Hoisting and Rigging Handbook* is intended as a reference document for use by supervisors, line managers, safety personnel, equipment operators, and any other personnel responsible for hoisting and rigging operations at AEDC sites. The handbook quotes verbatim or paraphrases (with minor editorial changes for consistency) the requirements of the OSHA and the ASME. It also encompasses hoisting and rigging requirements, codes, standards, and regulations, eliminating the need to maintain extensive (and often incomplete) libraries of hoisting and rigging standards throughout AEDC.

The word *shall* denotes a mandatory action and *should* denotes a recommended action in keeping with best management practices. To permit use of each chapter as a standalone document, there is some repetition from chapter to chapter.

This handbook addresses the following items that are not covered in detail in the general industry standards:

- Management responsibility and accountability
- Operator/inspector training and qualification requirements
- Definition of critical lifts and the additional requirements for making them
- The need and responsibilities of a person-in-charge for critical lifts
- The need and responsibilities of an Designated Leader
- Special requirements for the testing, inspection, and maintenance of hoisting equipment in hostile environments
- Nondestructive testing/nondestructive examination requirements for such items as hooks, welds, and spreader bars
- Special requirements for inspection and load-testing of hoisting and rigging equipment/accessories
- Hook latch requirements for cranes, slings, and rigging accessories
- Design standards for such equipment as cranes, forklifts, and hooks
- Operating practices for hoisting and rigging operations
- Rigging information and load tables
- Good and bad rigging practices.

The full implementation of the requirements and recommendations of this handbook will strengthen hoisting and rigging programs throughout the AEDC complex and decrease the probability of serious accidents resulting in personnel injury or death or severe property damage.

Not all hoisting and rigging operations are covered by this handbook, therefore contact the AEDC Crane System Engineer for clarification. Hoisting and rigging equipment fabricated onsite or operated in a manner not envisioned by this Handbook shall be designed, constructed, operated, inspected and tested in accordance with the design engineer of record and applicable design standards. This Handbook does not address elevators, drilling rigs, or the lifting of loads with construction equipment not normally intended for lifting purposes (e.g., excavators, payloaders). Applicable regulatory documents should be consulted to ensure conformance with these requirements.

To propose improvements to this handbook, please provide suggested text changes and supporting technical documentation to the AEDC Crane System Engineer.

1.0 CHAPTER 1 -TERMINOLOGY AND DEFINITIONS

The following are specialized terms commonly used when discussing hoisting and rigging operations. Many may not be used in this handbook, but are included for general information. Terms are arranged alphabetically. Illustrations are included for clarity.

ABRASION: the mechanical wearing of a surface resulting from frictional contact with other materials or objects.

ACCELERATION STRESS: Additional stress imposed due to increasing load velocity.

ADVANCED RIGGER: see “QUALIFIED RIGGER.”

ALTERNATE LAY: Lay of wire rope in which the strands are alternately regular and lang lay.

ANSI: American National Standards Institute.

APPOINTED PERSON: Assigned specific responsibilities by the employer or the employer’s representative.

AREA LIFT MANAGER: A term use by the base operating contractor. For the purpose of this document see “DESIGNATED LEADER.”

AREA, METALLIC: Sum of the cross-sectional areas of individual wires in a wire rope or strand.

ASSET OWNER: A person assigned the role of managing the life cycle of an asset. The Asset Owner ensures the capability, capacity, and configuration of assets. For the purpose of this document the title Asset Owner is synonymous with the ASME B30 role of “site supervisor- a person who exercises supervisory control over the work site on which the hoisting equipment is being used and over the work that is being performed on that site.”

ATTACHMENT: A device other than conventional forks or load backrest extension, mounted removable or permanently on the elevating mechanism of a truck for handling the load. Popular types are fork extension clamps, rotating devices, side shifters, load stabilizers, rams, and booms.

AUTHORIZED: Assigned by a duly constituted administrative or regulatory authority.

AUXILIARY HOIST: Supplemental hoisting unit usually of lower load rating and higher speed than the main hoist.

BACK STAY: Guy used to support a boom or mast or that section of a main cable, as on a suspension bridge, or cableway, and the like, leading from the tower to the anchorage.

BAIL: A U-shaped member of a bucket, socket, or other fitting.

BASE OPERATING CONTRACTOR: The contractor directly accountable to the Air Force for the AEDC mission.

BASIC RIGGER: see “QUALIFIED RIGGER.”

BASKET OR SOCKET: The conical portion of a socket into which a splayed rope end is inserted and secured with zinc.

BATTERY-ELECTRIC TRUCK: An electric truck in which the power source is a storage battery.

BECKET LOOP: A loop of small rope or a strand of rope fastened to the end of a large wire rope to facilitate installation.

BENDING STRESS: Stress on wires of a wire rope imposed by bending. This stress need not be added to direct load stresses. When sheaves and drums are of suitable size, bending stress does not affect normal life of the wire rope.

BIRDCAGE: A colloquialism describing the appearance of a wire rope that is forced into compression. The outer strands form a “cage” and at times displace the core.

BIRDCAGING: The twisting of fiber or wire rope in an isolated area in the opposite direction of the rope lay, causing it to take on the appearance of a birdcage.

BOOM (Crane): A member hinged to the rotating superstructure and used for supporting the hoisting tackle.

BOOM LINE: A wire rope for supporting or operating the boom on derricks, cranes, draglines, shovels, etc.

BRAKE: A device used for slowing or stopping motion by friction or electromagnetic means.

BRAKE, DRAG: A brake that provides stopping force without external control.

BRAKE, HOLDING: A brake that sets automatically and that prevents motion when power is off.

BRAKE, PARKING: A device to prevent the movement of a stationary vehicle.

BRAKING, COUNTER TORQUE: A method of controlling speed by reversing the motor line voltage polarity or phase sequence to develop torque in the direction opposite to the rotation of the motor.

BRAKING, DYNAMIC: a method of controlling speed by using the motor as a generator, with the energy being dissipated in resistors.

BRAKING, MECHANICAL: A method of slowing motion by friction.

BRAKING, REGENERATIVE: A form of dynamic braking in which the electrical energy generated is fed back into the power system.

BREAKING STRENGTH: The measured load required to break a wire rope or chain.

BRIDGE: The part of a crane, consisting of girders, walkways, railings, trucks, and drive mechanisms, that carries the trolley or trolleys.

BRIDGE TRAVEL: Horizontal travel of the crane parallel with runway rails.

BRIDLE SLING: A sling composed of multiple legs (branches), the top ends of which terminate in a fitting that latches onto the lifting hook.

BULL RING: The main large ring of a sling to which sling legs are attached.

BUMPER (BUFFER): a device for reducing impact when a moving crane or trolley reaches the end of its permitted travel, or when two moving cranes or trolleys come into contact. This device may be attached to the bridge, trolley, or runway stop

CAB: The operator’s compartment on a crane.

CABLE: A term loosely applied to wire ropes, wire strands, manila ropes, and electrical conductors.

CABLE-LAID WIRE ROPE: A type of wire rope consisting of several independent wire ropes laid into a single wire rope.

CABLE CROWD ROPE: A wire rope used to force the bucket of a power shovel into the material being handled.

CANTILEVER TRUCK: A self-loading counterbalanced or non-counterbalanced truck equipped with a cantilever load-engaging means, such as forks (see Figure 10-3).

CARRIAGE: A support structure for forks or attachments, generally roller-mounted, traveling vertically within the mast of a cantilever truck.

CENTER: A single wire or fiber in the center of a strand around which the wires are laid.

CENTER CONTROL: The position near the center of a truck cab from which the operator controls movement of the truck.

CHOKER ROPE: A short wire-rope sling used to form a slip noose around the object to be moved or lifted (see Figure 1-1).

CIRCUMFERENCE: Measured perimeter of a circle circumscribing the wires of a strand or the strands of a wire rope.

CLAMP, STRAND: A fitting used to form a loop at the end of a length of strand; consists of two grooved plates and bolts.

CLEARANCE: The distance by which one object clears another, or the clear space between them.

CLEVIS: A U-shaped fitting with pins.

CLIP: A fitting used to clamp two parts of wire rope.

CLOSED SOCKET: A wire-rope fitting consisting of an integral becket and bail.

CLOSING LINE: Wire rope that closes a clamshell or orange-peel bucket and then operates as a hoisting rope.

COIL: Circular bundle of wire rope not packed on a reel.

COLLECTOR: Contacting device mounted on a bridge or trolley and used to collect current from the conductor system.

COME-ALONG: A portable, hand-operated device consisting of housing, length of chain or wire rope, two hooks, and a ratcheting lever, that is used for miscellaneous pulling.

CONDUCTOR: Wire, angles, bars, tees, or special sections mounted to transmit current to the collectors.

CONICAL DRUM: Grooved hoisting drum of varying diameter.

CONSTRUCTION (WIRE ROPE): Refers to the design of wire rope, including number of strands, number of wires per strand, and arrangement of wires in each strand.



Figure 1-1 Choker Rope.

CONTINUOUS BEND: Reeving of wire rope over sheaves and drums so that it bends in one direction (as opposed to reverse bend).

CONTROLLER: An operator's device for regulating the power delivered to a motor or other equipment.

CONTROLLER, SPRING RETURN: A controller that, when released, will return automatically to a neutral position.

CORE: The center member of a wire rope around which the strands are laid. It may be fiber, a wire strand, or an independent wire rope.

CORING LINE: Wire rope used to operate the coring tool for taking core samples during the drilling of a well.

CORROSION: Chemical decomposition by exposure to moisture, acids, alkalies, or other destructive agents.

CORRUGATED: A term used to describe the grooves of a sheave or drum when worn to show the impression of a wire rope.

COUNTERBALANCED TRUCK: A truck equipped with load-engaging means wherein, during normal transporting, the entire load is external to the polygon formed by the wheel contacts (see Exhibit 10.1).

COVER WIRES: The outer layer of wires.

CRANE: A machine used for lifting and lowering a load vertically and moving it horizontally and that has a hoisting mechanism as an integral part of it. A "crane" has three (3) axis of movement, any less see "Hoist."

CRANES, TYPES OF:

Cab-Operated Crane: a crane whose movements are controlled by an operator through the use of controllers located in a cab that is attached to the crane.

Cantilever Gantry Crane: A gantry or semigantry crane in which the bridge girders or trusses extend transversely beyond the crane runway on one or both sides.

Floor-Operated Crane: A crane whose operation is controlled by use of a pendant in the hands of an operator on the floor or on an independent platform.

Gantry Crane: A crane similar to an overhead crane, except that the bridge for carrying the trolley or trolleys is rigidly supported on two or more legs running on fixed rails or other runway.

Jib Crane: A fixed crane with a vertical rotating member supported at the bottom (also at top in some types) from which an arm extends to carry the hoist trolley. Jib cranes are most commonly mounted on a vertical column, supplied as part of the jib crane, or on existing structural members (e.g., a wall-mounted jib crane). Note: For the purpose of this document and training requirements, a Jib Crane is considered a Hoist.

Mobile Crane: Mobile cranes are defined as wheel-mounted cranes, truck cranes, and crawler cranes.

A **wheel-mounted** crane consists of a rotating structure with power plant, operating machinery, and boom, mounted on a base or platform equipped with axles and rubber-tired wheels for travel. The base is usually propelled by an engine in the superstructure, but it may be equipped with a separate engine controlled from the superstructure (see ASME B30.5-2007 for examples).

A **truck-mounted** crane consists of a rotating superstructure with power plant that operates machinery and boom, mounted on an automotive truck equipped with a power plant for travel. Commercial truck-mounted cranes are included in this category (see ASME B30.5-2007 for examples).

A **crawler crane** consists of a rotating superstructure with power plant, operating machinery, and boom mounted on a base equipped with crawler treads for travel (see ASME B30.5-2007 for examples).

Overhead Traveling Crane: A crane with a movable bridge carrying a movable or fixed hoisting mechanism and traveling on an overhead fixed-runway structure.

Power-Operated Crane: A crane whose mechanism is driven by electricity, air, hydraulics, or internal combustion.

Pulpit-Operated Crane: a crane whose movements are controlled by an operator through the use of controllers located in a control room or a fixed or movable cab or platform that is independent of the crane..

Remote-Operated Crane: A crane whose movements are controlled by an operator through the use of controllers contained in a portable operating station not attached to the crane.

Semigantry Crane: A gantry crane with one end of the bridge rigidly supported on one or more legs running on a fixed rail or runway, the other end of the bridge being supported by a truck running on an elevated rail or runway.

Shop Crane: A Portable Automotive Lifting Device (PALD), self-contained hydraulic and pneumatic-hydraulic crane characterized by a pair of laterally spaced legs, an upright mast, a pivoting boom with a boom extension and hook, and a hydraulic unit. The hydraulic unit moves the boom up and down at a pivot point for the purpose of raising, removing, transporting in the lowered position, and replacing automotive engines, transmissions and other components. Shop cranes have a capacity of 4 tons (8000 pounds) or less.

Wall-Mounted Crane: A crane having a jib, with or without a trolley, supported from a sidewall or line of columns of a building. It is a traveling-type crane and operates on a runway attached to the sidewall or line of columns.

Wall-Mounted Jib Crane: See Cranes, Types of, Jib Crane.

CRITICAL DIAMETER: Diameter of the smallest bend for a given wire rope that permits the wires and strands to adjust themselves by relative movement while remaining in their normal positions.

CYLINDRICAL DRUM: Hoisting drum of uniform diameter.

DECELERATION STRESS: Additional stress imposed on a wire rope due to decreasing the load velocity.

DEDICATED SPOTTER (Power Lines): A person assigned to monitor the separation between the power line and the equipment, load line and load (including rigging and lifting accessories), and ensure through communication with the crane operator that the required minimum approach distance is not breached. The assigned person's sole responsibility is to be the dedicated spotter. The assigned person must meet the same training and qualification criteria as the Qualified Signal Person.

DEFLECTION: Sag of a rope in a span, usually measured at midspan as the depth from a chord joining the tops of the two supports. Any deviation from a straight line.

DESIGN FACTOR: Ratio of ultimate strength of a material to the design working (unit) stress, unless defined otherwise in the text of this volume, for specific applications.

DESIGNATED: Selected or assigned by the employer or the employer's representative as being qualified to perform specific duties.

DESIGNATED LEADER: A qualified person who directly oversees the work being performed by a crane and the associated crew. This person remains at the job site throughout the lift.

DIAMETER: Distance measured across the center of a circle circumscribing the wires of a strand or the strands of a wire rope.

DIESEL-ELECTRIC TRUCK: An electric truck in which the power source is a generator driven by a diesel engine.

DOCKBOARD: A portable or fixed device for spanning the gap or compensating for the difference in level between loading platforms and carriers.

DOG-LEG: Permanent short bend or kink in a wire rope caused by improper use.

DRAGLINE: Wire rope used to pull an excavating or drag bucket.

DRIVE: Motor, coupling, brake and gear case, or gear cases used to propel bridge, trolley, or hoist.

DRIVE GIRDER: A girder on which is mounted the bridge drive, cross shaft, walk, railing, and operator's cab.

DRUM: A cylindrical-flanged barrel of uniform (cylindrical drum) or tapering (conical drum) diameter on which a wire rope is wound for operation or storage. It may be smooth or grooved.

ELASTIC LIMIT: Limit of stress beyond which a permanent deformation takes place within the material. This limit is approximately 55-65% of breaking strength of steel-wire ropes.

ELECTRIC TRUCK: A truck in which the principal energy is transmitted from power source to motor(s) in the form of electricity.

END CONTROL: An operator-control position that is located at the end opposite the load end of the truck.

EQUALIZER: A device that compensates for unequal length or stretch of a hoist rope or chain.

EQUALIZING SLINGS: Slings composed of wire rope and equalizing fittings.

EQUALIZING THIMBLES: A special type of fitting used as a component part of some wire-rope slings.

EYE OR EYE SPLICE: A loop with or without a thimble formed in the end of a wire rope.

FAIL-SAFE: A provision designed to automatically stop or safely control any motion in which a malfunction could occur.

FATIGUE: The tendency of a material to break under repeated stress.

FIBER CENTERS: Cords or rope made of vegetable fiber used in the center of a strand.

FIBER CORES: Cords or rope made of vegetable fiber used in the core of a wire rope.

FIRST POINT: The first setting on the operator's controller that starts crane motion (slowly) in each direction.

FITTING: Any accessory or hardware used as an attachment for wire rope.

FLAG: Mark or marker on a rope to designate position of load.

FLAT ROPE: Wire rope made of parallel alternating right-lay and left-lay ropes sewn together by relatively soft wires.

FLATTENED STRAND ROPE: A wire rope with either oval or triangular strands that present a flattened rope surface.

FLEET ANGLE: Angle between the position of a rope at the extreme end wrap on a drum and a line drawn perpendicular to the axis of the drum through the center of the nearest fixed sheave.

FORKS: Horizontal tine-like projections, normally suspended from the carriage, used to engage and support loads.

FORK HEIGHT: The vertical distance from the floor to the load-carrying surface adjacent to the heel of the forks with the mast vertical, and in the case of reach trucks, with the forks extended.

FORKLIFT TRUCK: A high-lift self-loading truck equipped with load carriage and forks for transporting and tiering loads (see Figure 10-3).

GALVANIZE: To coat with zinc to protect against corrosion.

GALVANIZED ROPE: Rope made of galvanized wire.

GALVANIZED STRAND: Strand made of galvanized wire.

GALVANIZED WIRE: Wire coated with zinc.

GAS-ELECTRIC TRUCK: An electric truck in which the power source is a generator driven by an LP-gas or gasoline engine.

GROMMET: A seven-strand wire-rope sling made from one continuous length of strand or an endless synthetic-web sling.

GROOVED DRUM: Drum with grooved outer surface to accommodate and guide a rope.

GROOVES: Depressions in the outer surface of a sheave or drum for positioning and supporting a rope.

GUY LINE: Strand or rope, usually galvanized, for holding a structure in position.

HANDLING FIXTURE: A cradle, structure, shipping fixture, or container designed specifically to facilitate supporting, lifting or handling a component during fabrication, loading, shipping, storage, or installation.

HIGH-LIFT TRUCK: A self-loading truck equipped with an elevating mechanism designed to permit tiering. Popular types are high-lift platform trucks (see Exhibit 10.1).

HIGH-LIFT PLATFORM TRUCK: A self-loading truck equipped with an elevating mechanism intended primarily for transporting and tiering loaded skid platforms (see Exhibit 10.1).

HOIST: A device used to lift or lower items. A hoist can have no more than two axis of movement otherwise see “Crane.” Note: For the purpose of this document and training requirements, a Jib Crane is considered a Hoist.

HOIST, LEVER OPERATED: A lever-operated manual device used to lift, lower, or pull a load and to apply or release tension.

HOLDING LINE: Wire rope on a clamshell or orange-peel bucket that holds the bucket while the closing line is released to dump the load.

HOOK LOAD: The total live weight supported by the hook of a crane, derrick, or other hoisting equipment, including the load, slings, spreader bars, and other tackle not part of the load, but supported by the hook and required for the handling of the load.

IDLER: Sheave or roller used to guide or support a rope.

INDEPENDENT WIRE ROPE CORE: Wire rope used as the core of a larger rope.

INNER WIRES: All wires of a strand except surface or cover wires.

INSULATED LINK: A connecting device placed between the load hook and the platform rigging, which electrically isolates them. Normally used when working near electrically energized circuits or when electric welding operations are to be performed from the platform.

INTERNAL-COMBUSTION ENGINE TRUCK: A truck in which the power source is a gas or diesel engine.

INTERNALLY LUBRICATED: Wire rope or strand having all wires coated with lubricant.

KINK: Permanent distortion of wires and strands resulting from sharp bends.

LAGGING: External wood covering on a reel of rope or a strand.

LANG-LAY ROPE: Wire rope in which the wires in the strands and the strands in the rope are laid in the same direction.

LAY LENGTH: Lengthwise distance on a wire rope in which a strand makes one complete turnaround the rope’s axis (see Figure 1-2).

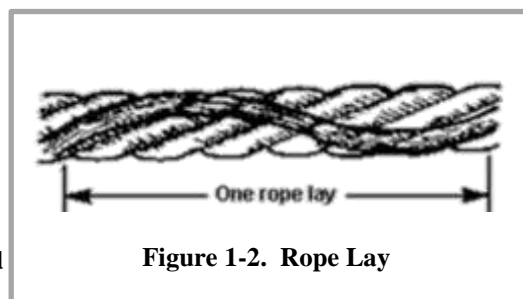


Figure 1-2. Rope Lay

This is an uncontrolled

LIFT: Maximum safe vertical distance through which a hook can travel. The hoisting of a load.

LIFT, CRITICAL: See Section 2.1.1 for the requirements.

LIFT DIRECTOR: A title used by OSHA and ASME to mean a person who directly oversees the work being performed by the hoisting equipment and the associated crew. This person remains at the job site during the lifting operation. For the purpose of this document see “DESIGNATED LEADER.”

LIFT, NON-STANDARD: The load to be lifted is between 50% and 85% of the rated capacity of the mobile crane operating on a rubber surface (Pick and carry).

LIFT, ORDINARY: Any lift not designated as a critical lift or non-standard.

LIFT, PLANNED ENGINEERED: Any lift in excess of the manufacturers rated load capacity of the crane (Fixed Cranes). Planned engineered lifts will always be classified as a “Critical Lift.” No such lift shall be made without the authorization of the AEDC Crane System Engineer. This authorization will only be granted after the AEDC Structural Engineer has reviewed the design of the crane-supporting structure, has inspected the structure as required by ASME B 30 standards and has approved its use for the intended lift.

LINE: A rope used for supporting and controlling a suspended load.

LOAD: The total weight superimposed on the load block or hook.

LOAD BLOCK: The assembly of hook or shackle, swivel, bearing, sheaves, pins, and frame suspended by the hoisting ropes or load chain. This shall include any appurtenances reeved in the hoisting rope or load chain

LOAD-BACKREST EXTENSION: A device extending vertically from the fork carriage frame.

LOAD-BEARING PARTS: Any part of a material-handling device in which the induced stress is influenced by the hook load. A *primary* load-bearing part is a part the failure of which could result in dropping, upset, or uncontrolled motion of the load. Load-bearing parts, which, if failed, would result in no more than stoppage of the equipment without causing dropping, upset, or loss of control of the load are not considered to be primary load-bearing parts.

LOAD CENTER (FORKLIFTS): The horizontal longitudinal distance from the intersection of the horizontal load-carrying surfaces and vertical load engaging faces of the forks (or equivalent load-positioning structure) to the center of gravity of the load.

LOW-LIFT TRUCK: A self-loading truck equipped with an elevating mechanism designed to raise the load only sufficiently to permit horizontal movement (see Exhibit 10.1).

MAGNET: An electromagnetic device carried on a crane hook and used to pick up loads.

MAIN HOIST: The primary hoist mechanism provided for lifting and lowering the maximum-rated load.

MAN TROLLEY: A trolley having an operator’s cab attached to it.

MARLINE SPIKE: Tapered steel pin used in splicing wire rope.

MESSENGER STRAND: Galvanized strand or bronze strand used to support telephone and electrical cables.

MODULUS OF ELASTICITY: Mathematical quantity giving the ratio, within the elastic limit, between a definite range of unit stress on a wire rope and the corresponding elongation.

MOUSING: A method of bridging the throat opening of a hook to prevent the release of load lines and slings, under service or slack conditions, by wrapping with soft wire, rope, heavy tape, or similar materials.

NARROW-AISLE TRUCK: A self-loading truck intended primarily for right angle stacking in aisles narrower than required by counterbalanced trucks of the same capacity (see Exhibit 10.1).

NONDESTRUCTIVE EXAMINATION (NDE): The development and application of technical methods to examine materials or components, in ways that do not impair future usefulness and serviceability, in order to detect, locate, measure, and evaluate discontinuities, defects, and other imperfections; to assess integrity, properties, and composition; and to measure geometrical characteristics.

NONDESTRUCTIVE TESTING (NDT): See NONDESTRUCTIVE EXAMINATION.

NONROTATING WIRE ROPE: See ROTATION-RESISTANT WIRE ROPE.

NON-STANDARD LIFT: See LIFT, NON-STANDARD

ON-THE-JOB EVALUATION (OJE): A practical evaluation of operator skills, which demonstrates, in a timed event, their abilities to safely operate hoisting equipment or perform rigging operations.

ON-THE-JOB PROFICIENCY EVALUATOR (OJPE): A person designated by management to conduct OJE.

OPEN SOCKET: A wire-rope fitting consisting of a basket and two ears with a pin.

ORDER-PICKER TRUCK, HIGH-LIFT: A truck, controllable by an operator stationed on a movable platform, which has a load-engaging means, and is intended for (manual) stock selection. The truck may be capable of self-loading and/or tiering (see Exhibit 10.1).

OVERHEAD GUARD: A framework fitted to a truck over the head of a riding operator.

PALLET TRUCK: A self-loading, non-motorized or motorized low-lift truck equipped with wheeled forks of dimensions sized to go between the top and bottom boards of a double-faced pallet, the wheels fitting into spaces between the bottom boards, to raise the pallet. (see Exhibit 10.2).

PEENING: Permanent distortion of the outside wire, in a wire rope, caused by pounding.

PERIODIC INSPECTION: A complete, documented, inspection of the piece of in-use hoisting equipment, conducted at least annually, not to exceed one year. This inspection can be conducted sooner than one year depending on the use. The inspection expiration date shall be one day prior to the anniversary date of the previous periodic inspection. The crane may remain in service on the expiration date but shall be taken out of service the following day and remain out of service until the next periodic inspection is completed. For example, if a crane is inspected 30 June, the expiration date shall be 29 June of the following year. The date of the inspector's signature on the inspection tag is the official inspection date, from which the inspection expiration date is determined.

PERSON-IN-CHARGE (PIC): The manager or other responsible person (other than the equipment operator) known to be qualified and appointed to be responsible for the safe handling of critical loads.

POWERED INDUSTRIAL TRUCK: A mobile, power-driven vehicle used to carry, push, pull, lift, stack, or tier material.

PRECISION LOAD POSITIONING DEVICES: A rigging accessory designed specifically to precisely raise and lower a load through a limited range of lifting/lowering motion (stroke). Standards units typically have 12 in. (30 cm) stroke and can position a load within 0.001 in. (0.025 mm). These devices commonly include a built-in load scale and serve as a load-indicating device.

PREFORMED WIRE ROPE: Wire rope in which the strands are permanently shaped, before being fabricated into the rope, to the helical form they assume in the wire rope.

PREFORMED STRAND: Strand in which the wires are permanently shaped, before being fabricated into the strands, to the helical form they assume in the strand.

PRE-STRESSING: Stressing a wire rope or strand before use under such a tension and for such a time that stretch that would otherwise occur once the load is picked up is largely nonexistent.

PROOF LOAD: A specific load applied in the performance of a proof test.

PROOF TEST: A nondestructive tension (load) test performed to verify construction and workmanship of slings or rigging accessories.

PUBLIC CARRIER: A for-hire company engaged in the public transportation of goods.

QUALIFIED: A person who, by possession of a recognized degree, certificate, or professional standing, or who, by extensive knowledge, training, and experience, successfully demonstrated an ability to solve or /resolve problems relating to the subject matter, the work, or the project.

QUALIFIED ENGINEER/QUALIFIED ENGINEERING ORGANIZATION: An engineer or engineering organization whose competence in evaluation of the type of equipment in question has been demonstrated to the satisfaction of the responsible manager.

QUALIFIED INSPECTOR: One whose competence is recognized by the responsible manager and whose qualification to perform specific inspection activities has been determined, verified, and attested to in writing.

QUALIFIED OPERATOR: One who has had appropriate and approved training, including satisfactory completion of both written and operational tests to demonstrate knowledge, competence, and skill, in the safe operation of the equipment to be used.

QUALIFIED RIGGER: One who meets the definition of a “qualified person” as it applies to the assigned rigging tasks. Employers must determine whether a person is qualified to perform specific rigging tasks. Each qualified rigger may have different credentials or experience. The person designated as the qualified rigger must have the ability to properly rig the load for a particular job. This does not mean that a rigger must be qualified to do every type of rigging job.

QUALIFIED SIGNAL PERSON: A qualified person who has met the requirements of 29 CFR 1926.1428 and has successfully passed the required oral or written test and a practical evaluation.

NOTE: The term “rigger” or “qualified rigger” in this handbook refers to the function performed, and in no way relates to the worker’s classification in any union or bargaining unit.

RATED CAPACITY: The maximum hook load that a piece of hoisting equipment is designed to carry the maximum load that an industrial truck or a sling, hook, shackle, or other rigging tackle is designed to carry.

NOTE: At the option of the user, a rated capacity can be assigned that is less than the design-rated capacity.

REACH TRUCK: A self-loading truck, generally high-lift, having load-engaging means mounted so it can be extended forward under control to permit a load to be picked up and deposited in the extended position and transported in the retracted position (see Exhibit 10.1).

REEL: The flanged spool on which wire rope or strand is wound for storage or shipment.

REEVING: A system in which a rope or chain travels around drums, sprockets, or sheaves.

REGULAR-LAY ROPE: Wire rope in which the wires in the strands and the strands in the rope are laid in opposite directions.

REVERSE BEND: Reeving of a wire rope over sheaves and drums so that it bends in opposite directions.

RIDER TRUCK: A truck that is designed to be controlled by a riding operator.

RIGGER: See Qualified Rigger

RIGGING: The hardware or equipment used to safely attach a load to a lifting device. The art or process of safely attaching a load to a hook by means of adequately rated and properly applied slings and related hardware.

ROLLERS: Relatively small-diameter cylinders or wide-faced sheaves used for supporting or guiding ropes.

ROTATION-RESISTANT WIRE ROPE: Wire rope consisting of a left-lay, lang-lay inner rope covered by right-lay, regular-lay outer strands.

RUNNING SHEAVE: A sheave that rotates as the load block is raised or lowered.

RUNWAY: Assembly of rails, girders, brackets, and framework on which a crane operates.

SAFE WORKING LOAD: Load that a rope may carry economically and safely.

SEALE: A strand construction having one size of cover wires with the same number of one size of wires in the inner layer and each layer having the same length and direction of lay. Most common construction is one center wire, nine inner wires, and nine cover wires.

SEIZE: To securely bind the end of a wire rope or strand with seizing wire or strand.

SEIZING STRAND: Small strand, usually of seven wires, made of soft-annealed-iron wire.

SEIZING WIRE: A soft-annealed-iron wire.

SELF-LOADER: A truck with tires that can fit between the top and bottom boards of a double-faced pallet.

SERVE: To cover the surface of a wire rope or strand with a wrapping of wire.

SHACKLE: a U-shaped load-bearing connector designed to be used with a removable pin.

SHALL: A word indicating a mandatory action.

SHEAVE: A grooved wheel or pulley used with a rope to change direction and point of application of a pulling force.

SHEAVE, NON-RUNNING (EQUALIZER): A sheave used to equalize the tension in opposite parts of a rope, called non-running because of its slight movement.

SHEAVE, RUNNING: A sheave that rotates as the load block is lifted or lowered.

SHOULD: A word indicating a recommended action, the advisability of which depends on the facts in each situation.

SIDE LOADER: A self-loading truck, generally high-lift, having load-engaging means mounted in such a manner that it can be extended laterally under control to permit a load to be picked up and deposited in the extended position and transported in the retracted position (see Exhibit 10.1).

SIDE PULL: a component of the hoist pull acting horizontally when the hoist lines are not operated vertically.

SIGNAL PERSON: see “QUALIFIED SIGNAL PERSON.”

SITE SUPERVISOR: An ASME B30 role meaning a person who exercises supervisory control over the work site on which the hoisting equipment is being used and over the work that is being performed on that site. For the purpose of this document see “ASSET OWNER.”

SLINGS: Wire ropes, chains, synthetic web, and metal mesh made into forms, and with or without fittings, for handling loads.




















SLINGS, BRAIDED: Very flexible slings composed of several individual wire ropes braided together.

SMOOTH-FACED DRUM: Drum with a plain, not grooved, face.

SPAN: The horizontal, center-to-center distance of runway rails.

ANY BOLT ON THIS LIST SHOULD BE TREATED AS DEFECTIVE WITHOUT FURTHER TESTING

ALL GRADE 5 AND GRADE 8 FASTENERS OF FOREIGN ORIGIN WHICH DO NOT BEAR ANY MANUFACTURE HEADMARKS:

GRADE 5		GRADE 8	
GRADE 5 FASTENERS WITH THE FOLLOWING HEADMARKS:			
MARK	MANUFACTURER	MARK	MANUFACTURER
	J Inn Her (TW)		KS Kosaka Kogyo (JP)
GRADE 8 FASTENERS WITH THE FOLLOWING HEADMARKS:			
MARK	MANUFACTURER	MARK	MANUFACTURER
	A Asahi Mfg (JP)		KS Kosaka Kogyo (JP)
	E Daitai (JP)		M Minamida Sogyo (JP)
	FM Fastener Co. of Japan (JP)		MS Minato Kogyo (JP)
	H Hiramoto Metal (JP)		NF Nippon Fasteners (JP)
	J Inn Her (TW)		RT Takai Ltd (JP)
	KY Kyocel Mfg (JP)		UNY Unyite (JP)
	Hollow Inlaco (CA, TW, JP, YU) (Greater than 1/2 inch diameter)		
GRADE 8.2 FASTENERS WITH THE FOLLOWING HEADMARKS:			
MARK	MANUFACTURER		
	KS Kosaka Kogyo (JP)		
GRADE A325 FASTENERS (BENNETT DENVER TARGET ONLY) WITH THE FOLLOWING HEADMARKS:			
MARK	MANUFACTURER		
Type 1 	A325KS Kosaka Kogyo (JP)		
Type 2 	A325KS Kosaka Kogyo (JP)		
Type 3 	A325KS Kosaka Kogyo (JP)		

KEY: CA - CANADA JP - JAPAN TW - TAIWAN YU - YUGOSLAVIA

AUGUST 1992

Figure 1-4. Suspect Headmark List

SPIRAL GROOVE: Groove that follows the path of a helix around a drum, similar to a screw.

SPLICING: Interweaving of two ends of rope to make a continuous or endless length without appreciable increasing the diameter. Also refers to making a loop or eye in the end of a rope by tucking the ends of the strands.

SPLICE, HAND TUCKED: A loop or eye formed in the end of a rope by tucking the end of the strands back into the main body of the rope in a prescribed manner.

SPLICE, MECHANICAL: A loop or eye formed in the end of a wire rope by pressing or swaging one or more metal sleeve over the wire rope junction.

SPOTTER (Power Line): see “DEDICATED SPOTTER”

STABILITY EQUILIBRIUM: A State in which opposing forces are balanced.

STAINLESS-STEEL ROPE: Wire rope made of chrome-nickel steel wires having great resistance to corrosion.

STEEL-CLAD ROPE: Rope with individual strands spirally wrapped with flat steel wire.

STRAND: An arrangement of wires helically laid about an axis or another wire or fiber center to produce a symmetrical section.

SUSPECT/COUNTERFEIT ITEMS (S/CI): (Figure 1-4)

A suspect item is one in which visual inspection, testing, or other means indicate it may not conform to established Government or industry-accepted specifications or to national consensus standards.

A counterfeit item is a suspect item that has been copied or substituted without legal right or authority to do so or one whose material, performance, or characteristics are knowingly misrepresented by the vendor, distributor, supplier, or manufacturer.

SWAGED FITTINGS: Fittings in which wire rope is inserted and attached by a cold-forming method.

SWITCH, ELECTRIC: A device for making, breaking, or changing the connections in an electrical circuit.

SWITCH, EMERGENCY STOP: A manually or automatically operated electric switch to cut off electric power independently of the regular operating controls.

SWITCH, LIMIT: A switch that is operated by some part or motion of a power-driven machine or equipment to alter the electrical circuit associated with the machine or equipment.

SWITCH, MAIN: A switch controlling the entire power supply to a crane or other equipment, often called the disconnect switch.

TAG LINE: A rope used to prevent rotation of a load.

TAPERING AND WELDING: Reducing the diameter of the end of a wire rope and welding it to facilitate reeving.

THIMBLE: Grooved metal fitting to protect the eye of a wire rope (Figure 1-5).



Figure 1-5. Thimble

TIERING: The process of placing one load on or above another.

TINNED WIRE: Wire coated with tin.

TROLLEY: A unit consisting of frame, trucks, trolley drive, and hoisting mechanism moving on the bridge rails in a direction at right angles to the crane runway.

TROLLEY GIRTS: Structural members that are supported on the trolley trucks and that contain the upper sheave assemblies.

TROLLEY TRAVEL: Horizontal travel of a trolley at right angles to runway rails.

TROLLEY TRUCK: An assembly consisting of wheels, bearings, axles, and structural-supporting hoist mechanism and load girts.

TRUCK, POWERED INDUSTRIAL: A mobile, power-propelled truck used to carry, push, pull, lift, stack, or tier material (see Figure 10-3).

TURNBUCKLE: A device attached to wire rope for making limited adjustments in length. It consists of a barrel and right- and left-hand threaded bolts.

TWO-BLOCKING: The act of continued hoisting in which the load-block and head-block assemblies are brought into physical contact, thereby preventing further movement of the load block and creating shock loads to the rope and reeving system.

VERIFICATION: A procedure in which a design, calculation, drawing, procedure, instruction, report, or document is checked and signed by one or more parties. The one or more persons designated to sign verify, based on personal observation, certified records, or direct reports, that a specific action has been performed in accordance with specified requirements.

WEDGE SOCKET: Wire-rope fitting in which the rope end is secured by a wedge.

WHEEL BASE: Distance between centers of outermost wheels for bridge and trolley trucks.

WHEEL LOAD: The load on any wheel with the trolley and lifted load (rated load) positioned on the bridge to give maximum-loading conditions.

WIRE ROPE: Wire strands laid helically around an axis or a core.

WIRE (ROUND): Single continuous length of metal, cold drawn from a rod.

WIRE (SHAPED): A single continuous length of metal either cold drawn or cold rolled from a rod.

2.0 CHAPTER 2 - CRITICAL / NON-STANDARD / ORDINARY LIFTS

This chapter provides guidelines for critical / non-standard / ordinary lift determination and requirements for planning and performing each classification of lift safely and judiciously. A **qualified and competent** person shall classify each lift critical, non-standard, or ordinary prior to planning the lift, based on the following criteria.

2.1 CRITICAL / NON-STANDARD / ORDINARY LIFT DETERMINATION

2.1.1 A lift shall be designated CRITICAL if any of the following conditions are met:

2.1.1.1 Any lift that involves the lifting of people. (Chapter 4 has been devoted to the subject, and is to be referred to for guidance and documentation requirements.)

2.1.1.2 The lift involves lifting or movement of explosives. Written procedures and operations must be validated/verified using an inert prototype for all first time lifts involving explosives. Documented validation/verification obtained from the test customer will satisfy this requirement.

2.1.1.3 The lift involves the use of two cranes to lift a common load, when the load exceeds 50% of either crane's rated capacity.

2.1.1.4 The item being lifted contains radioactive or other hazardous materials or chemicals, which if dropped or upset could result in a release/spill that meets State or Federal reporting criteria.

2.1.1.5 Additional requirements specific to FIXED CRANES.

2.1.1.5.1 Any planned engineered lift.

2.1.1.5.2 Any lift that exceeds 95% of the rated load capacity.

2.1.1.6 Additional requirements specific to MOBILE CRANES.

2.1.1.6.1 Lifts in vicinity of overhead power lines. The minimum clearance under most conditions is 20 feet. This means, if any part of the equipment, load line or load, if operated up to the equipment's maximum working radius in the work zone, could get closer than 20 feet to a power line. (See paragraph 9.6)

2.1.1.6.2 The lift involves lifting in excess of 85% of the crane's rated capacity, as shown on the applicable crane manufacturer's load charts for the configuration to be used.

2.1.1.6.3 Use of a crane or lifting device in any application, which deviates from the manufacturer's recommendations, including but not limited to:

- Boom configuration not per boom make-up chart.
- Moving a crane with longer boom than recommended.
- Exceeding capacities or restrictions shown on the load chart.

2.1.1.6.4 Operations, which require traveling the crane while carrying a load of 85% of the crane manufacturer's rated pick and carry capacity.

2.1.1.7 Any lift deemed critical by management, AEDC Crane **System** Engineer or the **base operating contractor's** safety office. Some additional conditions that should be taken into consideration that do not automatically classify the lift as critical are as follows:

2.1.1.7.1 The cost to replace or repair the load item, or the delay in operations of having the load item damaged would have a negative impact on facility, organizational, or AEDC budgets to the extent that it would affect program commitments.

2.1.1.7.2 The load item is unique and, if damaged, would be irreplaceable or not repairable and is vital to a system, facility, or project operation.

2.1.1.7.3 Lifts that are made where the load or crane could fall on pipelines or storage vessels containing flammable gases or liquids.

2.1.1.7.4 Lifts where the crane or load is in a confined space.

2.1.1.7.5 Lifts over active work areas, office buildings, or public access ways.

2.1.1.7.6 Lifts using rigs over 150-ton capacity and/or 200 feet of boom.

2.1.1.7.7 Lifts with attachment points at or below CG.

2.1.1.7.8 Further site-specific criteria may be developed to supplement those cited above and may include loads which require exceptional care in handling because of size, weight, close-tolerance installation or high susceptibility to damage as well as lifts using multiple pieces of lifting equipment.

2.1.2 A lift shall be designated NON-STANDARD if the following condition is met:

2.1.2.1 The load to be lifted is between 50% and 85% of the rated capacity of the mobile crane.

2.1.3 A lift shall be designated ORDINARY if the lift is not designated as a critical lift or non-standard lift.

2.2 CRITICAL / NON STANDARD / ORDINARY LIFT REQUIREMENTS

2.2.1 Lifts classified as CRITICAL shall be performed in accordance with the following requirements before initiating the lift:

2.2.1.1 The operating organization **conducting the lift** shall appoint a Person-in-Charge (PIC), along with sufficient numbers of employees to ensure the lift can be completed safely, for the entire operation. The PIC shall meet the definitions of appointed, designated, and qualified as described in Chapter 1 and shall be present at the lift site during the entire lifting operation.

2.2.1.2 The PIC shall ensure that a **Critical Lift Plan is** prepared that defines the operation and includes the following:

2.2.1.2.1 Identification of the items to be moved, the weight, dimensions, and center of gravity of the load, stability analysis, and any hazardous or toxic materials that are present.

2.2.1.2.2 Identification of operating equipment to be used by type and rated capacity.

2.2.1.2.3 Rigging sketches that include (as applicable):

- Identification and rated capacity of slings, lifting bars, rigging accessories, and below-the-hook lifting devices.
- Load-indicating devices.
- Load vectors.
- Lifting points.
- Sling angles.
- Boom and swing angles.
- Methods of attachment.
- Crane orientations.

- Stability Analysis.
 - Other factors affecting equipment capacity.
- 2.2.1.2.4 Operating procedures and special instructions to operators including rigging precautions and safety measures to be followed as applicable.
- 2.2.1.3 Experienced operators who have been trained and qualified to operate the specific equipment to be used shall be **approved** by the PIC **before being assigned the task**.
- 2.2.1.4 Only **one qualified signal person at a time** shall give signals to the operator. However, the operator shall obey a STOP **or Emergency Stop** signal at all times, no matter who gives the signal.
- 2.2.1.5 The procedure and rigging sketches shall be reviewed and approved by the AEDC Crane **System** Engineer (or designee) and the responsible oversight organization (such as safety, quality assurance, or quality control) before the lift is made.
- 2.2.1.6 A pre-lift meeting(s) involving participating personnel shall be conducted and documented prior to making a critical lift. The critical lift plan/procedure shall be reviewed and questions shall be resolved.
- 2.2.1.7 If required by the critical lift procedure, a practice lift shall be performed before the critical lift. Conditions for a practice lift should closely simulate actual conditions involving: weight, rigging selection and configuration, load movement path, and other relevant factors. **The same assigned craftsmen shall perform the practice lift and the actual lift**, using the same lifting equipment during each lift.
- 2.2.2 Lifts classified as **NON-STANDARD** shall require a pre-lift meeting(s), involving participating personnel, to be conducted and documented prior to making the non-standard lift. The non-standard lift plan / procedure shall be reviewed and questions shall be resolved.
- 2.2.3 Lifts classified as **ORDINARY** shall be performed in accordance with the requirements for ordinary lifts specified in each section of this handbook for each particular equipment category.

2.3 CRITICAL LIFT PLAN APPROVALS

2.3.1 As a minimum, critical lift plans shall be approved in writing by:

2.3.1 Person-In-Charge (PIC)

2.3.1.1 Appropriate members of the lift team (rigger, crane operator)

2.3.1.2 AEDC Crane System Engineer

2.3.1.3 Base operating contractor's Asset Owner of item(s) to be lifted or at risk.

2.3.2 Within the scope of the contract, the base operating contractor's Chief Engineer shall ensure an appropriate level of review/approval is conducted for all critical lifts with special attention to lifts utilizing lift points below the center of gravity, need for a stability analysis, and/or lifting of explosives.

2.3.3 Critical lift plans for test articles and/or explosives shall be coordinated with the accountable AEDC Division Chief or designee.

Lift

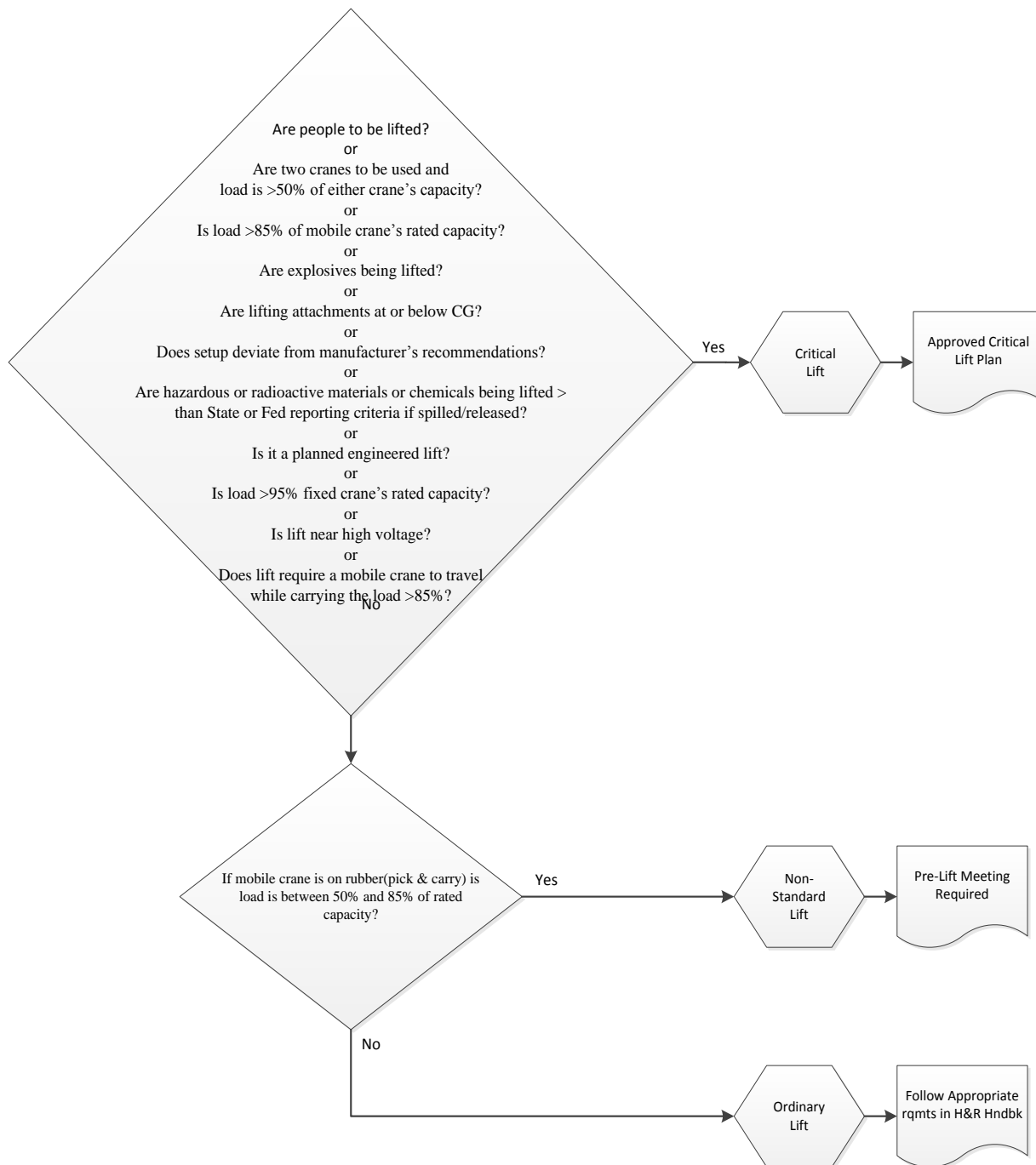
Exhibit 2.1 Critical Lift Matrix

Exhibit 2.2 Critical Lift Plan (Example)

SECTION I: APPROVALS AND DOCUMENTATION	
A. IDENTIFICATION	
Job Number:	Location:
Lift Identification Name:	
Date of Lift:	Time:
Lift Description/Type Operation:	
B. APPROVALS (SIGNATURES REQUIRED)	
Note: The minimum AEDC requirements for Critical Lift Plan coordination, approvals and documentation are in paragraph 2.3. The format is at the discretion of the Asset Owner or PIC.	
C. ATTACHMENTS (AS APPLICABLE)	
	1. Operator Certifications
	2. Capacity Certificates & Inspection Reports for Crane and All Lifting Equipment
	3. Inspection Reports for all Rigging Equipment
	4. Rigging Diagram
	5. Free Body Diagram
	6. Stability Analysis
	7. JSA/Hazard Analysis
	8. Engineering structural analysis and inspection documentation of support structure, if lift is a planned engineered lift.
	9. Stability Analysis for PIC Training

SECTION II: PRE-LIFT PLANNING			
	Pre-Lift Checklist to be completed by the PIC	(Initials)	
		Yes	No
1.	Has an inventory of equipment been done?		
2.	Have weather conditions been considered?		
3.	Have the general safety precautions been reviewed? Such as: PPE, Body placement, Danger zones, etc.		
4.	Have the electrical safety procedures been reviewed? Such as: Overhead power lines, electrical buss in area, etc.		
5.	Have the safe rigging practices been implemented?		
6.	Have the safety precautions been reviewed? Such as: Tag lines, Landing area, Fall Protection, etc.		
7.	Is all rigging designed for the application?		
8.	Has a method of attachment and handling been determined?		
9.	Are all lifting lugs/attachment engineered to specifications?		
10.	Have the cribbing mats/blocks/dunnage used under for outrigger floats been inspected and approved?		
11.	Has the stability of the ground been assured?		
12.	Is a tag line going to be used?		
13.	Have disconnecting/connecting means been developed? (i.e. Does someone have to climb on the load?)		
14.	Has the orientation of equipment been confirmed?		
15.	Is survey equipment required?		
16.	Is a Pre-Lift Meeting planned?		
17.	Are all required approvals signed including outside oversight, when required as directed by OGM?		

Prepared by Name: (print):				Initials:	
SECTION III - LOAD AND CAPACITY CALCULATIONS (MOBILE CRANE)					
A. WEIGHT OF EQUIPMENT BEING LIFTED - WITHOUT RIGGING					
1. Weight of Equipment Empty		lbs.			
2 Weight of Attachments:					
a. Piping and Accessories		lbs.			
b. Liquids Inside		lbs.			
c. Dirt and Debris		lbs.			
d. Internal Trays or Liners		lbs.			
e. Miscellaneous		lbs.			
3. Total Weight of equipment		lbs.			
B. TOTAL LOAD					
Erection Crane					
1. Percent of Equipment Weight		%	7. Weight of Jib Erected		lbs.
2. Amount of Equipment Weight		lbs.	Stored		lbs.
3. Weight of Headache Ball		lbs.	8. Weight of Jib Headache Ball		lbs.
4. Weight of Block		lbs.	9. Weight of Cable (Load Fall)		lbs.
5. Weight of Lifting Bar		lbs.	10. Auxiliary Boom Head		lbs.
6. Weight of Slings and Shackles		lbs.	11. Other:		lbs.
TOTAL WEIGHT			lbs.		
Tailing Crane					
1. Percent of Equipment Weight		%	7. Weight of Jib Erected		lbs.
2. Amount of Equipment Weight		lbs.	Stored		lbs.
3. Weight of Headache Ball		lbs.	8. Weight of Jib Headache Ball		lbs.
4. Weight of Block		lbs.	9. Weight of Cable (Load Fall)		lbs.
5. Weight of Lifting Bar		lbs.	10. Auxiliary Boom Head		lbs.
6. Weight of Slings and Shackles		lbs.	11. Other:		lbs.
TOTAL WEIGHT			lbs.		
Source of Load Weight:	(Name Plate, Drawings, Calculated, Weighed)				
Weight Verified By:	(Print/Sign)				

Prepared by Name: (print):	Initials:
C. CAPACITIES OF THE CRANE	
Erection Crane Configuration	
1. Type of Crane:	
2. Rated Capacity (Tons):	
3. Lifting Arrangement	
a. Max. Radius during Lift (under load)	_____ Ft.
b. Length of Boom	_____ Ft.
c. Angle of Boom at Pick	_____ Deg.
d. Radius of Boom at Set	_____ Ft.
e. Rated Capacity under Most Severe Conditions	
1. Over Rear	_____ Lbs.
2. Over Front	_____ Lbs.
3. Over Side	_____ Lbs.
f. Rated Capacity, Per Crane's Load Chart	_____ Lbs.
4. Jib	
a. Is the Jib to be used?	_____ Yes/No
b. Length of Jib	_____ Ft.
c. Jib Angle (to main boom)	_____ Deg.
d. Rated Jib Capacity, Per Crane's Load Chart	_____ Lbs.
5. Cable	
a. Number of Parts	_____
b. Size of Cable	_____ Inch
c. Maximum Capacity	_____ Lbs.
D. PERCENT OF CRANES CAPACITY	
$\frac{\text{Total Weight} \times 100}{\text{Rated Capacity}} = \text{_____} \%$	
E. SIZING OF SLINGS	
1. Sling Selection	
a. Type of Arrangement	_____
b. Number of Slings to Hook	_____
c. Sling Size	_____ Inch
d. Sling Length	_____ Ft.
e. Rated Capacity	_____ Lbs.

Prepared by Name: (print):	Initials:
C. CAPACITIES OF THE CRANE (continued)	
Trailing Crane Configuration	
1. Type of Crane:	
2. Rated Capacity (Tons):	
3. Lifting Arrangement	
a. Max. Radius during Lift (under load)	_____ Ft.
b. Length of Boom	_____ Ft.
c. Angle of Boom at Pick	_____ Deg.
d. Radius of Boom at Set	_____ Ft.
e. Rated Capacity under Most Severe Conditions	
1. Over Rear	_____ Lbs.
2. Over Front	_____ Lbs.
3. Over Side	_____ Lbs.
f. Rated Capacity, Per Crane's Load Chart	_____ Lbs.
4. Jib	
a. Is the Jib to be used?	_____ Yes/No
b. Length of Jib	_____ Ft.
c. Jib Angle (to main boom)	_____ Deg.
d. Rated Jib Capacity, Per Crane's Load Chart	_____ Lbs.
5. Cable	
a. Number of Parts	_____
b. Size of Cable	_____ Inch
c. Maximum Capacity	_____ Lbs.
D. PERCENT OF CRANES CAPACITY	
Total Weight x 100 Rated Capacity	= _____ %
E. SIZING OF SLINGS	
1. Sling Selection	
a. Type of Arrangement	_____
b. Number of Slings to Hook	_____
c. Sling Size	_____ Inch
d. Sling Length	_____ Ft.
e. Rated Capacity	_____ Lbs.

Prepared by Name: (print):		Initials:	
SECTION IV - LOAD AND CAPACITY CALCULATIONS (FIXED CRANE)			
A. CRANE CONFIGURATION			
Hoisting from:			
Main Crane Main Hoist		Second Crane Main Hoist	
Rated Load Capacity:		Rated Load Capacity	
Main Crane Auxiliary Hoist		Second Crane Auxiliary Hoist	
Rated Load Capacity:		Rated Load Capacity:	
B. LOAD CALCULATIONS			
Main Crane			
Main Hoist		Auxiliary Hoist	
1. Net Equipment Weight	Lbs.	1. Net Equipment Weight	Lbs.
2. Weight of Lifting Beam	Lbs.	2. Weight of Lifting Beam	Lbs.
3. Weight of Slings and Shackles	Lbs.	3. Weight of Slings and Shackles	Lbs.
4. Other	Lbs.	4. Other	Lbs.
TOTAL WEIGHT OF LOAD	Lbs.	TOTAL WEIGHT OF LOAD	Lbs.
Rated Load Capacity	Lbs	Rated Load Capacity	Lbs.
% Rated Load Capacity	%	% Rated Load Capacity	%
(% Rated Load Capacity = Total Weight X 100 / Rated Capacity)			
Second Crane			
Main Hoist		Auxiliary Hoist	
1. Net Equipment Weight	Lbs.	1. Net Equipment Weight	Lbs.
2. Weight of Lifting Beam	Lbs.	2. Weight of Lifting Beam	Lbs.
3. Weight of Slings and Shackles	Lbs.	3. Weight of Slings and Shackles	Lbs.
4. Other	Lbs.	4. Other	Lbs.
TOTAL WEIGHT OF LOAD	Lbs.	TOTAL WEIGHT OF LOAD	Lbs.
Rated Load Capacity	Lbs	Rated Load Capacity	Lbs.
% Rated Load Capacity	%	% Rated Load Capacity	%
(% Rated Load Capacity = Total Weight X 100 / Rated Capacity)			
Margin of Safety _____ pounds (Rated load minus below the hook load)			
Prepared by Name: (print):		Initials:	

C. BELOW THE HOOK WEIGHT CALCULATIONS (NET LOAD/RIGGING)

Description of Load: _____

Net Load Weight: _____

Source of Load Weight: _____

(Name Plate, Drawings, Calculated, Weighed)

Center of Gravity Established _____

Vertical: _____

Horizontal: _____

Lift Points Above Center of Gravity (Yes / No) _____

Lifting Beam: Capacity _____ Lbs.

Weight _____ Lbs.

Rigging

Slings: Number to Hook _____

Sling Size _____ Inch

Sling Length _____ Ft.

Rated Capacity _____ Lbs.

Number of Slings _____

Total Weight of Slings: _____ Lbs.

Shackles: Number to Sling _____

Shackle Size _____ Inch

Rated Capacity _____ Lbs.

Number of Shackles _____

Total Weight of Shackles: _____ Lbs.

Eyebolts: Number to Load _____

Eyebolt Size _____ Inch

Rated Capacity _____

Number of Eyebolts _____

Total Weight of Eyebolts: _____ Lbs.

Total Weight of Rigging: _____ Lbs.

D. CRANE LIMITATIONS

Wind Speed (If Applicable) _____

(If more than 20 MPH delay the lift, unless the manufacturer instructions indicate less.)

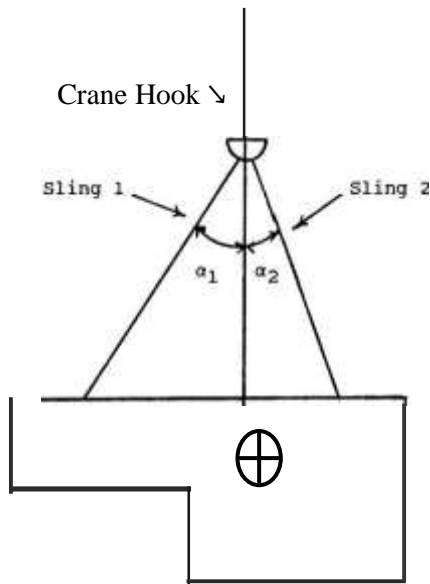
Load Line: Number of Parts _____

Size of Cable _____ Inch

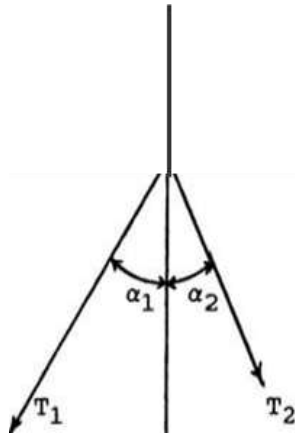
Maximum Capacity _____ Lbs.

Exhibit 2.3 Critical-Lift Pre-Lift Meeting Subjects

- Method of Communications.
- Pre-Lift Inspection of Area.
- Pre-Lift Operational Check of Crane
- Discussion of Responsibilities:
- Site Manager/Project Manager
- PIC
- Crane Operator(s)
- Rigger(s)
- Crane System Engineer (if applicable)
- Site Safety Representative

Exhibit 2.4 Example of Free Base / Lift Geometry Diagram

W

LIFT GEOMETRY**FREE BODY DIAGRAM**

W = Weight of load, lb.

 α_1 = Angle from vertical of sling 1 (in degrees) α_2 = Angle from vertical of sling 2 (in degrees) T_1 = Tension in sling 1 (in pounds) T_2 = Tension in sling 2 (in pounds)Problem: Find T_1 and T_2 when α_1 , α_2 and W are known.

Solution: For equilibrium to exist, the summation of forces in both the vertical and horizontal directions must be equal to zero.

Therefore: a) Vertical direction:

$$\cos \alpha_1 (T_1) + \cos \alpha_2 (T_2) = W$$

b) Horizontal direction:

$$\sin \alpha_1 (T_1) = \sin \alpha_2 (T_2)$$

Let: W = 100,000 lb.

$$\alpha_1 = 40 \text{ degrees}$$

$$\alpha_2 = 20 \text{ degrees}$$

$$\sin 40 = 0.643$$

$$\cos 40 = 0.766$$

$$\sin 20 = 0.342$$

$$\cos 20 = 0.940$$

Then: a) $0.766 (T_1) + 0.940 (T_2) = 100,000$

$$b) 0.643 (T_1) = 0.342 (T_2)$$

Solving b): $T_2 = (0.643/0.342) T_1 = 1.880 (T_1)$ Solving a): $0.766 (T_1) + 0.940 (1.880) T_1 = 100,000$
 $2.533 (T_1) = 100,000$
 $T_1 = 39,474 \text{ lb.}$ Solve for T_2 : $T_2 = 1.880 \times 39,474 \text{ lb.}$
 $T_2 = 74,211 \text{ lb.}$ As can be seen Sling 2 carries 1.9 times the load of Sling 1 ($74,211/39,474 = 1.9$)

Exhibit 2.5 Critical Lift Pre-lift Crane Checkout Checklist

- _____ 1. The crane operator(s) and PIC are to discuss and understand the method of communications, hand signals or radio. For fixed cranes, if not indicated on crane, it should be understood between the operator and PIC the intended east, west, etc. directions

NOTE: Steps 2 through 8 are intended to serve as pre-lift crane checkouts. If during the checkouts any anomalies are found, **STOP** the operation and notify the PIC or engineering. If at any step this procedure has to be stopped for repair or anomalies, steps 1 thru 5 shall be repeated in order as listed.

CAUTION: All persons involved in the critical lift pre-checks shall have hard hats, safety glasses, safety shoes, gloves, and any other PPE that would further contribute to the safety of this operation.

- _____ 2. Using the same method of calls established in step No. 1 the PIC is to direct the operator to execute the following operations. If during these operations any anomalies are found, STOP the operation and notify the coach or engineering.
- _____ a. Lower the crane hook to within 2 ft of the operational surface or its lower limit.
 - _____ b. Observe the extended cables for any broken strands, kinks, or abnormal wear.
 - _____ c. Inspect the hook for cracks, distortions or abnormal wear.
 - _____ d. If the hook has swivel features verify that it can be freely rotated by hand.
 - _____ e. Verify that the safety latch on the hook is in good order.
 - _____ f. Verify that the cable spools properly on the drum while raising the hook from the ground to near its' upper limit.
 - _____ g. Raise the hook to NEAR its upper limit. Verify that the cable spools properly on the drum while raising the hook from the ground to near its' upper limit.
 - _____ h. Verify that the hooks' movement is smooth while raising the hook and no abnormal noises are observed.
 - _____ i. Bump the upper limit device/anti two-block to assure that it is working properly.
- _____ 3. If two hooks or cranes are to be used in the operation, repeat step 2.
- _____ 4. Swing the boom or move the trolley to near the travel limits in both directions and observe the movement for hesitations, jerking or abnormal noises. STOP the movement while traveling in each direction to verify that the brakes operate satisfactorily.
- _____ 5. Raise and lower the boom or move the bridge in both directions to points in its travel limits that are beyond the points that the forth-coming critical lift will employ. Stop the boom or bridge movement in both directions to verify that the brakes are in good order. Observe the movement for any hesitations, jerking or abnormal noises.
- _____ 6. For mobile cranes only: Assure outriggers are extended to manufacturer's specifications, are resting on proper load bearing surfaces, and crane is within 1 percent grade. **Note:** Outrigger pads are required for all picks at AEDC.
- _____ 7. Prior to committing to the critical lift, all of the required rigging is to be inspected by the PIC or his designated personnel or agency and verified to have been proof tested and to be in good order.
- _____ a. All shackles and pins are to be inspected to be free from distortions or excessive wear. The pins should have free engagement of the threads or the correct restraining pins in place.

- _____ b. All chokers are to be certified and free from broken strands, kinks, distorted lay, excessive wear or other anomalies. Verify that the swaged fittings securing the choker eyes to the main strand are in good order. If the chokers are required to be a matched set, check the length and substitute as required.
 - _____ c. Any come-a-longs to be used in the lift are to be specified by engineering. They are to be inspected by the PIC to be in good order and in compliance with engineering specifications.
 - _____ d. Verify that any special brackets to be used in the lift show no distortions, cracks, or broken welds and that the lifting eyes and bolt holes align properly.
 - _____ e. Verify that all equipment supplied by the customer is in good order and is ready to commit to the forth-coming critical lift.
 - _____ f. Verify that any other special equipment that is to be used in the forth-coming lift is noted below and is in good order.
-
- _____ 8. The PIC is to verify that the lift areas are free from equipment or objects which would create hazards in the lifting operation.

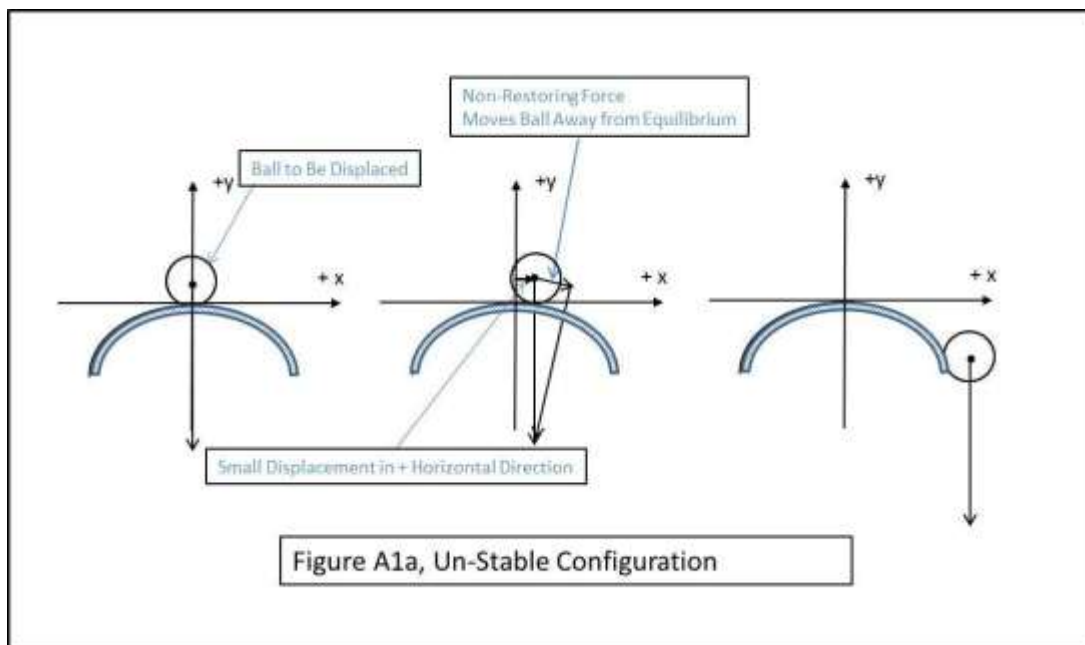
Exhibit 2.6 Description and Analysis Methodology for Hoisting Equilibrium Stability

The characteristic of a positively stable equilibrium configuration for a lift is defined as: if the slightest force acts momentarily to produce a small displacement from equilibrium, the system will return to the original equilibrium condition as soon as the disturbing force is removed.

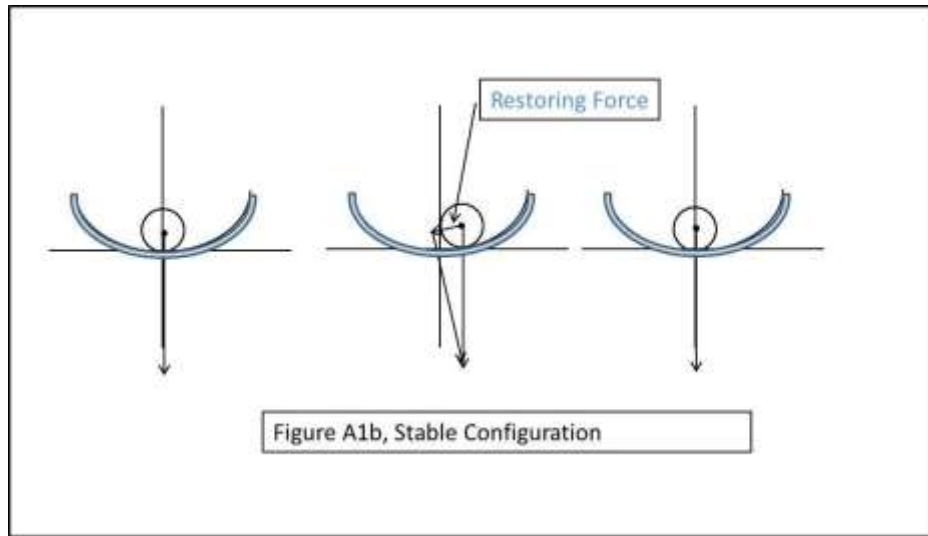
The characteristic of a negatively stable (un-stable) equilibrium configuration for a lift is defined as: if the slightest force acts momentarily to produce a small displacement from equilibrium, the system will move away from the original equilibrium condition even after the disturbing force is removed.

The characteristic of a neutrally stable equilibrium configuration for a lift is defined as: if the slightest force acts momentarily to produce a small displacement from equilibrium, the system neither returns to the original equilibrium nor to a position further away from the original configuration. Examples of the unstable and stable equilibrium cases are illustrated below.

Unstable Configuration: The condition of equilibrium exists for a ball placed on the highest point of the convex curve in Figure A1a and is indicative of an unstable equilibrium. The condition of equilibrium is due to the reactive force normal to the surface which is vertical and equals the gravity force acting through the ball center of gravity. All forces and moments are summed to zero. The slightest force applied horizontally to disturb the ball starts a motion downward along the convex surface continually moving away from the original equilibrium condition.

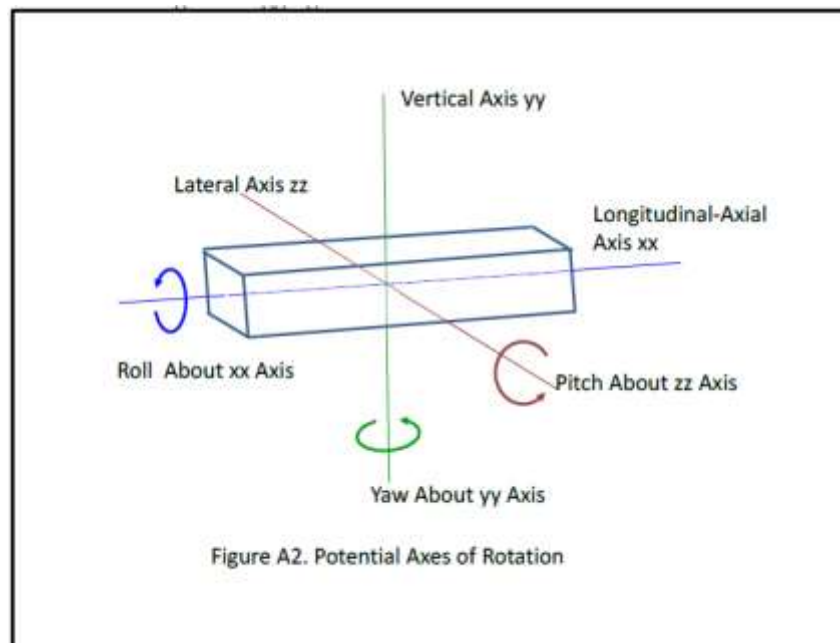


Stable Configuration: In A1b, the ball is placed at a low position of the concave curve and the position is stable. A small force that displaces the ball from equilibrium position creates a force normal the surface that causes the ball to return to the original position. This is considered a stable restoring force.



For an unstable position of equilibrium of the ball, as in Fig. A1a, the vertical position decreases for any small (virtual) positive or negative horizontal displacement, while in the case of a stable position of equilibrium, as in Fig. A1b, the vertical displacement increases on any small (virtual) positive or negative horizontal displacement. It can be stated that for an unstable position of equilibrium the vertical position of the ball is a (local) maximum and for a stable position of equilibrium it is a (local) minimum. The same kind of reasoning can be applied in the general case of a hoisting configuration.

In the investigation of any configuration of equilibrium of such a system, it is necessary to consider all possible axes of rotation, as depicted in Figure A2.

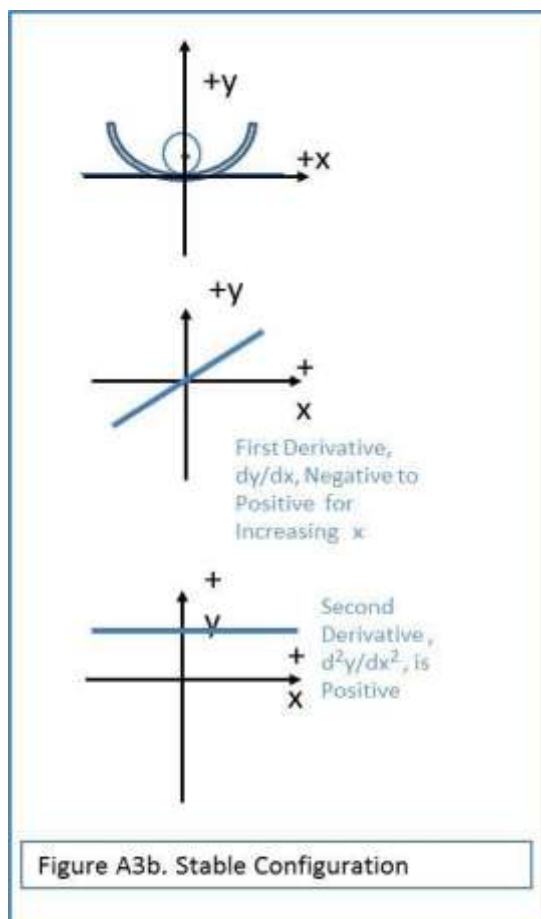
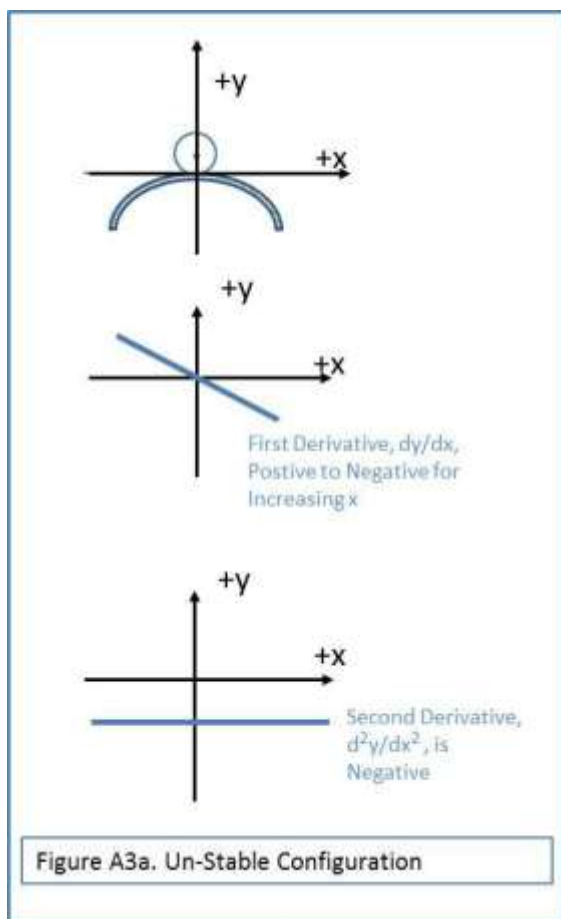


In classical mechanics the method to find local maxima and minima is to consider the second derivative. For consideration in lifting configurations this is done by calculating the vertical (Y direction)

displacement of the load CG for a small (virtual) displacement of the CG in the positive x (axial) or z (lateral) direction.

The change in the vertical CG for a change in the x or z direction is approximately equal to the first derivative (for small value of displacement).

The second derivative is approximated by taking the change in the first derivative for a small change in the x or z direction. If the approximated second derivative is positive the configuration is stable. If the approximated second derivative is zero the configuration is neutrally stable. If approximated second derivative is negative, the configuration is unstable.



For our case in Figure A1a and A1b we can display notionally the first and second derivative approximations as shown in Figure A3a,b. The second derivative of vertical displacement relative to horizontal displacement is required to assess equilibrium stability. A stable lifting configuration may still tilt in order to move the CG into equilibrium position, resulting in a condition where the CG is under the system line of suspension.

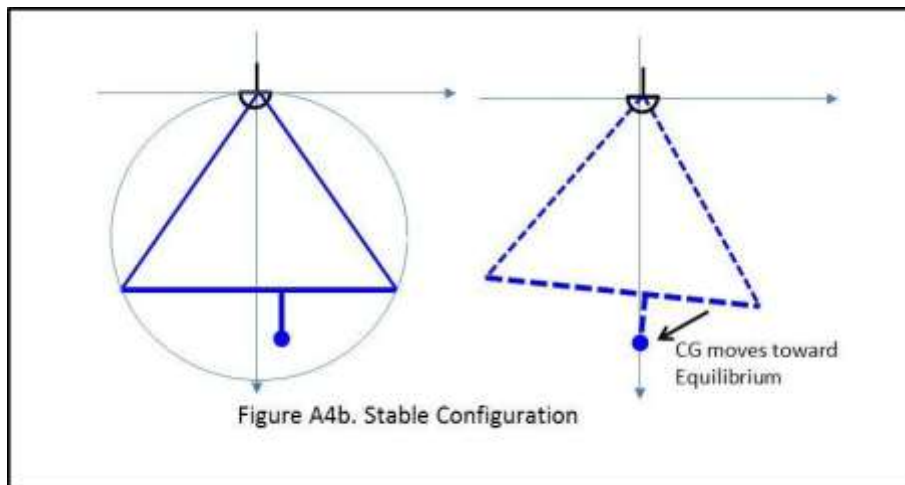
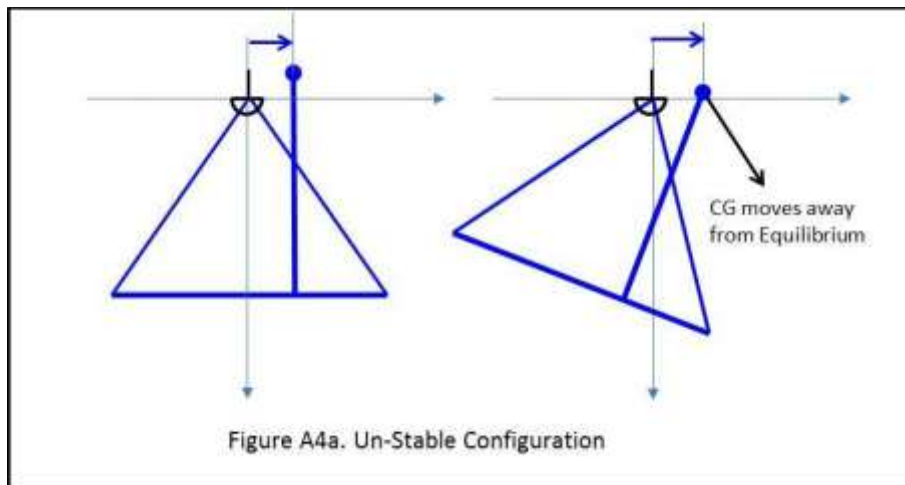
For analyzing lifting configurations, the rotation about the longitudinal and lateral axes must be considered for lifting stability. Forces about the yy (yaw about vertical) axis are generally not generated by the lift itself, but by external forces such as wind.

If the CG is below the attachment points, static equilibrium stability in the axes of rotation is assured. This is always the preferred lifting configuration.

If the CG is at or above the attachment point, the CG moves away from stable static equilibrium and towards unstable. The configuration is not necessarily unstable, but stability must be assessed. This is an un-preferred configuration.

If the CG of the load is at or above the attachment point of the rigging, the stability of the configuration must be analyzed and approved as part of the lift plan.

Graphic illustration of stable and unstable equilibrium for lifts is shown below for a 2 point lift to an apex attachment at the crane hook.



In the unstable configuration, Fig A4a, the CG moves away from equilibrium without restorative forces generated. For the stable configuration Fig A4b, the CG moves toward the equilibrium condition with the line of suspension below the hook.

3.0 CHAPTER 3 - PLANNED ENGINEERED LIFTS

3.1 GENERAL

It is recognized that lifts, in excess of the rated load capacity of an overhead crane may be required from time to time on a limited basis for specific purposes such as new construction or major repairs. This chapter specifies the requirements for when it becomes necessary to perform such a lift. When a Planned Engineered Lift becomes necessary, the following applies:

3.1.1 Every lift, exceeding the rated load capacity of an overhead crane, shall be treated as a special and separate event. Limitations and planned requirements shall be applicable, as follows:

3.1.1.1 Planned engineered lifts shall be limited to powered cranes having a load rating of 5 tons and above.

3.1.1.2 When planned engineered lifts are made, the load shall not exceed 125% of the crane load rating, except as provided in Paragraph 3.1.1.6.

3.1.1.3 Planned engineered lifts shall be limited to two occurrences on any crane within any continuous 12 month period, except as provided in Paragraph 3.1.1.6. If greater lift frequency is desired, consideration shall be given to rerating or replacing the crane.

3.1.1.4 Each planned engineered lift shall comply with the following requirements.

3.1.1.4.1 A written review of the crane service history shall be prepared, including reference to previous planned engineered lifts, structural repairs, and modifications of original design

3.1.1.4.2 The design of the structural, mechanical, electrical, pneumatic, and hydraulic components of the crane shall be reviewed, by means of applicable calculations for the load to be lifted, and approved by the crane manufacturer or a qualified person, in accordance with accepted crane design standards if the load to be lifted exceeds 125% of rated load, or if the frequency of planned engineered lifts exceeds two during a continuous 12-month period

3.1.1.4.3 The design of the crane-supporting structure shall be reviewed and approved by a qualified person for conformance to applicable design criteria. The crane support shall be inspected and any deterioration or damage shall be taken into consideration in design calculations for the load to be lifted.

3.1.1.4.4 The crane shall be inspected in accordance with Paragraph 7.2. just prior to making the lift.

3.1.1.4.5 The lift shall be made under controlled conditions under the direction of a designated person in accordance with a previously prepared lift plan. All persons in the area of the crane shall be alerted that the lift is being made.

3.1.1.4.6 The operator shall test the crane at the planned engineered load by lifting the load a short distance and setting the brakes. The lift shall only be continued if the brakes stop and hold the load. Any failure to hold the load shall be corrected before proceeding with the lift.

- 3.1.1.4.7 The crane shall be inspected in accordance with Paragraph 7.2. after the lift is completed and prior to being used for the lifting of any other load.
- 3.1.1.4.8 A record of the planned engineered lift, including calculations, inspections, and all distances moved, shall be placed on file for availability to appointed personnel.
- 3.1.1.5 The rated load test specified in Paragraph 7.3.2 is not applicable to planned engineered lift provisions.
- 3.1.1.6 The crane manufacturer shall be consulted if the planned engineered lift exceeds 125% of rated load or if the frequency of planned engineered lifts exceeds two during a continuous 12-month period.
- 3.1.1.7 All planned engineered lifts will be classified as a “Critical Lift.”

4.0 CHAPTER 4 - LIFTING PERSONNEL

4.1 GENERAL

Note: The requirements of this chapter are not intended to direct emergency response actions performed by appropriately trained and/or qualified rescue personnel or first responders.

This chapter specifies the operation, design, testing, and inspection requirements for the use of personnel lift platforms or baskets suspended from mobile or overhead cranes. This chapter implements the requirements of 29 CFR 1926.1431 “Cranes and Derricks” and ASME B30.23.

4.1.1 Personnel Lifting Evaluation

4.1.1.1 The use of a crane to hoist employees on a personnel lift platform is prohibited, except when the erection, use, and dismantling of conventional means of reaching the worksite, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform, or scaffold, would be more hazardous or is not possible because of structural design or worksite conditions. Riding the load, headache ball, hook, etc., is **always** prohibited.

4.1.1.2 The **Asset Owner** responsible for the overall work function to be performed shall determine that the erection, use, and dismantling of conventional means of reaching the work site (i.e., scaffold, ladder, stairway, aerial lift, or elevating work platform) would be more hazardous or is not possible because of structural design or worksite conditions.

4.1.1.3 For each personnel lifting procedure, **Asset Owner, with** for the task shall authorize the use of a crane-suspended work platform and attest to the need for the operation through a written justification. (See Exhibit 4.1, Section D.) A statement describing the operation and its period shall be included. The statement, after being approved by the authorizer, shall be retained at the job site.

4.1.1.4 The **Asset Owner** responsible for the overall work function shall not allow or require any operator to lift personnel under the following circumstances:

4.1.1.4.1 The operator does not feel physically or mentally fit to perform the operation.

4.1.1.4.2 The operator has been working for more than 10 hours prior to the start of the lift or the lift will not be completed before the operator has been working for 12 hours.

4.1.1.4.3 The operator did not have at least eight hours off, immediately prior to the work shift containing the person.

4.1.2 Designated Leader

4.1.2.1 The **Asset Owner** shall appoint a “Designated Leader” for the entire personnel lifting operation. The PIC must

4.1.2.2 The Designated Leader shall ensure that a pre-job plan is prepared that defines the operation. The Designated Leader shall ensure:

- 4.1.2.2.1 At each new job site prior to hoisting personnel, the personnel lift platform, rigging, and hook block shall be proof-tested by a qualified inspector to 125% of the personnel platform's rated capacity by holding it suspended for 5 minutes with the test load suitably distributed on the personnel platform.
- 4.1.2.2.2 The record of the most recent proof testing shall be maintained at the job site.
- 4.1.2.2.3 A meeting, with the qualified operator, signaler, persons to be lifted (when available), and the person responsible for overall worksite safety is held prior to the trial lift to review the procedure.
- 4.1.2.2.4 The procedures for entering and leaving the personnel platform and the points at which persons will enter and leave the device shall be reviewed. This meeting shall be held at each new work location, and shall be repeated for any employees newly assigned to the operation.
- 4.1.2.2.5 A personnel lifting critical lift plan is developed and followed per this chapter.
- 4.1.2.2.6 A trial lift is accomplished per paragraph 4.1.3.

4.1.2.3 The Designated Leader and the crane operator shall determine that:

- 4.1.2.3.1 The crane is uniformly level within 1% of level grade and firm footing exist under both crawler tracks or under each outrigger. Cribbing mats / dunnage / blocks under outrigger floats are used as necessary to provide a firm and substantial footing.
- 4.1.2.3.2 Cranes equipped with outriggers have outriggers extended in accordance with the manufacturer's instructions.
- 4.1.2.3.3 Crane systems, controls, operator aids, and safety devices are activated and functioning properly.
- 4.1.2.3.4 Area has been inspected for potential hazards, such as but not limited to excessive load and/or radius, overhead obstructions and electrical transmission lines, hazardous locations, inadequate surface and support to withstand all forces imposed, wind, weather, unstable conditions, and any other potentially hazardous conditions.
- 4.1.2.3.5 The total weight of the loaded personnel lift platform (including personnel) and related rigging does not exceed 50% of the crane rating under the planned conditions of use.
- 4.1.2.3.6 The personnel lift platform is not loaded in excess of its rated load capacity.
- 4.1.2.3.7 The number of employees occupying the platform does not exceed the number required for the work being performed.

4.1.3 Trial Lift

- 4.1.3.1 Each shift, before personnel initially enter the personnel lift platform, the operator and signaler shall conduct a trial lift. The trial lift shall include:

4.1.3.1.1 Loading the unoccupied personnel platform to at least the maximum anticipated load. Materials and tools to be used during the actual lift, if secured to prevent displacement, can be in the platform for the trial lift.

4.1.3.1.2 Making the trial lift from the location where personnel will enter the platform to each location where the platform will be hoisted and positioned. It is acceptable to perform a single trial lift on each shift for all locations to be reached from a single setup position.

4.1.3.2 The trial lift shall be repeated whenever:

4.1.3.2.1 A mobile crane is moved and set up in a new location or returned to a previously used location.

4.1.3.2.2 When the lift route is changed, unless the operator determines that the safety of the hoisted personnel is not affected.

4.1.3.3 A different crane operator is assigned.

4.1.4 Lifting Operations

4.1.4.1 Pre-Lift Meeting

4.1.4.1.1 A meeting attended by the Designated Leader, crane operator, signal person, riggers handling the tag lines and person(s) to be lifted shall be held each shift to plan and review procedures to be followed, including:

- Points at which persons will enter and leave the platform.
- Procedures for entering and leaving the platform.
- Special precautions if personnel will perform work from the suspended platform.

4.1.4.1.2 This meeting shall be held at each new work location, and shall be repeated for any employees newly assigned to the operation. See Exhibit 4.2.

4.1.4.2 Pre-Lift Inspection

The Pre-Lift Inspection shall be performed after the trial lift but prior to lifting personnel:

4.1.4.2.1 A visual (non-documented) inspection of the crane, rigging, and personnel lift platform shall be conducted by a qualified inspector. Any defects found that create a safety hazard shall be corrected prior to hoisting personnel. See Exhibit 4.3.

4.1.4.2.2 The platform shall be lifted a few inches and inspected to ensure that it is secure and properly balanced.

4.1.4.3 Lifting Personnel

4.1.4.3.1 Prior to hoisting personnel in a personnel lift platform, ensure that:

- No hazardous conditions exist with the platform and its associated rigging.
- The hoist line is not wrapped around any part of the platform.
- Hoist ropes are free of kinks.

- Multiple-part lines are not twisted around each other.
- The primary attachment is centered over the platform.
- Ropes are properly seated on drums and sheaves.
- The crane is within 1% of level.
- The crane has an anti-two-block device installed and it is operational.

4.1.4.3.2 Employees being hoisted or working in a personnel lift platform shall:

- Remain in continuous sight of, and in direct communication with, the operator or signaler. In situations where direct visual contact with the operator is not possible, and the use of a signaler would create a hazard for that person, direct communication alone (such as a two-way radio) may be used.
- Keep all parts of their bodies inside the suspended personnel lift platform during raising, lowering, and positioning to avoid pinch points.
- Wear body harnesses with lanyards attached to the lower load block or overhaul ball, or to a structural member within the platform that is capable of supporting a fall impact.
- Not stand on or work from the top rail, midrail, or toe board of the suspended personnel platform.
- When working above water, the requirements of 29 CFR 1926.106 shall also apply.
- When welding is being performed from the personnel lift platform, the electrode holders shall be protected from contact with metal components of the personnel platform.
- Have materials and equipment evenly distributed and secured while the platform is lifted, and shall not pull the platform out of plumb with the hoisting equipment

4.1.4.3.3 Operators of cranes hoisting personnel in a personnel lift platform shall:

- Before commencing or continuing the lift, consult with the Designated Leader whenever there is any doubt as to the safety of the lift.
- Remain at the controls when the personnel lift platform is occupied.
- Operate the crane so that lowering will be power-controlled (no free-fall).
- Ensure movement of the personnel lift platform is performed in a slow, controlled, cautious manner with no sudden movements of the crane or the platform. The lifting or lowering speed shall not exceed 100 ft/min (30 m/min).
- After the personnel lift platform is positioned, set all brakes and locks on the lift crane before personnel perform any work.
- If the personnel lift platform cannot be landed, ensure it is tied to the structure before personnel enter or exit.
- Ensure no other loads are lifted on any other load lines while conducting a personnel lift.

4.1.4.3.4 Suspended personnel lift platforms shall be used only for personnel, their tools, and sufficient materials to do their work. They shall not be used for transporting bulk materials.

4.1.4.3.5 Personnel lift platforms shall not be used in winds greater than 20 mph (32.2 km/hr), electric storms, snow, ice, sleet, or other adverse weather conditions that could affect the safety of personnel.

4.1.4.3.6 Use tag lines to control motion of occupied personnel lift platforms unless their use creates an unsafe condition.

4.1.4.3.7 Cranes shall not travel while personnel are in the platform. Exceptions to this provision shall be approved by the manager specifically responsible for the overall work function and precautions to be taken documented in the personnel lift plan.

4.1.5 Special Precautions

4.1.5.1 For additional safety of personnel and equipment, an insulating link shall be used whenever electrical welding is to be performed from a personal lift platform.

4.1.5.2 The platform shall not be used as a ground return for an electric welder. Ground return leads shall be insulated from the platform.

4.1.5.3 All work from a platform will cease and employees will take cover whenever lightning is within 10 miles of the job site.

4.2 MOBILE CRANES

Mobile cranes are designed and intended for handling materials, not personnel. In addition to the general requirements in paragraph 4.1, the following requirements shall be met when lifting personnel with a mobile crane:

4.2.1 Personnel are permitted to ride only in one of the following:

4.2.1.1 A personnel lift platform that is supported from the crane's hook, which meets the requirements of paragraph 4.4.

4.2.1.2 A personnel basket attached directly to the boom, which is approved by the crane manufacturer.

4.2.2 Cranes with variable-angle booms shall be equipped with a boom-angle indicator that is readily visible to the operator.

4.2.3 Cranes with telescoping booms shall be equipped with a device to indicate clearly to the operator, at all times, the boom's extended length, or an accurate determination of the load radius to be used during the lift shall be made prior to hoisting personnel.

4.2.4 A positive-acting device shall be used that prevents contact between the load block or overhaul ball and the boom tip (anti-two-blocking device), or a system shall be used that deactivates the hoisting action before damage occurs in the event of a two-blocking situation (two-block damage-prevention feature).

4.2.5 Cranes having booms in which lowering is controlled by a brake without aid from other devices, which slow the lowering speeds, is prohibited.

- 4.2.6 Crane load lines shall be capable of supporting, without failure, at least seven times the maximum intended load, except where rotation resistant rope is used, the lines shall be capable of supporting without failure, at least ten times the maximum intended load.
- 4.2.7 Hydraulic cranes shall have check valves or other devices that will prevent uncontrolled movement in the event of system failure, engine failure, or hose rupture.
- 4.2.8 Cranes shall have a means to prevent retraction of hydraulically or pneumatically activated outriggers or stabilizers in the event a hydraulic or pneumatic line fails.
- 4.2.9 Pendant supported, jib type, boom extensions without positive stops are prohibited for personnel lifting.
- 4.2.10 Hooks on overhaul ball assemblies, lower load blocks, or other attachment assemblies shall be of the type that can be closed and locked, eliminating the hook throat opening. (See Figure 4-1). Alternatively, an alloy anchor type shackle with a bolt, nut, and retaining pin may be used

4.3 OVERHEAD CRANES

Overhead cranes are designed and intended for handling materials, not personnel. In addition to the general requirements in paragraph 4.1, the following requirements shall be met when lifting personnel with an overhead crane.

- 4.3.1 Personnel are permitted to ride only in a personnel lift platform that is supported from the crane's hook, which meets the requirements of paragraph 4.4.

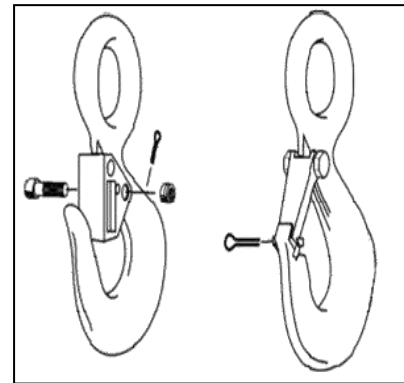


Figure 4-1.

Two Types of Positive Hooks

- 4.3.2 A hoist-limit switch/device shall be provided in the hoisting direction to stop the hoisting motion to prevent two-blocking.

4.4 PERSONNEL LIFT PLATFORM

4.4.1 Platform Design and Construction

- 4.4.1.1 Platform design and construction is not covered in this chapter. Nevertheless, because many platform design and construction features can be observed and should be known by the platform user (see Figure 4-2), the following key design and construction requirements are presented.

- 4.4.1.2 The personnel lift platform and suspension system shall be designed by a qualified person competent in

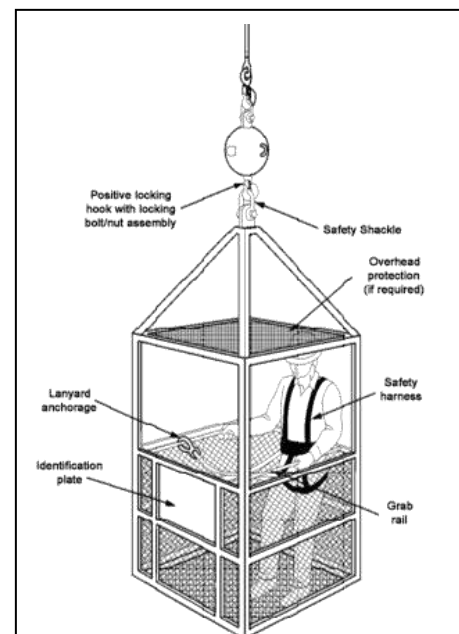


Figure 4-2. Personnel Lift Platform

structural design and familiar with national consensus standards governing personnel platform design.

4.4.1.3 All welding of the platform shall be performed by a qualified welder in accordance with ANSI/AWS D1.1. Where special steels or other materials are used, the manufacturer shall provide welding procedures. Welds shall be inspected by a qualified inspector.

4.4.1.4 The personnel lift platform shall have:

4.4.1.4.1 A minimum design factor of five.

4.4.1.4.2 A plate specifying its empty weight and its rated load capacity or maximum intended load.

4.4.1.4.3 Perimeter protection consisting of a top rail approximately 45 in. (10 cm) high, and a midrail approximately halfway between the top rail and the toe board.

4.4.1.4.4 A grab rail inside the personnel lift platform to minimize hand exposure.

4.4.1.4.5 Anchorage points within the platform for attaching personnel fall protection lanyards.

4.4.1.4.6 The sides of the platform enclosed from the toe board to the midrail with solid construction or expanded metal having openings no greater than ½ in. (1.27 cm).

4.4.1.4.7 Platform access gates, including sliding or folding types, if installed, shall have a positive acting device to restrain the gate from accidental opening. Swinging type access gates shall open only to the interior of the personnel lift platform.

4.4.1.4.8 Rough edges exposed to contact by employees surfaced (ground smooth) to prevent injury.

4.4.1.4.9 High-visibility color or marking for easy identification.

4.4.1.5 In addition to wearing hard hats, personnel shall be protected by overhead protection on the personnel lift platform when there is an overhead hazard. Sufficient headroom shall be provided to allow employees to stand upright in the platform.

4.4.2 Platform Suspension System

4.4.2.1 Wire rope, shackles, rings master links, and other rigging hardware must be capable of supporting, without failure, at least five (5X) times the maximum intended load applied or transmitted to that component and guided by the following:

4.4.2.1.1 One-leg system – design factor of seven (7).

4.4.2.1.2 Two- or more leg system – design factor of five (5) for each leg with only two legs under stress.

4.4.2.2 Sling suspension systems shall utilize a master link or safety type shackle to connect the personnel lift platform to the load line to ensure that the load is evenly divided among the suspension system legs.

- 4.4.2.3 The suspension system shall be designed to minimize tipping of the platform due to movement of employees occupying the platform.
- 4.4.2.4 The sling suspension system attaching the personnel lift platform to the hoist line shall not be used for any other purpose when not hoisting personnel.
- 4.4.2.5 Shackles used in any part of the suspension system shall be a safety type (bolt-type shackle with nut and cotter pin).
- 4.4.2.6 All eyes in wire rope slings shall be fabricated with thimbles.
- 4.4.2.7 Wire rope clips, wedge sockets, or knots shall not be used in suspension system sling assemblies.
- 4.4.2.8 Synthetic webbing, natural or synthetic fiber rope shall not be used for the suspension systems.
- 4.4.2.9 Chain sling suspension systems shall use a minimum of grade 80 chain.

4.5 INSPECTIONS

All equipment used in the lifting of personnel shall be inspected, tested, and maintained to protect against failure during lifting operation.

4.5.1 Frequent Inspection

4.5.1.1 General

The platform manufacturer shall furnish complete inspection criteria for the platform users. The criteria shall address all inspection frequency classifications and shall cover:

- 4.5.1.1.1 The platform
- 4.5.1.1.2 Rigging components
- 4.5.1.1.3 Fasteners
- 4.5.1.1.4 All safety features and attachments

4.5.1.2 Personnel Lift Platform

- 4.5.1.2.1 Prior to initial use, and at each new job, the platform shall be inspected by a qualified inspector in accordance with the instructions provided by the manufacturer.
- 4.5.1.2.2 The platform, suspension system, attachment points, and any motion controls shall be inspected at least each day, before use, by a designated person. The inspection is to identify conditions that have been specifically indicated by the platform manufacturer, or a qualified person, as potentially creating a hazardous operating condition. Visually inspect items such as the following:
 - Ensure all Platform and suspension system marking information is legible.
 - Platform structure:
 - Load supporting members, welds, and bolts.

- Perimeter protection; top rail, midrail, toe board, and barrier from toe board to midrail.
- Fall protection device anchorage points.
- Gate locking mechanisms.
- Platform flooring.
- Suspension attachment points.
- Attachment mechanisms: Master links, shackles, slings, bolt-ups, etc.
- Special purpose items:
 - Overhead protection
 - Platform controls

4.5.1.2.3 For frequent inspections, dated records for the hoisting equipment and personnel lift platform shall be made and kept by the platform user for the duration of the personnel lift operation.

4.5.2 Periodic Inspection

4.5.2.1 Personnel Lift Platform

4.5.2.1.1 At least once every 12 months, or as required by the personnel lift platform manufacturer, a periodic inspection of the platform shall be performed by a qualified inspector in accordance with the instructions provided by the manufacturer.

4.5.2.1.2 Platforms, which have been out of service for 12 or more consecutive months, shall receive a periodic inspection prior to use.

4.5.2.1.3 Dated inspections records for the platform shall be made. The last periodic inspection records shall kept by the platform user in the platform's historical file and available for review.

4.5.2.2 Hoisting Equipment

Hoisting equipment shall be inspected in accordance with requirements of Chapter 7 or 9.

4.6 TESTING

4.6.1 Platform Manufacturer Test

The platform manufacturer shall perform the following testing:

4.6.1.1 Test the personnel lift platforms:

4.6.1.1.1 Suspension mechanisms or attachment components.

4.6.1.1.2 Occupant safety features.

4.6.1.1.3 Platform rating.

4.6.1.1.4 When the complete production platform is not supplied by one manufacturer, the manufacturer's platform test shall be conducted at final assembly by the platform assembler or a qualified inspector. Dated records of the test(s) shall be made and filed in the platform's historical file.

4.6.1.2 Slings (wire rope or chain) shall receive an initial load test before installation by applying a test load to each individual leg equal to twice the rated load of the leg. If a master link or safety shackle is used in the suspension system, it shall be tested to at least the weight of the platform plus the platform rating.

4.6.1.2.1 All tested components shall be visually inspected after testing.

4.6.1.2.2 Any components showing damage shall be replaced and the test procedure repeated.

4.6.1.3 Non-destructive testing of the platform's suspension system attaching points.

4.6.2 Proof Testing

4.6.2.1 At each new job site, prior to hoisting people in the personnel platform, the platform and rigging shall be proof tested to 125% of the platform's rated capacity.

4.6.2.2 With the proof test load evenly distributed in the platform, the platform shall be hoisted and held in a suspended position for 5 minutes.

4.6.2.3 When feasible the proof testing may be done concurrently with the trial lift.

4.6.2.4 After proof testing, the platform shall be inspected by a qualified person. Any damage or deficiencies revealed during the inspection, or by the proof test, shall be corrected and another proof-test conducted.

4.6.2.5 After any structural repair or modification to a personnel lift platform, the platform shall be proof tested to 150% of the platform's rating.

4.6.2.6 Suspended platforms shall be tested by raising the platform to a height, then lowering it at a speed of not less than 100 ft/min. Once a lowering speed of 100 ft/min or more is reached, the platform descent shall be halted by applying the hoisting equipment brakes and then the platform allowed to hang for a period of not less than 5 min. After this test and hanging period, the platform shall be inspected by a qualified person. Any damage revealed by the inspection shall be corrected and another proof test conducted.

4.6.2.7 When feasible, the hoisting equipment to be used for lifting personnel should be the equipment used to perform the proof test at the job site.

4.6.2.8 The record of the most recent proof testing shall be maintained at the job site.

4.6.3 Hoisting Equipment

Hoisting equipment shall be tested in accordance with requirements of Chapter 7 or 9.

4.7 LIFTING PERSONNEL NEAR ELECTRICAL POWER LINES

Paragraph 9.5.2 outlines the requirements for crane operations near power lines.

- 4.7.1 If possible, when lifting personnel near electrical power lines, the lift shall be performed to eliminate possibility of the crane, load line, or personnel platform becoming a conductive path.
- 4.7.2 Cranes shall not lift any personnel under electrical power lines if any combination of boom, personnel platform, load line, or machine components will enter the prohibited zone (Figure 4-3).
- 4.7.3 Lifting personnel near electrical power lines shall not be allowed unless there is no less hazardous way to perform the job. Conditions specified in 4.7.2 must be considered when lifting personnel near electrical power lines.

Exhibit 4.1 Personnel Lifting—Planning and Authorization Form.

PERSONNEL LIFTING - PLANNING AND AUTHORIZATION	
A. GENERAL INFORMATION	
Project Name & Number (Purpose): _____	
Date: _____	Location: _____
Crane Number: _____	Crane Model & Type: _____
Basket Number / Identification: _____	Proof Test Date: _____
Names of Personnel in Basket: 1. _____	
2. _____	
3. _____	
Designated Leader or Person-In-Charge (PIC): _____	
B. WEIGHT CALCULATIONS - CRANE CAPACITY	
Note: If this crane is not equipped with a functional anti-two block device, it may not be used to lift personnel in a basket.	
1. Weight of Basket with Rigging: _____	Lbs.
2. Number of Persons in Basket: _____	X 250 = _____ Lbs.
3. Weight of Tools/Materials to be Carried in the Basket: _____	Lbs.
4. Total intended load weight (line B1+B2+B3): _____	Lbs.
5. Radius at Farthest Point During Lift: _____	Ft.
6. Charted Capacity for Crane as Configured: _____ (Deduct if applicable for load block, whip line ball wire rope & jib in working stowed position)	Lbs.
7. Capacity with Safety Factor (line B6. X .50) _____	Lbs.
Warning: If the result on line B4 exceeds the result of line B7 STOP. You are not within the crane's charted capacity. Note: If wire rope on crane is rotation resistant the safety factor is 10.	
C. WEIGHT CALCULATION – PRE-PERSONNEL LIFT TEST	
1. Total Intended Load Weight (from line B.4. above) times 2 _____	Lbs.
The amount shown on line C.1. is the weight needed for the proof test.	
D. LIFT JUSTIFICATION and AUTHORIZATION	
1. What are the alternatives to this personnel lift? _____	
2. Why are they not being used? _____	
Manager Authorizing Lift (Signature): _____ Date: _____	

E.	COMPLIANCE CHECKLIST	YES	NO
1.	Is the personnel basket, its suspension system and associated rigging and hardware designed and constructed in accordance with AEDC H&R Handbook Chap 4: Personnel Lifting?	_____	_____
2.	Does the crane to be used meet the Company's requirements including anti-two block device, load-line strength, power-down, boom angle indicator, and hooks with close and lock device?	_____	_____
3.	Is the crane uniformly level to within 1% of level grade?	_____	_____
4.	Is the total intended load weight equal to or less than 50% of the crane's capacity as configured?	_____	_____
5.	Has a trial lift in accordance with AEDC H&R Handbook Chap 4 been done?	_____	_____
6.	Has a pre-lift inspection been done after the trial lift in accordance with AEDC H&R Handbook Chap 4, and all defects corrected?	_____	_____
7.	Has the Crane Operator, Signal Person, Personnel to go in basket and Designated Leader (or Person-In-Charge) of task conducted a pre-lift safety meeting?	_____	_____
8.	Has a proof test been conducted in accordance with AEDC H&R Handbook Chapter 4	_____	_____
9.	Are the weather conditions satisfactory for the lift?	_____	_____
10.	Are tag lines provided?	_____	_____
11.	Is the area below the basket barricaded?	_____	_____
12.	Have the communication requirements set forth in AEDC H&R Handbook Chap 4 been met?	_____	_____
13.	Is the working area of the lift clear of all power lines?	_____	_____
14.	Do all persons to go in the basket have a safety belt or harness and adequate anchorage points to secure lanyards?	_____	_____
<p>If all of the above questions are answered "yes" or "N/A", you may proceed. Changes in the crane location, configuration and lift route will require another checklist.</p>			
<p>I acknowledge that all requirements have been met and all conditions are satisfactory for this operation.</p> <p>_____</p> <p>Designated Leader or Person-In-Charge (PIC)</p>			

Exhibit 4.2 Crane Suspended Personnel Pre-lift Safety Meeting Form.

CRANE SUSPENDED PERSONNEL - PRE-LIFT SAFETY MEETING		
Project Name & Number: _____		
Date: _____	Location: _____	
Designated Leader or PIC: _____		
Crane Operator: _____		
Qualified Signal Person: _____		
Tag Line Person(s) : _____		
Persons to be Hoisted: _____ / _____ / _____		
REVIEW		
_____	Pre-Lift Checklist	
_____	Competent Person Inspections	
_____	Trial Lift Results	
_____	Personnel Basket Work Practices	
_____	Communication Method(s)	
_____	Emergency Procedures	
_____	Other Identified Hazards or Safety Procedures to be Implemented:	
_____	_____	_____
Designated Leader or PIC	Date	Time

Exhibit 4.3 Personnel Platform Pre-Lift Inspection Form.

PERSONNEL LIFT PLATFORM PRE-LIFT INSPECTION		
Inspector: _____	Date: _____	
Platform ID: _____		
1. Trial Lift Completed with anticipated lift weight _____ (lb or kg)		
	UNSAT	SAT
2. Markings		
Platform (All Information Legible)		
Suspension System		
3. Structure		
Load Supporting Welds/Bolts		
Load Supporting Members		
Barrier From Toe Board to Intermediate Rail		
Hand Rail		
Fall Protection Device Anchorage Points		
Gate Locking Mechanisms		
Platform Flooring		
Suspension Attachment Points		
4. Attachment Mechanisms		
Pins/Ears/Bolt-Up's/Eyes (Circle)		
Wire Rope/Chain/Rigid Leg (Circle)		
Master Links		
5. Special Purpose Items (i.e., Overhead Protection, Flotation, Platform Controls)		
List: (1) _____		
(2) _____		
(3) _____		
6. General Comments: _____		

_____ Designated Leader or PIC signature	_____ Date	

5.0 CHAPTER 5 - HOSTILE ENVIRONMENTS

This chapter describes provisions for hoisting and rigging operations in hostile work environments.

5.1 GENERAL

5.1.1 This chapter contains the special provisions for hoisting and rigging operations and equipment in hostile environments where standard operating, maintenance, inspection, or test procedures cannot be followed because of radiation or radioactive contamination, toxic/hazardous chemicals or gases, or temperature extremes.

5.1.2 Hoisting and rigging activities can usually be accomplished where the environment will allow normal operations with access for hands-on equipment contact. In those situations, operations, maintenance, inspections, and tests shall be done in accordance with regular provisions of this handbook.

5.1.3 Hoisting and rigging equipment or operations shall be reviewed by a designated person to determine compliance with the requirements of this handbook. If it is determined to be impossible or unreasonable for the requirements of this handbook to be met because of hostile environmental conditions, a hostile environment plan shall be prepared to document alternative compliance methods and procedures.

5.1.4 Safety of personnel shall remain the first priority.

5.2 HOSTILE ENVIRONMENT PLAN

A hostile environment plan shall be prepared by a designated person and shall cover operations, equipment, inspection, testing, and maintenance. See Exhibit 5.1, Hostile Environment Plan, at the end of this chapter.

5.2.1 Plan Approval

At a minimum, the plan shall be reviewed and approved by responsible management at the facility where the crane, hoist, or other equipment is located and by responsible management of an overview organization such as safety or quality assurance. While the site-specific organizational structure will determine other required reviews and approvals, approval by the following is recommended:

5.2.1.1 Responsible operations manager.

5.2.1.2 Asset Owner or System Manager.

5.2.1.3 AEDC Crane System Engineer.

5.2.2 Plan Actions/Features

The plan shall address only those actions or features that require deviation from the requirements of this handbook due to a hostile environment. At a minimum, it shall contain the following information:

5.2.2.1 The specific requirements that cannot be met.

5.2.2.2 The difference between the requirement and actual conditions.

5.2.2.3 Justification for not meeting this handbook's requirements.

5.2.2.4 A statement of actions or features to be used to compensate for the differences.

5.2.2.5 Specific maintenance, inspections, and tests to be performed whenever access is possible.

5.2.2.6 Replacement or retirement criteria for equipment that is designed to operate with little or no maintenance.

5.2.3 Plan Requirements

Detailed operation, inspection, testing, and maintenance procedures that state specific requirements and acceptance criteria shall be prepared, based on the hostile environment plan.

5.2.4 Plan Distribution

The **Asset Owner** shall ensure that the approved hostile environment plan is distributed as follows:

5.2.4.1 **Base operating contractor's safety office** or equivalent (for information).

5.2.4.2 Equipment operators, maintenance organizations, and other organizations/personnel affected by the plan.

5.2.4.3 Equipment history file. Hostile environment plans in the equipment history file shall be readily available to appointed personnel.

5.2.5 Marking and Posting

Equipment the use of which is required by a hostile environment plan shall be posted with the following information: "Special Maintenance and Operating Instructions Required – see Hostile Environment Plan."

5.2.6 Inspection and Testing

5.2.6.1 Handling fixtures and rigging accessories shall be qualified in accordance with Chapters 11, 12, and 14 of this handbook prior to being exposed to the hostile environment.

5.2.6.2 Nylon (rope or webbing) slings should not be used in a radiation area unless necessary. When it is necessary to use a nylon or polyester sling in a radiation area, the **Asset Owner** shall ensure that radiation exposure does not exceed 100,000 rad during the life of the sling.

Exhibit 5.1 Hostile Environment Plan

HOSTILE ENVIRONMENT PLAN	
Building: _____	Location: _____
Type crane/hoist _____ (e.g., overhead top-running bridge & trolley, top-running bridge with underhung hoist, jib crane, monorail hoist, overhead hoist)	
Capacity: _____	(Auxiliary): _____
Power method: _____	
Manufacturer: _____	
<div style="display: flex; justify-content: space-between;"> 1.a H&R handbook requirement that will not be met Section number: _____ </div> <div style="margin-top: 5px;"> <u>Copy the applicable section:</u> _____ _____ _____ </div> <div style="margin-top: 10px;"> 1.b <u>Difference between handbook requirement and what is to be allowed by this plan:</u> _____ _____ _____ </div> <div style="margin-top: 10px;"> 1.c <u>Justification for not meeting the handbook requirement:</u> _____ _____ _____ </div> <div style="margin-top: 10px;"> 1.d <u>Actions or features to compensate for differences:</u> _____ _____ _____ </div> <div style="margin-top: 10px;"> Include information regarding replacement or retirement criteria for this equipment. Include information regarding any special design, maintenance, or test considerations that apply to this equipment. _____ _____ </div>	
APPROVALS	SIGNATURE/DATE
*Facility Manager: _____	_____
*Manager, Oversight Organization: _____	_____
Others: _____	_____
_____	_____
_____	_____
_____	_____
*means approval is mandatory	

6.0 CHAPTER 6 - PERSONNEL QUALIFICATION AND TRAINING

This chapter describes personnel qualification and training. Only qualified personnel shall operate the equipment covered in this standard.

6.1 GENERAL

6.1.1 This chapter delineates the requirements for the qualification and training of operators, riggers, inspectors, maintenance personnel, trainers, On the Job Performance Evaluators (OJPE), Person-In-Charge (PIC), Designated Leader, and First-line Supervisors.

6.1.2 Personnel who are designated to operate hoisting and rigging equipment or perform work covered by this standard shall be qualified and trained to the level of proficiency consistent with assigned tasks.

6.2 QUALIFICATION

6.2.1 General

6.2.1.1 Only qualified personnel or trainees, under the direct supervision of qualified personnel, who meet the following requirements shall be allowed to rig, operate, inspect, or perform maintenance on cranes, hoists, or powered forklift trucks:

6.2.1.2 Be at least 18 years old.

6.2.1.3 Understand spoken and written English or a language generally in use at the work location.

6.2.2 On-the-Job Evaluation (OJE)

6.2.2.1 On-the-job-evaluations, OJEs, shall be conducted by the designated On-The-Job Performance Evaluator, OJPE, (see paragraph 6.2.14). OJPEs shall evaluate each operator and document that the operator has demonstrated to them that they have the necessary knowledge and skills to operate the equipment safely before deeming the operator qualified. This document shall become part of the operators training record. Operators must be evaluated for each higher class of equipment before they can be deemed qualified to operate it. Operators who pass an OJE for a class of equipment are considered qualified on all equipment of the same class. Contractors, facilities, and/or organizations may choose to implement additional facility-specific OJT and/or OJE requirements.

6.2.2.2 Class and type divisions for OJEs shall be consistent with OSHA and industry standards.

6.2.3 On-the-Job Training (OJT)

6.2.3.1 The employer will make OJT available for hoisting and rigging equipment operators. If an operator will use attachments, the OJT will include use and installation of approved attachments (Example: crane jibs and boom extensions.).

6.2.3.2 Personnel must satisfy prerequisites and physical requirements for the type of equipment to be operated before being allowed to participate in an OJT program (see paragraph 6.2.3 - 6.2.9). The OJT program shall be based on the equipment manufacturer's operating instructions, typical tasks, operating environment, and facility or the **base operating contractor's** specific procedures. The OJT program shall provide training and practice under the direct supervision of a qualified operator or qualified OJT instructor in the work environment. Complexity of equipment and tasks, along with the operator's experience shall determine the need for OJT.

6.2.3.3 Trainee qualification requirements shall include, but are not limited to the following:

6.2.3.3.1 Satisfactory completion of an on-the-job training program. Previous training may be accepted to meet training requirements. Previous training may include any of the following:

- Vendor or equipment manufacturer training.
- Completion of an apprenticeship program.
- Journeyman status in an applicable trade.
- Operator log books showing documented seat time

6.2.3.3.2 For previous training to be acceptable for AEDC qualification, documented evidence must include type and class of equipment and hours of experience. For qualifications not related to equipment operation (rigging), personnel must have documented evidence of training and experience related to an activity covered by this manual. Documented evidence may be any of the following:

- Certificates of training.
- Journeyman card or documents issued by a trade union.
- A degree or accreditation from a college or trade school.

6.2.3.4 **The employer** may allow previously qualified or experienced personnel to bypass the OJT and undergo an On the Job Evaluation (OJE). The **supervisor** shall evaluate and validate training. When previous training and experience are accepted, personnel shall be considered qualified when they have accomplished the following:

6.2.3.4.1 For mobile or cab operated overhead cranes, they have at least one year of experience on the same type crane, or 3 years of combined experience on similar or like cranes, or have successfully completed a mentoring program and have passed an operators test.

6.2.3.4.2 Satisfactory completion of a written examination covering safety, operational characteristics and limitations, and controls of the type crane for which they are being qualified.

6.2.3.4.3 Demonstrate their ability to read, write, comprehend, and exhibit arithmetic skills and load/capacity chart usage, in the language of the crane manufacturer's operations and maintenance instruction materials.

6.2.3.4.4 Satisfactory completion of a written and verbal test on load/capacity chart usage covering various crane configurations.

6.2.3.4.5 Satisfactory completion of a practical operating skill evaluation test (OJE), demonstrating proficiency, and basic knowledge in handling the specific type crane for which the operator is being evaluated, including:

- Pre-start and post-start inspection.
- Maneuvering skills.
- Shutdown.
- Securing the crane.

6.2.4 Operators of Cab-Operated

6.2.4.1 Operators and operator trainees shall meet the following physical qualifications.

6.2.4.1.1 Have vision of at least 20/30 Snellen in one (1) eye, and 20/50 in the other, with or without corrective lenses.

6.2.4.1.2 Be able to distinguish colors, regardless of position, if color differentiation is required for operation.

6.2.4.1.3 Have adequate hearing, with or without a hearing aid, for specific operation.

6.2.4.1.4 Have the physical strength, coordination, and sufficient reaction speed to meet the demands of equipment operation.

6.2.4.1.5 Show no evidence of physical defects or emotional instability that could be a hazard to themselves or others, or which, in the opinion of the examiner, could interfere with safe performance; such evidence may be sufficient cause for disqualification. In these cases, medical judgments and tests may be required.

6.2.4.1.6 Show no evidence of being subject to seizures or to loss of physical control; such evidence shall be sufficient reason for disqualification. Medical examinations may be required to determine these conditions.

6.2.4.1.7 Have normal depth perception, field of vision, manual dexterity, coordination, and no tendencies to dizziness or similar potentially hazardous characteristics.

6.2.4.1.8 Have no detectable or known disease or physical restriction that would render them incapable of safely operating equipment or carrying out rigging duties. Where any deficiency of an upper or lower extremity exists, the acceptability of a candidate shall be the decision of the supervisor, after consulting with the designated physician.

6.2.4.2 Operators shall be required by the employer to pass a practical operating skill evaluation (OJE). Qualification shall be limited to the type of equipment for which the operator is being evaluated. The actual or simulated operation shall enable trainees to demonstrate basic knowledge and skills at a level that ensures the safety of personnel and equipment.

6.2.5 Operators of Mobile Cranes

6.2.5.1 Operators and operator trainees shall meet the following physical qualifications:

6.2.5.1.1 Have vision of at least 20/30 Snellen in one (1) eye and 20/50 in the other, with or without corrective lenses.

6.2.5.1.2 Be able to distinguish colors, regardless of position, if color differentiation is required for operation.

- 6.2.5.1.2 Have adequate hearing, with or without a hearing aid, for a specific operation.
- 6.2.5.1.4 Have physical strength, coordination, and sufficient reaction speed to meet the demands of equipment operation.
- 6.2.5.1.4 Show no evidence of physical defects or of emotional instability that could be a hazard to themselves or others, or which, in the opinion of the examiner, could interfere with their safe performance; such evidence may be sufficient cause for disqualification. In these cases, medical judgments and tests may be required.
- 6.2.5.1.5 Show no evidence of being subject to seizures or to loss of physical control; such evidence shall be sufficient reason for disqualification. Medical examinations may be required to determine these conditions.
- 6.2.5.1.6 Have normal depth perception, field of vision, manual dexterity, coordination, and no tendencies to dizziness or similar potentially hazardous characteristics.
- 6.2.5.1.7 Have no detectable or known disease or physical restriction that would render them incapable of safely operating equipment or carrying out rigging duties. Where any deficiency of an upper or lower extremity exists, the acceptability of a candidate shall be the decision of the supervisor, after consulting with the designated physician.
- 6.2.5.1.8 Operator physical examinations shall be required every three years or more frequently if supervision deems it necessary.
- 6.2.5.2 Operators shall be required to pass a written examination covering characteristic and performance questions appropriated to the crane type for which qualifications is sought as well as operational characteristics, controls, and emergency control skills such as response to:
 - 6.2.5.2.1 Fire.
 - 6.2.5.2.2 Power line contact.
 - 6.2.5.2.3 Loss of stability.
 - 6.2.5.2.4 Control malfunction.
- 6.2.5.3 Operators shall pass a combination written and verbal test on load/chart usage that covers a selection of the configurations (the crane may be equipped to handle) for the type crane for which qualification is being sought.
- 6.2.5.4 The operator shall complete a practical operating skill evaluation test (OJE), demonstrating proficiency and basic knowledge in handling the specific type crane for which the operator is being evaluated, including:
 - 6.2.5.4.1 Pre-start and post-start inspection.
 - 6.2.5.4.2 Maneuvering skills.

6.2.5.4.3 Shutdown.

6.2.5.4.4 Securing the crane.

6.2.5.5 Qualification shall be limited to the type of equipment for which the operator is being evaluated.

6.2.6 Operators of Floor-Operated Cranes and Hoists

6.2.6.1 Physical qualifications shall be based on specific job requirements.

6.2.6.2 Operators of cranes shall be required to pass both the classroom training and operating skill evaluation (OJE). Operators of hoist are only required pass the classroom training, no OJE is required. Qualification shall be limited to the type of equipment for which the operator is being evaluated.

6.2.6.3 The actual or simulated operation shall enable operators to demonstrate basic knowledge and skills at a level that ensures the safety of personnel and equipment.

6.2.7 Operators of Remote Operated Cranes

6.2.7.1 The use of remote-controlled equipment involves such a wide variety of service requirements and conditions that each installation should be carefully analyzed and operation reviewed to determine whether paragraphs 6.2.3 or 6.2.6 should apply.

6.2.7.2 Operators shall be required by the employer to pass a written examination covering operational characteristics, controls, and emergency control skills.

6.2.7.3 Operators shall be required by their employer to pass a practical operating skill evaluation (OJE). Qualification shall be limited to the type of equipment for which the operator is being evaluated.

6.2.7.4 The actual or simulated operation shall enable operators to demonstrate basic knowledge and skills at a level that ensures the safety of personnel and equipment.

6.2.8 Operators of Forklift Trucks

6.2.8.1 Physical qualifications shall be based on specific job requirements.

6.2.8.2 Operators shall be required to pass a practical operating skill evaluation (OJE). Qualification shall be limited to the type of forklift for which the operator is being evaluated.

6.2.8.3 The actual or simulated operation shall enable operators to demonstrate basic knowledge and skills at a level that ensures the safety of personnel and equipment.

6.2.9 Riggers

6.2.9.1 The employer shall ensure that personnel assigned to perform rigging tasks meet the definition of a qualified person for the specific tasks assigned.

6.2.9.2 The employer shall document the methods used to establish rigging qualifications

6.2.9.3 There shall be a means to verify rigging qualifications for each employee assigned to perform rigging tasks.

6.2.10 Person-In-Charge (PIC)

6.2.10.1 The PIC shall have the necessary knowledge and experience of the specific type of equipment and completion of the operation. The PIC shall understand the rules and procedures implemented at the site to ensure that the following are completed:

6.2.10.1.1 Necessary administrative requirements.

6.2.10.1.2 Personnel assignments and responsibilities.

6.2.10.1.3 Selection of proper equipment/tools.

6.2.10.1.4 Recognition and control of hazardous or unsafe conditions.

6.2.10.1.5 Job efficiency and safety.

6.2.10.1.6 Critical-lift documentation.

6.2.10.1.7 Direct operations in the case of an accident.

6.2.10.1.8 Exercise authority to start and stop work activities.

6.2.11 Designated Leader

6.2.11.1 The Designated Leader must meet the criteria for both a competent person and a qualified person, or be a qualified person supervised by a competent person during the lifting operation (ref. 1926.1432(b)(1)). The Designated Leader shall have sufficient knowledge and experience to accomplish the following responsibilities (ref. ANSI/ASME B30.5, 5-3.1.3 and B30.23, 23-3.1.1):

6.2.11.1.1 Ensure that personnel involved understand how the lift is to be made.

6.2.11.1.2 Ensure that the weight of the load is determined and that proper equipment and accessories are selected.

6.2.11.1.3 Survey the lift site for hazardous or unsafe conditions.

6.2.11.1.4 Ensure that equipment is properly set up and positioned.

6.2.11.1.5 Ensure that a **Qualified Signal Person** is assigned, if required, and is identified to the operator.

6.2.11.1.6 Direct the lifting operation to ensure that the job is done safely and efficiently.

6.2.11.1.7 Stop the job when any potentially unsafe condition is recognized.

6.2.11.1.8 Direct operations if an accident or injury occurs.

6.2.11.1.9 Allow crane operation near electric power lines only when:

- The requirements of Chapter 2 and paragraph 9.6 have been satisfied.
- A qualified “dedicated spotter” is assigned, if required, and is identified to the operator.

6.2.11.1.10 Ensure precautions are implemented when hazards associated with critical lifts or other special lifting operations are present.

6.2.11.1.11 Ensure that the applicable requirements of Chapter 4 are met when lifting personnel.

6.2.11.1.12 Ensure that a crane's load rigging is performed by a qualified rigger(s).

6.2.11.1.13 Ensure that the load is properly rigged and balanced before it is lifted more than a few inches.

6.2.12 Inspectors

6.2.12.1 Qualified inspectors shall have the necessary knowledge and experience to inspect hoisting and rigging equipment.

6.2.12.2 Employees who operate cranes to perform crane inspections shall be trained and qualified to operate the crane on which the inspection is being performed. See general and crane specific qualification requirements in paragraph 6.2, "Qualification."

6.2.11.3 Crane operation by crane inspectors shall be limited to those crane functions necessary to perform the inspection on the crane.

6.2.13 Instructors

Instructors responsible for developing or presenting hoisting and rigging training programs shall meet the qualification standards specified by a qualified third-party training source or a qualified person following the employer's train-the-trainer process.

6.2.14 On-the-Job Performance Evaluators (OJPE)

On the Job Performance Evaluators (OJPE) are responsible for conducting On The Job Evaluations (OJE) of hoisting and rigging equipment operators. These persons may serve as an instructor if they meet the qualification standards specified in paragraph 6.2.13.

6.2.15 First-Line Supervisors

The first-line supervisor of hoisting and rigging operations should be knowledgeable of the specific types of hoisting and rigging operations under their supervision and their operational hazards. The supervisor shall be familiar with applicable rules and procedures implemented at the site to ensure that hoisting and rigging work under their control is done efficiently and safely, with safety as top priority. Supervisors should ensure that employees fully understand the importance of safety and that they recognize their own authority and responsibility to stop work when safety is questionable.

6.2.16 Crane Maintenance Personnel

6.2.16.1 Employees who operate cranes to perform crane maintenance shall be trained and qualified to operate the cranes on which maintenance is being performed.

6.2.16.2 Crane operation by maintenance personnel shall be limited to those crane functions necessary to perform maintenance on the crane or to verify the performance of the crane after maintenance has been performed.

6.2.16.3 Employees who perform maintenance activities on equipment covered by this standard should have an understanding of the following criteria:

6.2.16.3.1 The tools to accomplish their work.

6.2.16.3.2 Access to operating instructions to perform adjustments.

6.2.16.3.3 Parts information furnished by the manufacturer or the responsible maintenance/engineering organization.

6.2.16.3.4 Manufacturers' recommendations as to points and frequency of lubrication and levels and types of lubricant to be used.

6.2.16.3.5 Maintenance and repair procedures recommended by the manufacturer or responsible maintenance/engineering organization.

6.2.16.3.6 Wiring diagrams.

6.2.16.3.7 Documentation requirements for maintenance and repair.

6.2.17 Signal Person

6.2.17.1 Employees assigned to the duties of Signal Person for crane operations shall be trained and qualified to perform the duties prior to giving any signals.

6.2.17.2 Each signal person must be:

6.2.17.2.1 Trained per paragraph 6.3.11 below.

6.2.17.2.2 Demonstrate competence in the application of the type of signals used through a practical evaluation.

6.2.18 Asset Owner (Hoisting and Lifting Operations)

6.2.18.1 The asset owner of hoisting and rigging operations shall be knowledgeable of the specific types of hoisting and rigging operations under their supervision and the associated hazards.

6.2.18.1.1 The Asset Owner shall be familiar with applicable rules and procedures implemented at the site to ensure that hoisting and rigging work under their control is done safely.

6.2.18.1.2 Asset Owners shall be qualified for the following responsibilities:

- Ensuring that the crane and equipment meets the inspection and maintenance requirements of this handbook prior to initial site usage.
- Determining if additional regulations are applicable to crane operations.
- Ensuring that a qualified person is assigned as the Designated Leader.

- Ensuring that crane operations are coordinated with other jobsite activities that will be affected by or will affect lift operations.
- Ensuring that the area for the crane is adequately prepared. The preparation includes, but is not limited to, the following:
 - Access roads for the crane and associated equipment
 - Sufficient room to assemble and disassemble the crane
 - An operating area that is suitable for the crane with respect to levelness, surface conditions, support capability, proximity to power lines, excavations, slopes, underground utilities, subsurface construction, and obstructions to crane operation
 - Traffic control as necessary to restrict unauthorized access to the crane's working area
- Ensuring that work involving the assembly and disassembly of a crane is supervised by a qualified person.
- Ensuring that crane operators meet the requirements of para. 5-3.1.2.
- Ensuring that conditions that may adversely affect crane operations are addressed. Such conditions include, but are not limited to, the following:
 - Poor soil conditions
 - Wind velocity or gusting winds
 - Heavy rain
 - Fog
 - Extreme cold
 - Artificial lighting
- Permitting critical lifts only when equipment and procedures required by Chapters 2 and 4, the crane manufacturer, or a qualified person are employed. multiple crane lifts
- Ensure lifting of personnel meets the requirements of Chapter 4.
- Allowing crane operation near electric power lines only when the requirements of paragraph 9.6 have been met.
- Ensuring that work performed by the rigging crew is supervised by an appropriately qualified person.
- Ensuring that crane maintenance is performed by qualified crane maintenance personnel.

6.3 TRAINING

6.3.1 General

6.3.1.1 Organizations that employ personnel who operate, rig, inspect, or perform maintenance on equipment covered in this standard shall provide training programs, including a means of evaluation, to ensure that the personnel are competent to perform the operations. This training shall also include applicable site-specific hoisting and rigging procedures, which address abnormal or emergency operations as well as possible equipment failure.

6.3.1.2 Training shall utilize the methods best suited for the students and the subject material. This may include, but is not limited to, computer-aided training, classroom training, simulated field training, on-the-job training (OJT), and training by equipment manufacturer or commercial training companies.

6.3.1.3 Score standards shall be set for each examination. The minimum passing score will depend on the subject, testing technique, and test difficulty. Management shall determine the course of action for persons receiving negative evaluations.

6.3.2 Operators of Cab-Operated and Floor Operated Cranes

6.3.2.1 Only qualified and authorized operators or operator trainees under the direct supervision of a qualified operator shall be permitted to operate cab-operated and floor-operated cranes.

6.3.2.2 The initial training of operators shall include:

6.3.2.2.1 Applicant training on equipment for which qualification is sought, under the direction of a qualified operator or instructor who is designated by management to instruct in the operation of hoisting equipment.

6.3.2.2.2 Instructor's review of the applicant's knowledge includes results of written and oral evaluation, and witnessing a demonstration of the operator's skills.

6.3.2.3 Operators should be able to demonstrate knowledge of equipment operating characteristics, capabilities, limitations, effects of variables, safety features, and operating procedures. The following checklist contains basic factors with which an operator should be familiar. This checklist must be tailored to suit actual conditions.

6.3.2.3.1 Operating characteristics.

6.3.2.3.2 Environmental hazards – weather.

6.3.2.3.3 Electrical hazards.

6.3.2.3.4 Traveling with load.

6.3.2.3.5 Traveling without load.

6.3.2.3.6 Lifting personnel.

6.3.2.3.7 Inspections/tests.

6.3.2.3.8 Load weight estimation.

6.3.2.3.9 Emergency procedures.

6.3.2.3.10 Rigging.

6.3.2.3.11 Lessons learned.

6.3.2.3.12 Hand signals.

6.3.2.3.13 Load dynamics.

6.3.2.3.14 Applicable standards and regulations.

6.3.2.3.15 Critical lifts.

6.3.2.3.16 Safety features of equipment.

6.3.2.3.17 Terminology and definitions.

6.3.2.3.18 Ropes and reeving.

6.3.2.3.19 Two-blocking.

6.3.2.3.20 Records and documents.

6.3.2.3.21 Limit switches, warning signals.

6.3.2.3.22 Operating practices.

6.3.2.3.23 Fire protection.

6.3.2.3.24 Crane components.

6.3.2.3.25 Access and egress.

6.3.2.3.26 Warning devices.

6.3.3 Mobile Crane Operators

6.3.3.1 Only qualified and authorized operators or operator trainees under the direct supervision of a qualified operator shall be permitted to operate mobile cranes.

6.3.3.2 In addition to the listed basic factors from paragraph 6.3.2.3, the following factors need to be taken into consideration by mobile crane operators:

6.3.3.2.1 Stability.

6.3.3.2.2 Load charts.

6.3.3.2.3 Crane setup.

6.3.3.2.4 Refueling.

6.3.3.2.5 Lifting operations involving multiple cranes.

6.3.3.2.6 Assembly and disassembly.

6.3.3.2.7 Outriggers.

6.3.3.2.8 Operator aids.

6.3.4 Operators of Truck-Mounted Cranes – Capacity 1 Ton or Less

6.3.4.1 Only authorized operators or operator trainees under the direct supervision of an authorized operator shall be permitted to operate truck mounted cranes – capacity 1 ton or less.

- 6.3.4.2 There is no formal training program for these type cranes. All training is provided under direct supervision of an authorized operator and through manufacturer's operation manuals.
- 6.3.4.3 Operators should be able to demonstrate knowledge of the equipment operating characteristics, capabilities, limitations, effects of variables, safety features, and operating procedures.

6.3.5 Forklift Truck Operators

6.3.5.1 Only qualified and authorized operators shall be permitted to operate powered forklift trucks. Operator trainees may operate powered forklift trucks under the direct supervision of a qualified operator or trainer and only where such operation does not endanger the trainee or other employees.

6.3.5.2 The initial training of operators shall include:

6.3.5.2.1 A combination of formal instruction (e.g., lecture, discussion, interactive computer learning, videotape, written material).

6.3.5.2.2 Practical training (demonstrations performed by the trainer and practical exercises performed by the trainee).

6.3.5.2.3 Evaluation of the operator's performance in the workplace including results of written and oral evaluation, and witnessing a demonstration of the operator's skills.

6.3.5.3 The following checklist contains basic factors with which a forklift truck operator should be familiar. This checklist must be tailored to suit actual conditions.

6.3.5.3.1 Operating instruction, warnings, and precautions for the type of forklift truck the operator will be authorized to operate.

- Where they are located.
- What they do.
- How they work.

6.3.5.3.2 Differences between the forklift truck and the automobile.

6.3.5.3.3 Forklift truck controls and instrumentation.

6.3.5.3.4 Engine or motor operation.

6.3.5.3.5 Steering and maneuvering.

6.3.5.3.6 Visibility, including restrictions due to loading.

6.3.5.3.7 Fork and attachment adaptation, operation, and use limitations.

6.3.5.3.8 Forklift truck capacity and load weight determination.

6.3.5.3.9 Forklift truck stability and load dynamics.

6.3.5.3.10 Forklift truck inspections and maintenance that the operator will be required to perform.

6.3.5.3.11 Refueling and/or charging and recharging of batteries.

6.3.5.3.12 Operating limitations.

6.3.5.3.13 Any other operating instructions, warning, or precautions listed in the operator's manual for the type of forklift truck that the employee is being trained to operate.

6.3.5.3.14 Traveling with and without a load.

6.3.5.3.15 Lifting personnel.

6.3.5.3.16 Emergency procedures.

6.3.5.3.17 Lessons learned.

6.3.5.3.18 Hand signals.

6.3.5.3.19 Applicable standards and regulations.

6.3.5.3.20 Critical lifts.

6.3.5.3.21 Modifications.

6.3.5.3.22 Terminology and definitions.

6.3.5.3.23 Records and documents.

6.3.5.3.24 Operating practices.

6.3.5.3.25 Fire protection.

6.3.5.4 The following checklist contains basic factors with which a forklift operator should be familiar as they relate to workplace topics.

6.3.5.4.1 Surface conditions where the forklift will be operated.

6.3.5.4.2 Composition of loads to be carried and load stability.

6.3.5.4.3 Load manipulation, stacking, and unstacking.

6.3.5.4.4 Pedestrian traffic in areas where the forklift will be operated.

6.3.5.4.5 Narrow aisles and other restricted places where the forklift will be operated.

6.3.5.4.6 Hazardous (classified) locations where the forklift will be operated.

6.3.5.4.7 Ramps and other sloped surfaces that could affect the forklift's stability.

6.3.5.4.8 Closed environments and other areas where insufficient ventilation or poor vehicle maintenance could cause a buildup of engine exhaust (gasoline or diesel).

6.3.5.4.9 Other unique or potentially hazardous environmental conditions in the workplace that could affect safe operation.

6.3.5.5 Refresher training in relevant topics shall be provided to the operator when:

6.3.5.5.1 The operator has been observed to operate the forklift truck in an unsafe manner.

6.3.5.5.2 The operator has been involved in an accident or near-miss incident.

6.3.5.5.3 The operator has received an evaluation that reveals that the operator is not operating the forklift truck safely.

6.3.5.5.4 The operator is assigned to drive a different type of forklift truck.

6.3.5.5.5 A condition in the workplace changes in a manner that could affect the safe operation of the forklift truck.

6.3.6 Riggers

6.3.6.1 Training programs for riggers should address two levels of required performance:

6.3.6.1.1 Persons who perform rigging functions as an incidental part of their normal work assignment

6.3.6.1.2 Persons whose principal assignment is the performance of rigging work

6.3.6.2 Only qualified and authorized persons or trainees **in OJT status** and under the direct supervision of a qualified **person** shall be permitted to perform rigging functions.

6.3.6.3 Training of personnel performing rigging tasks shall include the applicable portions of Chapters 11 thru 14 of this handbook and safe rigging practices. Classroom training shall be presented by a Hoisting and Rigging Instructor. OJT trainers shall be assigned by the trainee's supervisor or management according to the employer's policies.

6.3.7 Hoisting and Rigging Inspectors

6.3.7.1 Employees who perform required, documented inspections of equipment covered by this standard shall receive inspector training.

6.3.7.2 Inspector training shall include basic inspection techniques and acceptance/rejection criteria as specified in this standard and other applicable sources.

6.3.7.3 The following equipment categories for general inspection are examples that should be considered:

6.3.7.3.1 Overhead, gantry, and polar cranes.

6.3.7.3.2 Monorail, jib, and other hoists.

6.3.7.3.3 Mobile cranes (hydraulic and lattice boom).

6.3.7.3.4 Forklift trucks.

6.3.7.3.5 Wire-rope, chain, and synthetic-web slings.

6.3.7.3.6 Rigging accessories.

6.3.7.4 Employees who perform crane inspections do not have to be a fully qualified crane operator to operate the crane for inspection purposes; however, they must be trained on the operation of the crane. These crane inspectors will be given a crane inspector sticker to show proof of training.

6.3.8 Hoisting and Rigging Instructors

6.3.8.1 Instructors designated by management to be responsible for developing or presenting hoisting and rigging training programs shall develop technical competence by becoming familiar with the

requirements of this standard and by satisfactorily completing documented training or technical experience in the hoisting and rigging discipline.

6.3.8.2 Instructors should attend recognized training courses, workshops, or seminars in order to remain current on industry practices and changes in applicable codes and standards.

6.3.9 OJPE Evaluators

6.3.9.1 OJPE Evaluators shall be designated by management and shall be fully qualified to operate the piece of hoisting and rigging equipment for which they are performing the OJE on.

6.3.9.2 OJPE Evaluators shall evaluate each operator and certify in writing that the operator has demonstrated to them that they have the necessary knowledge and skills to operate the equipment safely before deeming the operator qualified.

6.3.10 Hoisting and Rigging Maintenance Personnel

Employees who operate cranes to perform crane maintenance shall be trained and qualified to operate the cranes on which maintenance is being performed.

6.3.11 Signal Person

6.3.11.1 Signal persons shall be trained on the following topics:

6.3.11.1.1 Types of signals used to include:

6.3.11.1.2 Standard hand signals as defined by OSHA

6.3.11.1.3 Non-standard hand signals. When they are is allowed and provisions for using them.

6.3.11.1.4 Suitability of signals to be used.

6.3.11.1.5 Interruption of signals. What to do if signaling ability is interrupted.

6.3.11.1.6 Equipment operation and limitations including the crane dynamics involved in swinging and stopping loads and boom deflection from hoisting loads.

6.3.11.1.7 Working near power lines.

6.3.11.2 Signal person shall demonstrate knowledge and understanding through an oral or written test. And be designated as qualified per paragraph 6.2.17 above.

6.4 REQUALIFICATION

6.4.1 Mobile Crane Operators shall re-qualify at least every 5 years in accordance with OSHA 29 CFR 1926 Subpart CC.

6.4.2 Overhead Crane operator shall re-qualify in accordance with employer's requirements or every 5 years.

6.4.3 Forklift Operators shall re-qualify at least every 3 years in accordance with OSHA 29 CFR 1910.178.

6.5 RECORDS

A record of training and skill evaluations shall be kept on file and shall be readily available.

7.0 CHAPTER 7 - OVERHEAD AND GANTRY CRANES

This chapter specifies operation, inspection, maintenance, and testing requirements for the use of overhead and gantry cranes and implements the requirements of ASME B30.2, B30.11, and B30.17. Only equipment built to the appropriate design standards shall be used at AEDC.

7.1 GENERAL

This chapter applies to overhead and gantry cranes, including semi-gantry, cantilever gantry, wall cranes, storage bridge cranes, and others having the same fundamental characteristics. Overhead and gantry cranes include top-running single- or multiple-girder bridge with top-running trolley hoists (Figure 7-1), top-running single-girder bridge with underhung trolley hoists (Figure 7-2), and monorails/underhung cranes (Figure 7-3). Hoist units and trolleys are most commonly electric powered, but can be air powered or hand chain operated. These cranes may be cab operated, pulpit operated, floor operated, or remotely operated. Such cranes are grouped together because all have trolleys and similar travel characteristics and are governed by OSHA 29 CFR

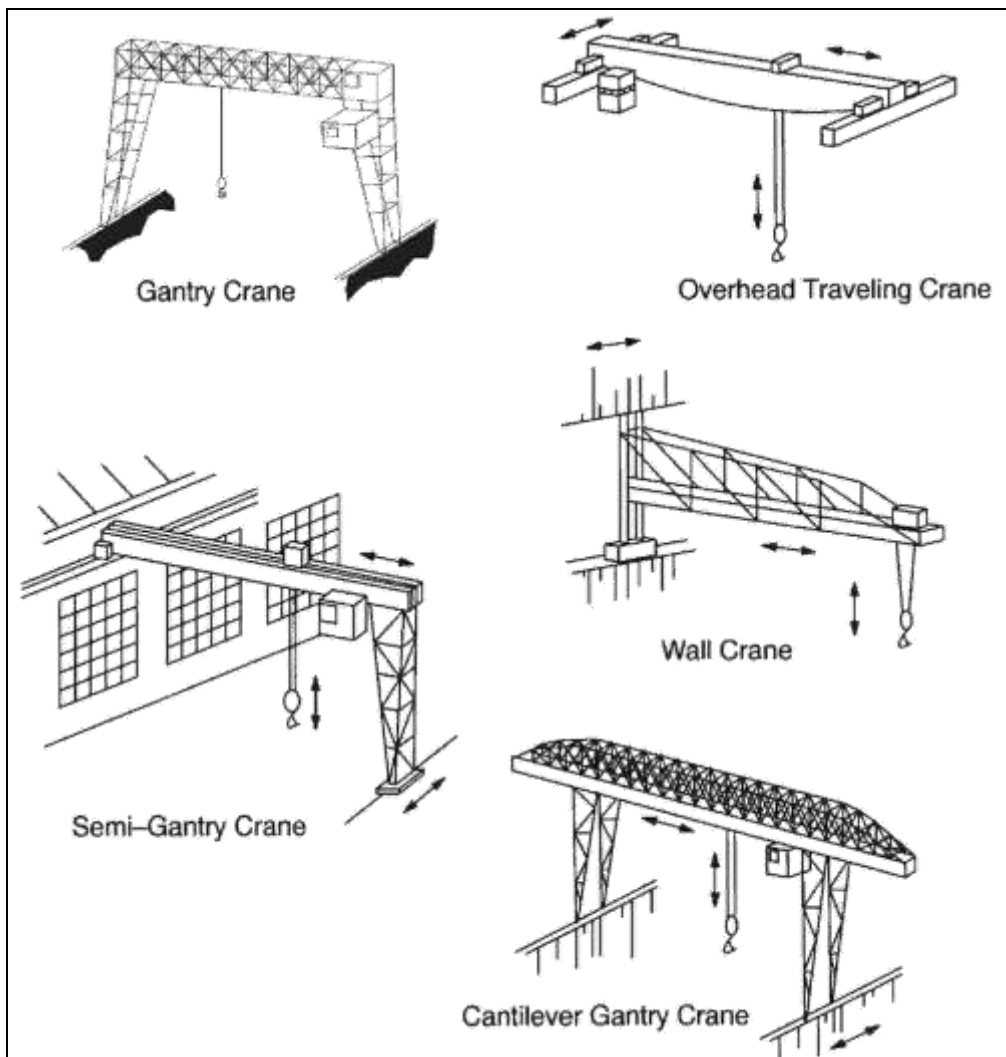


Figure 7-1. Top-running single- or multiple-girder bridge with top-running trolley hoist

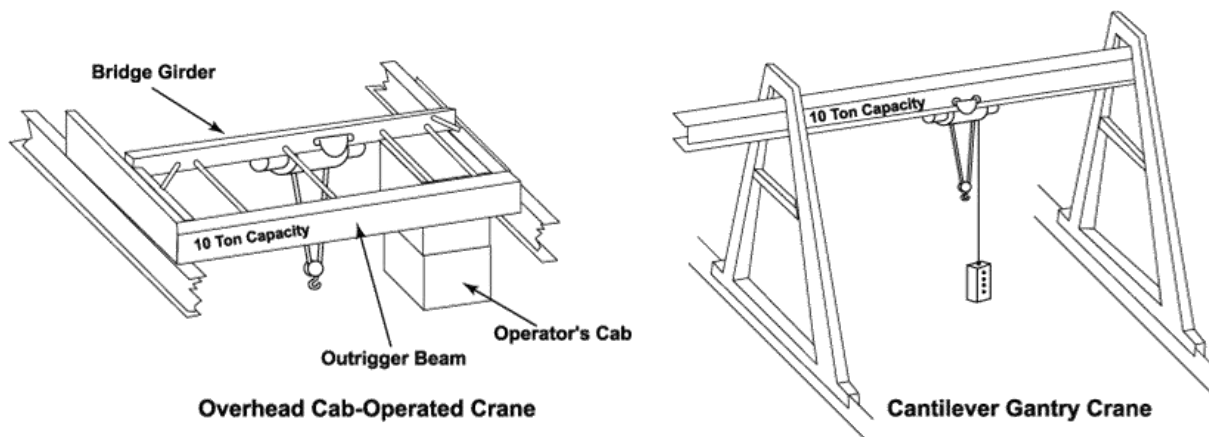


Figure 7-2. Top-running single-girder bridge with underhung trolley hoist.

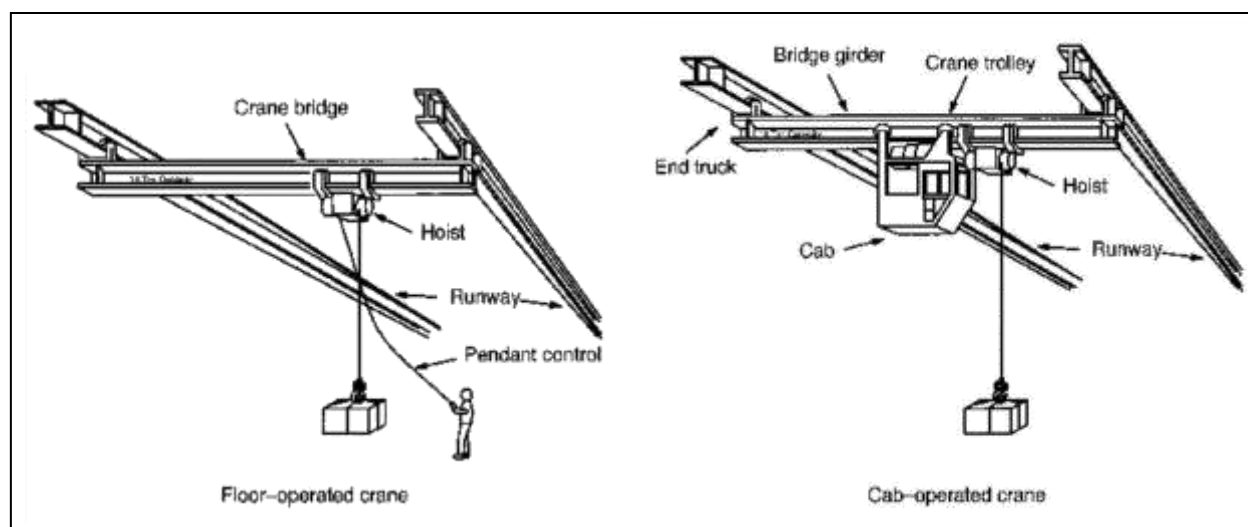


Figure 7-3. Monorails and underhung cranes.

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7.1.1 Fall Protection

Anyone accessing the structure of an overhead cab or pulpit operated crane, this includes operators, inspectors, electricians, etc., shall wear a full body harness and carry a lanyard or self-retracting lifeline. This is done for several reasons: If an emergency arises and self-rescue becomes necessary, the employee will have the necessary equipment on; if rescue becomes necessary because of incapacitation of the employee the fire department's rescue team will not have to spend precious time trying to fit the employee with a harness; and should it become necessary to walk on the gantry or bridge or work from an area not protected by guardrails, fall protection equipment will be available.

7.1.2 Operator Training/Qualification

7.1.2.1 Operators of overhead cranes shall be trained and qualified as required in Chapter 6.

7.1.2.2 Cranes shall be operated only by the following qualified personnel:

7.1.2.2.1 Qualified operators

7.1.2.2.2 Trainees under the direct supervision of a designated person.

7.1.2.2.3 Maintenance, inspection, and test personnel, when it is necessary in the performance of their duties.

7.1.2.3 No one other than personnel specified above shall enter a crane cab or pulpit, with the exception of persons such as oilers and supervisors, whose duties require them to do so, and then only with the knowledge of the crane operator.

7.1.3 Rated-Load Marking

The rated capacity shall be marked on each side of the crane's bridge. If the crane has more than one hoisting unit, each hoist shall have its rated capacity marked on it or on its load block. Markings on the bridge, trolley, and load block shall be legible from the ground or floor. Load blocks should be painted to contrast with the bridge and trolley to facilitate quick visual identification.

7.1.4 Modification

Cranes may be modified or rerated if the modifications or supporting structures are analyzed thoroughly by a qualified engineer or by a manufacturer of cranes. Modifications and reratings must be approved by the base operating contractor's safety office. A rerated crane, or one whose load-supporting components have been modified, shall be tested in accordance with paragraph 7.3.2 Rated Load Tests . The new rated capacity shall be displayed in accordance with paragraph 7.1.3.

7.1.5 Egress

On cab-operated cranes, there shall be a means of egress to permit departure under emergency conditions.

7.1.6 Brakes

7.1.6.1 Each independent hoisting unit shall be equipped with at least one holding brake applied directly to the motor shaft or some part of the gear train.

7.1.6.2 Each independent hoisting unit greater than 1 ton (except worm-gear hoists, the angle of whose worm prevents the load from accelerating as it is being lowered) shall be equipped with a controlled-braking means in addition to the holding brake to control speed of lowering.

7.1.6.3 Holding brakes on hoists shall be applied automatically when power is removed.

- 7.1.6.4 A hand-operated hoist shall be so designed that when the actuating force is removed, it will automatically stop and hold a test load up to 125% of the rated load
- 7.1.6.5 Brakes shall be provided with a means for adjustment to compensate for wear. The wearing surface of all brake drums or discs shall be smooth.
- 7.1.6.6 Any combination of service, emergency, and parking functions may be provided by a single friction brake if it can be applied without having power available.
- 7.1.6.7 If holding brakes are provided on the bridge or trolleys, they shall not prohibit the use of a drift point in the control circuit.
- 7.1.6.8 Foot brake pedals shall be cleaned and properly maintained so that the operator's foot will not easily slip off the pedal.

7.1.7 Power Shutoff

- 7.1.7.1 The power supply to the runway conductors shall be controlled by a switch or circuit breaker located on a fixed structure. The switch shall be easily accessible and visible from the floor and capable of being locked in the OPEN position.
- 7.1.7.2 On cab-operated cranes, an enclosed switch or circuit breaker (with provisions for locking in the OPEN position) shall be provided in the leads from the runway conductors. A means of opening this device shall be located within reach of the operator when the operator is in the operating position. When the operator opens this switch or circuit breaker, the holding brakes shall set.
- 7.1.7.3 On floor, remote, or pulpit-operated cranes, an enclosed disconnect device shall be provided in the leads from the runway conductors. This device shall be mounted on the bridge or footwalk near the runway collectors. There shall be provisions for locking the device in the OPEN position unless the crane is the only load on a lockable switch or circuit breaker that is accessible from the floor. One of the following types of floor, remote, and pulpit-operated disconnects shall be provided.
 - 7.1.7.3.1 A nonconductive rope attached to the main disconnect device on a floor-operated crane. If this is selected, the rope shall be suspended adjacent to the operating ropes if manual controllers are used or near the pendant push-button station if magnetic controls are used.
 - 7.1.7.3.2 An under-voltage trip for a main circuit breaker, operated by an emergency stop button in the pendant push-button station or the pulpit.
 - 7.1.7.3.3 A main-line contactor operated by a switch or push button on the pendant push-button station, the remote-control station, or the pulpit.

7.1.8 Hoist Limit Switch

- 7.1.8.1 The hoisting motion of all cranes shall have an overtravel-limit switch/ device in the hoisting direction to stop the hoisting motion.

7.1.8.2 Lower-travel limit switches/devices should be provided for all **power-driven** hoists where the load block enters pits or hatchways in the floor.

7.1.9 Load Limits

7.1.9.1 No crane shall be loaded beyond its rated load except for test purposes as provided in paragraph 7.3.2 below.

7.1.9.2 Provisions for special overrated load lifts (also called planned engineered lifts) are outlined in ASME B30 standards. However, no such lift shall be made without the authorization of the AEDC Crane System Engineer. This authorization will only be granted after the AEDC Structural Engineer has reviewed the design of the crane-supporting structure, has inspected the structure as required by ASME B 30 standards and has approved its use for the intended lift.

7.1.10 Electrical Equipment

7.1.10.1 Wiring and equipment shall comply with the National Electrical Code, NFPA 70, Article 610, “Cranes and Hoists.”

7.1.10.2 Lever-operated controllers shall be provided with a notch or latch that in the “off” position prevents the handle from being inadvertently moved to the “on” position. An “off” detent or spring return arrangement is acceptable.

7.1.10.3 For floor operated cranes, the control or controls, if rope operated, shall automatically return to the “off” position when released by the operator.

7.1.10.4 Cranes not equipped with spring-return controllers, spring-return master switches, or momentary-contact pushbuttons shall be provided with a device that will disconnect all motors from the line in the event of a power failure. This disconnect device shall not permit any motor to be restarted until the control or master switch handle is brought to the “off” position, or a reset switch or power-on button is operated.

7.1.10.5. As far as practicable, the movement of each control handle shall be in the same general direction as the resultant movements of the load.

7.1.10.6 Remotely operated cranes shall function so that if the control signal for any motion becomes ineffective, that motion shall stop. In addition, signals received from any source other than the operating station (transmitter) shall not result in operation of any motion.

7.1.10.7 The control circuit voltage shall not exceed 600 volts alternating current (AC) or direct current (DC). The voltage at pendant push buttons shall not exceed 150 volts AC and 300 volts DC.

7.1.10.8 Pendant Control Station Requirements.

7.1.10.8.1 A pendant push-button station shall be supported so that the electrical conductors are protected from strain.

7.1.10.8.2 Makeshift field-fabricated pendants shall not be used. Pendant control boxes shall be constructed to prevent electrical shock.

- 7.1.10.8.3 Push buttons (except on/off buttons) shall spring-return to the “off” position when the operator releases pressure. Buttons shall be clearly marked to identify their function. To minimize operator fatigue, return-spring force shall be the minimum necessary for positive return.
- 7.1.10.8.4 To the extent possible, each crane control shall be marked to indicate the direction of resultant motion.
- 7.1.10.9 Unless the crane is the only load on a lockable switch or circuit breaker accessible from the floor, a lockable switch, or enclosed type circuit breaker in the leads from the runway conductors shall be mounted on the bridge or footwalk near the runway collectors. In either the floor or bridge/footwalk mount, a means to open the switch with a magnetic contactor controlled from the operator's station shall be provided. This provides for emergency shutdown of all power to the crane.
- 7.1.10.10 Open-type runway conductors mounted on the crane runway beams or overhead shall be positioned or fitted with guards so that persons cannot inadvertently come into contact with them. Securely fastened guards shall be provided to prevent contact between bridge conductors and hoist ropes if hoist ropes could come into contact with conductors.
- 7.1.10.11 A crane using a lifting magnet shall have a magnet circuit switch (enclosed type) with provision for locking in the open position. Means for discharging the inductive load of the magnet shall be provided.
- 7.1.10.12 If a service receptacle is provided in the cab or on the bridge, it shall be a grounded three-prong permanent receptacle not exceeding 300 volts.

7.1.11 Warning Devices

- 7.1.11.1 Except for floor-operated cranes, a gong, bell, horn, flashing light, or other effective warning device shall be provided for each crane with a power traveling mechanism. A warning device is recommended for floor-operated cranes with a power traveling mechanism.
- 7.1.11.2 A warning light visible from the operating floor, crane bridge, and runways should be provided. The warning light, if provided, shall be activated at all times when the runway conductors are energized.
- 7.1.11.3 For outdoor, overhead, and gantry crane operations with a top-running trolley, a wind-indicating device shall be provided. The device shall give a visible and audible alarm to the crane operator at a predetermined wind velocity.

7.1.12 Maintenance History

- 7.1.12.1 The crane maintenance file is a compilation of various documents and records relating to operation, maintenance, inspection, testing, evaluating, and repair of the equipment.
- 7.1.12.2 The master file shall be located in the AEDC crane library. A secondary file may be centrally located or proportioned into satellite holding areas.

7.1.12.3 The maintenance history of the crane shall be retained throughout its service life. Maintenance records shall be retained in the crane history file, or an electronic record keeping system may be used. If a computer system is used, and maintenance records are not retained in the crane history file, the crane history file shall state where the electronic maintenance records are available.

7.1.12.4 The most recent copy of dated records that document maintenance of critical items such as hoisting machinery, sheaves, hooks, chains, ropes, and other lifting devices shall be retained in a maintenance file.

7.1.12.5 The intent of the crane maintenance files are to provide the user with evidence of a safe and reliable maintenance program. Inspection records should be retained in a format and location that provides for ease in accessibility. Maintenance file information should provide a source for comparing present conditions with past conditions to determine whether existing conditions show a trending pattern of wear, deterioration, or other comparable factors that may compromise safe, continued use of the equipment

7.1.12.6 Crane maintenance files shall contain the following documentation, as applicable:

7.1.12.6.1 Section A: Preventive Maintenance

- Specification Data Sheet / Crane Manual
- 12 Month PM (Latest plus previous one)
- 1 Month PM (Latest plus previous two).
- Oil Analysis Trend Data (Life of Component)

7.1.12.6.2 Section B: Repairs/Alterations

- Repair Work Orders (Life - Synergen W/O Log)
- Purchase Orders for:
 - Load Bearing / Load Controlling Parts (7 yrs)
 - Repair / Service Work (7 yrs)
 - Operational Safety Devices (7 yrs)
 - Deficiency Reports (Life)
- Documents involving Crane Alterations (Life)
- Crane Acceptance Test (New Cranes / Modifications)
- Coupling Alignment Data/Hoist Rollback Data (Life)
- Deficiency Reports (Life)

7.1.12.6.3 Section C: Test Reports / Certifications

- Non-Destructive Test Reports (Latest)
- Certification of Load Test and Extensions (Latest plus one)
- Wire Rope Breaking Strength Certification (Latest)
- Operational Lifts Exceeding the Certified Capacity (5 yrs.)

7.1.12.6.4 Section D: Miscellaneous

- Accident Reports (Life)
- Miscellaneous Other information
- AEDC Crane System Engineer Monthly Random Audit (As performed - 5 yrs.)
- Other

NOTE: Although complete maintenance information for old cranes may not be available, the AEDC Crane System Engineer should acquire as much of the pertinent information as possible.

7.2 INSPECTIONS

7.2.1 General

There shall be no apparent damage, excessive wear, or deformation of any load-bearing part of the equipment. Brakes shall work satisfactorily and load brakes shall be designed to hold any load up to at least 125% of the rated capacity of the equipment without slipping or overheating. All safety devices, load indicators, controls, and other operating parts of the equipment shall be checked during each inspection and shall be in good working order. Parts found to be defective during inspection or nondestructive examination shall be replaced or repaired.

7.2.2 Crane Service

Crane service is defined as follows:

7.2.2.1 Normal service – operating at less than 85% of rated load and not more than 10 lift cycles/hr except for isolated instances.

7.2.2.2 Heavy service – operating at 85 to 100% of rated load or in excess of 10 lift cycles/hr as a regular specified procedure.

7.2.2.3 Severe service – operating at normal or heavy service under abnormal operating conditions (i.e., extreme temperatures, corrosive atmospheres).

7.2.3 Initial Inspection

Prior to their initial use, all new, reinstalled, modified, or repaired cranes shall be inspected by a qualified inspector to ensure compliance with applicable provisions of this chapter. Inspections of repaired and modified cranes may be limited to the provisions affected by the alteration, repair, or modification as determined by a qualified person. Dated and signed inspection reports shall be kept on file and shall be readily available.

7.2.4 Daily Preoperational Check

7.2.4.1 Operators or other designated personnel shall visually inspect at a minimum the following items each day or prior to first use if the hoist has not been in regular service (records are not required):

7.2.4.1.1 All functional operating mechanisms for maladjustment interfering with proper operation.

7.2.4.1.2 Deterioration or leakage in lines, tanks, valves, drain pumps, and other parts of air or hydraulic systems.

7.2.4.1.3 Hooks for cracks, deformation, latch engagement (if provided), and damage from chemicals (see Chapter 13).

7.2.4.1.4 Hoist rope for significant wear, kinking, crushing, bird caging, corrosion, or broken strands or wires.

7.2.4.1.5 Hoist chains, including end connections, for excessive wear, twist, distorted links interfering with proper function, or stretch beyond manufacturer's recommendations.

7.2.4.1.6 Hoist upper-limit devices for proper operation.

7.2.4.2 Operators or other designated personnel shall examine deficiencies and determine whether the equipment should be removed from service or if a more detailed inspection is required.

7.2.5 Monthly Rope, Chain, and Hook Inspection

7.2.5.1 On a monthly basis, the operator or other designated person shall thoroughly inspect the following items for damage, wear, or other deficiencies that might reduce capacity or adversely affect the safety of the crane:

7.2.5.1.1 This shall be accomplished by lowering the hook block to its lowest position and examining for any condition that could result in an appreciable loss of strength.

7.2.5.1.2 Hoist rope, including end connections, for significant wear, kinking, crushing, bird caging, corrosion, broken strands or wires.

7.2.5.1.3 Hoist chains, including end connections, for excessive wear, twist, distorted links interfering with proper function, or stretch beyond manufacturer's recommendations.

7.2.5.1.4 Hooks for cracks, deformation, damage from chemicals, and evidence of heat damage. The hook attachment and securing means should also be checked. (See Chapter 13).

7.2.5.1.5 Signed and dated inspections records shall be kept on file in accordance with 7.1.12.6.

7.2.5.2 Before the crane is returned to service, deficiencies that could reduce its capacity or adversely affect its safety shall be corrected.

7.2.6 Frequent Inspection

7.2.6.1 Designated personnel shall visually inspect the crane at the following intervals (records are required):

7.2.6.1.1 Normal service – monthly.

7.2.6.1.2 Heavy service – weekly to monthly.

7.2.6.1.3 Severe service – daily to weekly.

7.2.6.2 In addition to the requirements of Section 7.2.4 these inspections shall include the following:

7.2.6.2.1 Hoist braking system for proper operation.

7.2.6.2.2 Rope or chain reeving for compliance with hoist manufacturer's recommendations.

7.2.6.2.3 Operating mechanisms for proper operations, proper adjustment, unusual sounds, or excessive wear.

7.2.6.2.4 Warning devices for proper operation.

7.2.6.2.5 Rope for proper spooling onto the drums and sheaves.

7.2.6.3 Operators or other designated personnel shall examine deficiencies and determine whether the equipment should be removed from service or if a more detailed inspection is required.

7.2.6.4 Dated and signed inspection records shall be kept on file in accordance with paragraph 7.1.12.6.

7.2.7 Periodic Inspection

7.2.7.1 General

7.2.7.1.1 A qualified inspector shall perform a complete inspection at the following intervals:

7.2.7.1.1.1 Normal service – yearly.

7.2.7.1.1.2 Heavy service – yearly.

7.2.7.1.1.3 Severe service – quarterly.

7.2.7.1.2 The qualified inspector shall examine deficiencies and determine whether they constitute a safety hazard and whether the crane should be removed from service until it is repaired.

7.2.7.1.3 Dated and signed inspection records shall be kept on file in accordance with 7.1.12.6.

7.2.7.2 Cranes - In addition to the requirements of Section 7.2.6, periodic inspections shall include the following:

7.2.7.2.1 Components for deformation, cracks, or corrosion.

7.2.7.2.2 Bolts, rivets, nuts, and pins for being loose or absent.

7.2.7.2.3 Check for suspect/counterfeit parts (see Chapter 1).

7.2.7.2.4 Sheaves and drums for cracks or wear.

7.2.7.2.5 Parts such as pins, bearings, shafts, gears, rollers, locking and clamping devices, bumpers, and stops for wear, cracks, or distortion.

7.2.7.2.6 Brake system parts, linings, pawls, and latches for excessive wear.

7.2.7.2.7 Load, wind, and other indicators over their full range for any significant inaccuracies.

- 7.2.7.2.8 Gasoline, diesel, electric, or other power plants for improper performance or noncompliance with other applicable standards.
- 7.2.7.2.9 Chain-drive sprockets for excessive wear and chains for excessive stretch.
- 7.2.7.2.10 Electrical apparatus for signs of pitting or any deterioration of controllers, master switches, contacts, limit switches, and push-button stations (not limited to these items).
- 7.2.7.2.11 Hooks with damage from chemicals, deformation, cracks; having more than 5% in excess of normal throat opening, not to exceed $\frac{1}{4}$ inch; or any visibly apparent bend or twist from the plane of the unbent hook (see Chapter 13).
- 7.2.7.2.12 Hook retaining nuts or collars and pins, welds, or riveting used to secure the retaining members for soundness.
- 7.2.7.2.13 Nondestructive examination of hooks, welds, bearings, or other suspect load-bearing parts when required by the inspector.
- 7.2.7.2.14 Testing of motion limit devices, which interrupt power or cause a warning to be activated, for proper performance (each motion shall be inched or operated at low speed into the limit device with not load on the crane).
- 7.2.7.2.15 All function, instruction, caution, and warning labels or plates for legibility.
- 7.2.7.2.16 Deterioration of controllers, master switches, contacts, limit switches, and push-button stations, but not limited to these items
- 7.2.7.2.17 Rope and end connections in accordance with 7.2.7.3.

7.2.7.3 Wire Rope

- 7.2.7.3.1 A qualified inspector shall inspect all ropes at least annually. This inspection shall include examination of the entire length of the rope, without detaching it from the hoist drum. More frequent intervals shall be determined by a qualified person, based on such factors as expected rope life as determined by experience on the particular installation or similar installations, severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. The qualified inspector shall carefully note any deterioration such as described below resulting in appreciable loss of original strength and determine whether further use of the rope constitutes an acceptable risk.
 - 7.2.7.3.1.1 Reduction from nominal diameter of more than 5%.
 - 7.2.7.3.1.2 The number, distribution or concentration of broken outside wires.
 - 7.2.7.3.1.3 Worn outside wires.
 - 7.2.7.3.1.4 Sections of rope that are normally hidden during inspection or maintenance procedures, such as parts passing over sheaves (these are points most subject to deterioration).
 - 7.2.7.3.1.5 Corroded or broken wires at end connections
 - 7.2.7.3.1.6 Corroded, cracked, bent, worn, or improperly applied end connections.
 - 7.2.7.3.1.7 Kinking, crushing, cutting, or unstranding.

7.2.7.3.2 All rope on cranes that have been idle for 1 month or more, but less than 1 year, shall be inspected before the crane is returned to service. This inspection conducted in accordance with 7.2.6.

7.2.7.3.3 No precise rules can be given for determining the exact time to replace rope because many variables are involved. Safety in this respect depends largely on the use of good judgment by an appointed person in evaluating remaining strength in a used rope, after allowance for deterioration disclosed by inspection. Safety of rope operation depends on this remaining strength.

7.2.7.3.4 Conditions such as the following shall be sufficient reason for questioning rope safety and considering replacement:

7.2.7.3.4.1 In running ropes, 12 randomly distributed broken wires in one rope lay, or 4 broken wires in one strand in one rope lay.

7.2.7.3.4.2 Wear of one-third of the original diameter of outside individual wires.

7.2.7.3.4.3 Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.

7.2.7.3.4.4 Evidence of heat damage from any cause.

7.2.7.3.4.5 Reductions from nominal diameter greater than 5%.

7.2.7.3.5 Replacement rope and connections shall have a strength at least as great as the original rope and connections furnished by the crane manufacturer. Any deviation from the original size, grade, or construction shall be specified by a rope manufacturer, the crane manufacturer, or a qualified person.

7.2.7.3.6 Never use discarded rope for slings.

7.2.7.4 Chain (Welded Link)

7.2.7.4.1 Operate the crane under load in raising and lowering directions, and observe the operation of the chain and sprockets. The chain should feed smoothly into and away from the sprockets.

7.2.7.4.2 If the chain binds, jumps, or is noisy, first see that it is clean and properly lubricated. If the trouble persists, inspect the chain and mating parts for wear, distortion, or other damage.

7.2.7.4.3 The chain should be cleaned before inspection. Examine visually for gouges, nicks, weld spatter, corrosion, and distorted links. Slacken the chain and move adjacent links to one side to inspect for wear at contact points. If wear is observed or stretching is suspected, the chain should be measured according to the hoist manufacturer's instructions. If instructions are not available, proceed as follows:

7.2.7.4.3.1 Select an unworn, unstretched length of the chain (e.g., at the slack end).

7.2.7.4.3.2 Suspend the chain vertically under tension and, using a caliper-type gauge, measure the outside length of any convenient number of links approximately 12 in. (305 mm) to 14 in. (356 mm) overall.

7.2.7.4.3.3 Measure the same number of links in the used sections and calculate the percentage of increase in length.

7.2.7.4.4 Conditions such as the following shall be sufficient reason for questioning safety and for considering replacement:

7.2.7.4.4.1 If the used chain exceeds a crane manufacturer's recommended length or, in the absence of such a recommendation, the used chain is 1.5% longer than the unused chain for powered hoists or is 2.5% longer than the unused chain for hand-operated chain, replace the chain.

7.2.7.4.4.2 The existence of gouges, nicks, corrosion, weld spatter, or distorted links.

7.2.7.4.5 Repairing the load chain by welding or any other means shall not be attempted by anyone other than the chain manufacturer.

7.2.7.4.6 Replacement chain shall be the same size, grade, and construction as the original chain furnished by the crane manufacturer unless otherwise recommended by the manufacturer due to working conditions.

7.2.7.4.7 Load-chain links that pass over the load sprocket on edge (alternate to those that lie flat in the pockets) should be installed with the welds away from the center of the sprocket. This precaution is not required on idler sprockets, which change the direction but not the tension in the chain.

7.2.7.4.8 The chain shall be installed without any twist between the hoist and an anchored end on either the loaded side or the slack side.

7.2.7.4.9 When a chain is replaced, disassemble and inspect the mating parts (sprockets, guides, and stripper) for wear, and replace if necessary.

7.2.7.4.10 Discarded load chain shall not be used for slings.

7.2.7.5 Chain (Roller)

7.2.7.5.1 Test the crane under load in raising and lowering directions, observing the operation of the chain and sprockets. If the chain binds, jumps, or is noisy; clean and properly lubricate it. If the trouble persists, inspect the chain and mating parts for wear distortion, or damage.

7.2.7.5.2 If wear is observed or stretching is suspected, the chain shall be measured according to the crane manufacturer's instructions. If instructions are not available, proceed as follows:

7.2.7.5.2.1 Suspend the hoist in normal position and apply a light load of approximately 50 lb (23 kg).

7.2.7.5.2.2 Select a 12 in. (305 mm) section of chain that normally travels over the load sprocket.

7.2.7.5.2.3 Determine elongation by measuring with a caliper from the edge of one chain pin to the corresponding edge of another pin. If elongation exceeds ¼ in. (6.3 mm) in 12 in. (305 mm) compared to new or unstretched chain values, the chain shall be replaced.

7.2.7.5.2.4 Inspect for twist. Replace if the twist in any 5-ft (1.52 m) section exceeds 15°.

7.2.7.5.2.5 Check for straightness in a plane perpendicular to the plane of the rollers. Replace if the chain has a bow exceeding ¼ in. (6.3 mm) in any 5-ft (1.52 M) section.

7.2.7.5.2.6 Additional inspection shall be made by removing the chain from the crane and cleaning it thoroughly. Deficiencies such as those listed below shall be carefully examined and a determination shall be made as to whether they constitute a safety hazard:

7.2.7.5.2.6.1 Pins turned from original position.

7.2.7.5.2.6.2 Rollers that do not run freely with light finger pressure.

7.2.7.5.2.6.3 Joints that cannot be flexed by easy hand pressure.

7.2.7.5.2.6.4 Side plates that are spread open.

7.2.7.5.2.6.5 Corrosion, pitting, or discoloration.

7.2.7.5.2.6.6 Gouges, nicks, or weld spatter.

7.2.7.5.3 Roller chain shall be replaced if any of the conditions exist as stated in Sections 7.2.7.5.2.6.1 through 7.2.7.5.2.6.6.

7.2.7.5.4 Deficiencies as stated in Section 7.2.7.5.2.6.6 above are reason for questioning chain safety and considering its replacement.

7.2.7.5.5 Repairing of roller chain by welding or heating shall not be attempted.

7.2.7.5.6 Replacement chain shall be the same size, grade, and construction as the original chain furnished by the crane manufacturer unless otherwise recommended by the manufacturer due to working conditions.

7.2.7.5.7 Roller chain, discarded or new, shall not be used for slings.

7.2.8 Cranes Not In Regular Service

7.2.8.1 A crane that has been shut down, due to lack of need, shall be locked and tagged out of service. The **asset owner** of the crane shall be responsible to initiate the work request to have the crane inspected.

7.2.8.2 Cranes that have been idle for 1 month or more but less than 6 months, shall be inspected before being placed in the service according to the requirements listed above in Section 7.2.6.

7.2.8.3 Cranes that have been idle for 6 months or longer shall be inspected before being placed in service according to the requirements listed above in Section 7.2.7.

7.2.8.4 The determination supporting these alternate inspection frequencies and procedures shall be made by a qualified person for each affected crane. Documentation supporting this determination shall be kept readily available.

7.3 TESTING

7.3.1 Operational Tests

7.3.1.1 Prior to initial use, all new, reinstalled, repaired, or modified cranes shall be tested by a designated person to ensure compliance with this chapter, including the following functions:

7.3.1.1.1 Lifting and lowering.

7.3.1.1.2 Trolley travel.

7.3.1.1.3 Bridge travel.

7.3.1.1.4 Locking, limiting, and indicating devices, if provided.

7.3.1.1.5 Limit switches/devices.

7.3.1.2 The trip setting of hoist-limit devices shall be determined by tests with an empty hook traveling at increasing speeds up to the maximum speed. The actuating mechanism of the upper-limit device shall be located so that it will trip the device under all conditions and in sufficient time to prevent contact of the hook or load block with any part of the trolley or crane.

7.3.2 Rated Load Test

7.3.2.1 Scheduled load-tests are not routinely required. Overhead and gantry cranes may be load-tested up to 100% of rated capacity when or if specified in a critical lift procedure. For cranes that frequently make critical lifts, responsible management may implement a periodic load-test program. Such periodic load-tests shall not exceed the rated capacity. Responsible management shall set the load-test frequency. (A 5-year frequency is recommended.)

7.3.2.2 At the discretion of the AEDC Crane System Engineer, a crane that has been out of service may be load-tested before returning to service. Consider the following when determining whether a load-test shall be required: (1) Will the crane make critical lifts? (2) What is the general condition and age of the crane? (3) What is the previous load-test and maintenance history of the crane? This load test shall be done only after a return-to-service inspection is completed and should not exceed the rated capacity.

7.3.2.3 Prior to initial use, all new or reinstalled cranes and cranes in which the load sustaining parts have been altered, modified, repaired, or replaced, or whose rated capacities have been affected shall be tested by or under the direction of a qualified inspector. Test may be limited to the functions affected by the alteration, repair, or modification, as determined by the qualified person.

7.3.2.4 The replacement of load chain and rope is specifically excluded from load-test requirements; however, an operational test of the hoist shall be made before returning the crane to service.

7.3.2.5 When rope clips or wedge socket end connections are used on a load line, the hoist should be cycled several times with a load approximately 15% of the rated capacity. Next, if rope clips are used, check and retighten nuts to the recommended torque. If a wedge socket is used, verify that the rope is properly seated.

7.3.2.6 A written report confirming the rated load testing of the crane shall be furnished by the inspector.

7.3.2.7 Test loads shall not be less than 100% or more than 125% of the rated capacity, unless otherwise recommended by the manufacturer or a qualified person.

7.3.2.8 Testing shall consist of the following operations as minimum requirements:

7.3.2.8.1 Hoist the test load a sufficient distance to ensure that the load is supported by the crane and held by the hoist brakes. Personnel shall be kept clear of the test load while it is suspended.

- 7.3.2.8.2 Transport the test load by means of the trolley for the full length of the bridge or as practical when obstructions are present.
- 7.3.2.8.3 Transport the test load by means of the bridge for the full length of the runway, in one direction with the trolley as close to the extreme right-hand end of the crane as practical, and in the other direction with the trolley as close to the extreme left-hand end of the crane as practical.
- 7.3.2.8.4 Lower the test load, stopping by the brakes.
- 7.3.2.9 The replacement of load chain and rope is specifically excluded from this requirement; however, an operational test of the crane shall be made in accordance with 7.3.1.1.1 prior to putting the crane back in service.
- 7.3.2.10 Operational testing of altered, repaired, or modified cranes whose load sustaining parts or rated capacities have not been affected may be limited to the functions affected by the alteration, repair or modification as determined by a qualified person.
- 7.3.2.11 The transporting of test loads as required by 7.3.2.1 above, shall be done insofar as interfering equipment/structures permit and in accordance with recommendations from the manufacturer or a responsible engineering organization. However, test loads should not be carried over critical systems or components.
- 7.3.2.12 Test weights shall be accurate to within -5% , $+0\%$ of stipulated values.
- 7.3.2.13 Load tests shall be performed only after inspection and maintenance of the crane are confirmed as current and any outstanding discrepancies have been addressed.
- 7.3.2.14 If a load test is conducted, it shall be performed as follows or as modified by a qualified person. Use Exhibit 7.1, to document this test. This will become the load test report.
- 7.3.2.14.1 Move the trolley to bridge's midspan, position the bridge at a location convenient for rigging the load test.
- 7.3.2.14.2 Rig and raise the test load approximately one foot above the floor (ground) to ensure the load is supported by the crane and held by the hoist brakes.
- 7.3.2.14.2.1 Hold the load for five minutes.
- 7.3.2.14.2.2 Verify that the hoist operates properly and holds the load without slippage of more than 0.5 inch.
- 7.3.2.14.2.3 Verify that there is no rotation of the cable drum during the test.
- 7.3.2.14.2.4 Raise the load approximately three feet and stop.
- 7.3.2.14.2.5 Lower the test load at full speed and stop abruptly. Verify the brake application is positive and effective.

7.3.2.14.3 Raise the test load for ample clearance and transport the test load by means of the trolley for the full length of the bridge; verify smooth starting, running and stopping.

7.3.2.14.4 With the trolley as close as practical to one end of the crane, transport the test load by means of the bridge for the full length of the runway in one direction and in the other direction with the trolley as close as practical to the other end of the crane; verify smooth starting, running and stopping.

7.3.2.14.5 Return the bridge to the starting position, lower the load to approximately one foot above the floor (ground); stop and hold the load for three minutes with the brakes.

7.3.2.14.5.1 Verify that the hoist operates properly and holds the load without slippage of more than 0.5 inch.

7.3.2.14.5.2 Verify that there is no rotation of the cable drum during the test.

7.3.2.14.6 Lower the load, disconnect the rigging, tag, and stow the crane.

7.3.2.14.7 Verify that no visible load bearing part (eg. Gearing, shafting, bearing, rope or chain end connections, brake component) has been adversely affected by the test.

7.3.2.15 After the test is completed, the load-test report shall be signed and dated by the Person-In-Charge of conducting the load test. The Person-In-Charge shall ensure that the test is forwarded to the AEDC Crane System Engineer so that it can be placed in the crane maintenance file. Test reports shall be retained in the crane maintenance file.

7.4 MAINTENANCE

7.4.1 Operating Equipment

7.4.1.1 A preventive maintenance program shall be established and based on the recommendation of the crane manufacturer. If equipment maintenance procedures deviate from published manufacturer's recommendations, the alternate procedures shall be approved in advance by the manufacturer or another qualified person and be kept readily available. Dated maintenance records should be kept where readily available to appointed personnel.

7.4.1.2 Replacement parts shall be at least equal to the original manufacturer's specifications.

7.4.1.3 All moving parts of the crane for which lubrication is specified shall be regularly lubricated. Check lubricating systems for delivery of lubricant. Follow manufacturer's recommendations as to points and frequency of lubrication, maintenance of lubricant levels, and types of lubricant to be used.

7.4.1.4 Maintenance personnel shall take the following precautions before performing maintenance on a crane:

7.4.1.4.1 Move the crane to a location where it will cause the least interference with other cranes and operations.

7.4.1.4.2 Place any attached loads on the ground or floor.

7.4.1.4.3 Place all controllers in the OFF position.

7.4.1.4.4 Perform a lockout/tagout procedure. Facility-specific lock and tag procedures shall be strictly followed. While maintenance is under way, “warning” or “out of order” signs shall be placed on the crane.

7.4.1.4.5 If personnel have access to the floor beneath the crane use warning signs and barriers on the floor where overhead maintenance work creates a hazard.

7.4.1.4.6 If the runway remains energized, place stops or signalers full-time at a visual vantage point to observe the approach of active cranes and prohibit contact by the active cranes with the idle crane, with persons performing maintenance, or with the maintenance equipment.

7.4.1.4.7 Install a guard or barrier between adjacent runways for the length of the established work area to prevent contact between persons performing maintenance and any crane on the adjacent runway.

7.4.1.4.8 After maintenance work is completed and before restoring the crane to normal operation, the following activities shall be completed:

7.4.1.4.8.1 Guards shall be reinstalled.

7.4.1.4.8.2 Safety devices shall be reactivated.

7.4.1.4.8.3 Replaced parts and loose material shall be removed.

7.4.1.4.8.4 Maintenance equipment shall be removed.

7.4.2 Wire Rope Maintenance

Personnel using wire rope shall ensure proper care by doing the following:

7.4.2.1 Store rope to prevent damage or deterioration.

7.4.2.2 Unreel or uncoil rope as recommended by the rope manufacturer and with care to avoid kinking or inducing a twist.

7.4.2.3 Before cutting rope, use some method to prevent unlaying the strands. Heat affected zones of flame cut wire rope shall not be allowed to bear load.

7.4.2.4 During installation, avoid dragging the rope in dirt or around objects that will scrape, nick, crush, or induce sharp bends in it.

7.4.2.5 Maintain rope in a well-lubricated condition to reduce internal friction and prevent corrosion. Ensure that lubricant applied, as part of a maintenance program, is compatible with the original lubricant and is a type that does not hinder visual inspection. Those sections of rope located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention when the rope is being lubricated.

7.4.3 Footwalks and Ladders

7.4.3.1 Footwalks shall have a well-maintained, slip-resistant walking surface.

7.4.3.2 Toeboards and handrails shall meet the requirements of ANSI A1264.1.

7.4.3.3 Ladders shall be permanently and securely fastened in place and shall be constructed in compliance with ANSI 14.3. Hands shall be free from encumbrances while using ladders.

7.4.3.4 Rails shall be level, straight, joined, and spaced to the crane span compatible with the design of the crane. When curves or grades are required, special design is necessary. Tolerances shall be in accordance with the crane specification. In lieu of crane specification tolerances, Crane Manufacturers Association of America (CMAA) Specification 70, Table 1.4.2-1, or CMAA Specification 74, Table 1.4.1-1, may be used as a guideline.

7.4.4 Crane Stops, Bumpers, Rail Sweeps, and Guards

7.4.4.1 The trolley shall be provided with stops at the limits of travel. A stop engaging the tread of the wheel shall be of a height at least equal to the radius of the wheel.

7.4.4.2 The bridge shall be provided with bumpers or other automatic means providing equivalent effect unless the crane has a fast deceleration rate caused by the use of sleeve bearings. The crane is not operated near the ends of bridge travel; or the crane is restricted to a limited distance and there is no hazard of striking any object in this limited distance.

7.4.4.3 Trolley bumpers or other automatic means of equivalent effect shall be provided, unless the trolley is not operated near the ends of trolley travel, or is restricted to a limited distance of the bridge girder and there is no hazard of striking any object in this limited distance, or is used in similar operating conditions.

7.4.4.4 When more than one bridge or trolley is mounted on the same runway, bumpers shall be provided between adjacent bridge ends or trolleys.

7.4.4.5 Bridge trucks shall have rail sweeps that extend below the rail top and are adjacent to and outboard of the leading wheels with respect to any direction of travel.

7.4.4.6 Exposed moving parts, such as gears, set screws, projecting keys, chains, chain sprockets, and reciprocating components, that constitute a hazard under normal operating conditions, shall be fitted with guards.

7.4.4.6.1 The following shall apply to all personnel involved in overhead and gantry crane operation.

7.4.4.6.2 At the initial stage of the planning process, an appointed person shall classify each lift into one of the AEDC specified lift categories (ordinary, critical or non-standard).

7.5 OPERATION

7.5.1 Conduct of Operator

- 7.5.1.1 Do not engage in any practice that will divert your attention while operating the crane.
- 7.5.1.2 Do not operate cranes without complying with the requirements of Chapter 6. Your immediate supervisor shall participate in this determination.
- 7.5.1.3 Do not allow other personnel in the cab or on any part of the crane unless their presence is imperative to the operation of the machine. Additional qualified operators may be in the cab only if required by procedure and will conduct themselves in a professional manner so as not to distract the on-duty operator.
- 7.5.1.4 Do not operate the crane when physically or otherwise unfit.
- 7.5.1.5 Operators shall be held directly responsible for the safe operation of their equipment. Whenever there is any question as to the safety of the activity, an operator has the authority to stop and refuse to handle loads until the matter has been resolved by supervisory personnel.
- 7.5.1.6 If a warning device is furnished, it shall be activated each time before traveling and intermittently when approaching work persons. If warning device is not available, the operator or PIC shall instruct all personnel not directly related to the lift to clear the area. The purpose of this instruction is simply to ensure that personnel are not exposed to unnecessary risk in accordance with Air Force Operational Risk Management (ORM) policy.
- 7.5.1.7 If you find the crane's main or emergency switch open when starting on duty, do not close it until it has been determined that no one is on or close to the crane. If there is a warning sign on the switch, do not remove it unless you placed it there. Do not close the switch until the warning sign has been removed by the person who placed it there.
- 7.5.1.8 Before closing the main switch, ensure that all controllers are in the OFF position.
- 7.5.1.9 If a power failure occurs during operation, immediately switch all controllers to the OFF position.
- 7.5.1.10 Before leaving a crane unattended, the operator shall place controllers in the "off" position and ensure that the main line disconnect device of the crane is open.
- 7.5.1.11 Become familiar with your equipment and its proper care. If adjustments or repairs are necessary, or any defects are known, report them promptly to your supervisor. Also, notify the next operator of the defects at shift change.
- 7.5.1.12 Contacts with runway stops or other cranes shall be made with extreme caution. If you are ordered to engage with or push other cranes, do this with particular care for the safety of persons on or below the cranes, and only after making certain that any persons on the other cranes are aware of what action is to be taken.
- 7.5.1.13 Secure outdoor cranes before leaving them.
- 7.5.1.14 When the wind-indicating alarm is given, anchor the bridge on outside cranes.
- 7.5.1.15 Before any maintenance work on the crane, maintenance personnel shall ensure the main switch is locked and tagged in the de-energized (OPEN) position. **LOTO procedures contained in**

AEDC Safety, Health, and Environmental Standard B4 High Voltage Electrical Work shall be strictly followed.

NOTE: It is recognized that selected maintenance work must be performed with the power on; however, such maintenance work shall be performed by maintenance personnel, not by the operator.

7.5.1.16 Operate all controls before beginning a new shift. If any controls do not operate properly, adjust or repair them before operations begin.

7.5.1.17 Do not hoist two or more separately rigged loads in one lift, even though the combined load is within the crane's rated capacity.

7.5.1.18 Ensure that a 10BC or larger fire extinguisher is installed in the cab of cab-operated cranes. The extinguisher shall be maintained in a serviceable condition.

7.5.1.19 Do not lift, lower, or travel the crane while anyone is on the load or hook.

7.5.2 Stowage

If tools, lubricants, or maintenance materials are stowed on the crane, a metal box securely fastened to the crane or walkway shall be used.

7.5.3 Hoist Limit Switch Device

7.5.3.1 At the beginning of each work shift, or the first time the crane is used during a shift, test the upper-limit switch/device of each hoist under no load. Exercise extreme care to avoid two-blocking; "inch" the block into the limit switch or run it in at slow speed. If the switch/device does not operate properly, immediately notify the supervisor.

7.5.3.2 If a lift is in progress during a shift change, this testing requirement is considered to have been satisfied for the completion of that lift. However, test the limit switch again before the next lift.

7.5.3.3 Do not use the final hoist-limit switch/device that controls the upper limit of travel of the load block as an operating control.

7.5.4 Standard Hand Signals

The standard hand signals for AEDC use shall be as specified in the latest edition of the ASME B30 standards for the particular type of crane or hoist being used (Figure 7-4).

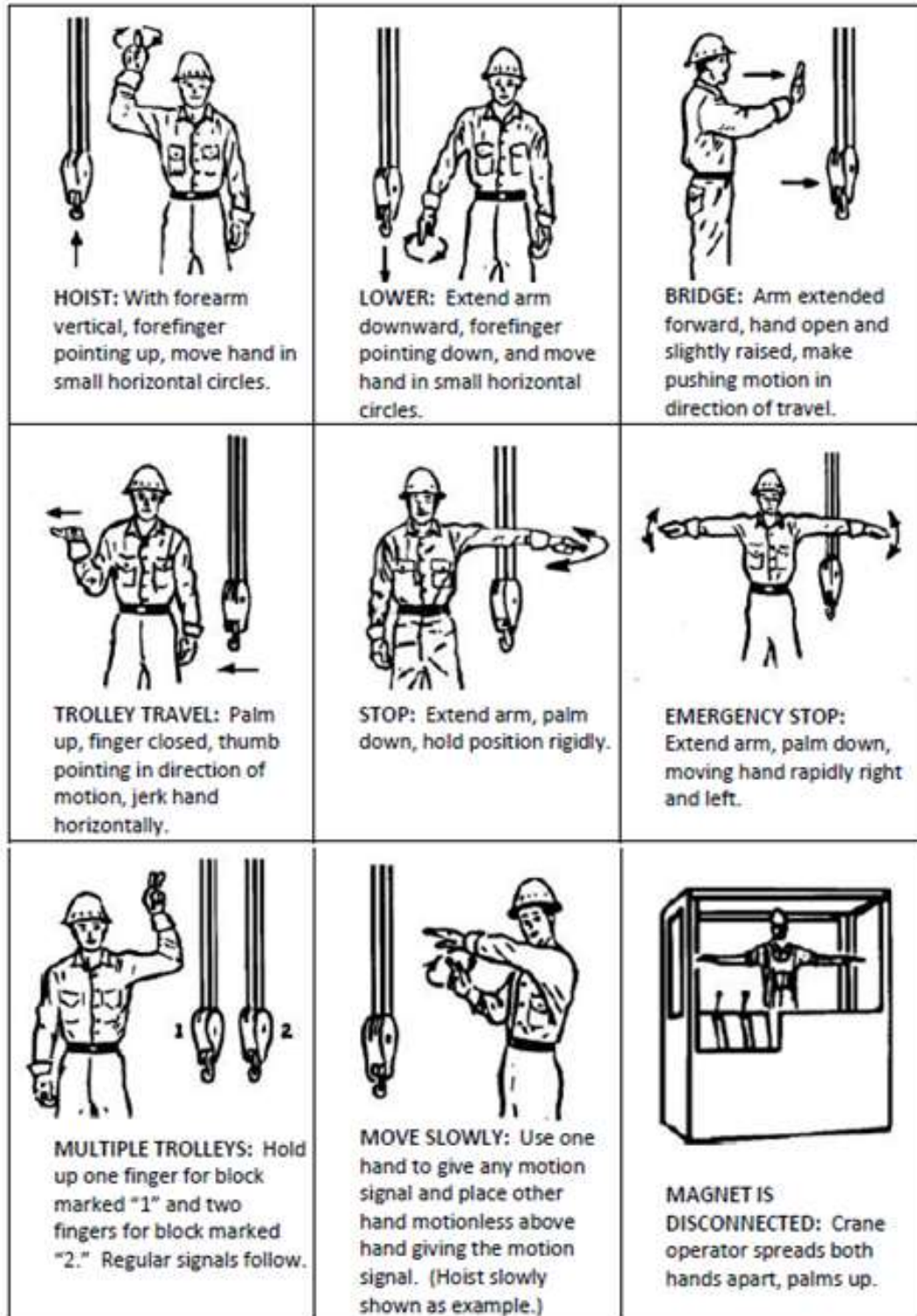


Figure 7-4 Standard hand signals for controlling overhead crane operation

7.5.5 Identification of Signal Person(s)

7.5.5.1 Any person acting as the signal person during crane operations shall be clearly identified to the crane operator before the lift is begun.

7.5.5.2 In those cases where the crane operator cannot see the signal person, a second qualified signal person shall be stationed where he or she can be seen by the operator and can effectively relayed signals to the operator.

7.5.5.3 Where voice (direct or two-way radio) communication is used, the signal person shall communicate directly with the operator, not through a third person. When using two-way radio, it is important to have channels devoted exclusively to crane communications. Signals shall be discernible and audible.

7.5.5.4 The operator shall obey signals only from the designated signal person. *Obey a STOP signal no matter who gives it.*

7.5.6 Size of Load

7.5.6.1 The weight of the load shall be determined prior to making the lift.

7.5.6.2 The crane and rigging equipment shall not be loaded beyond its rated capacity, except for authorized testing described in paragraph 7.3.

7.5.7 Attaching the Load

7.5.7.1 Ensure that the hoist rope is free from kinks or twists. Do not wrap the hoist rope around the load.

7.5.7.2 Ensure the load is attached to the load-block hook by means of slings or other approved devices.

7.5.7.3 Take care to make certain that the sling clears all obstacles.

7.5.8 Moving The Load

7.5.8.1 The person appointed to direct the lift shall see that the load is well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches.

7.5.8.2 Before starting to hoist, note the following conditions:

7.5.8.2.1 Hoist rope shall not be kinked.

7.5.8.2.2 Multiple-part lines shall not be twisted around each other.

7.5.8.2.3 The hook shall be positioned above the center of gravity of the load in such a manner as to minimize swinging when the load is lifted.

7.5.8.2.4 If there is a slack-rope condition, it should be determined that the rope is properly seated on the drum and in the sheaves.

7.5.8.2.5 All personnel including the qualified rigger shall be clear of the load.

7.5.8.3 During hoisting, take care to ensure that:

- 7.5.8.3.1 The load is lifted slowly until it clears the ground or other support to minimize swinging.
- 7.5.8.3.2 There is no sudden acceleration or deceleration of the moving load.
- 7.5.8.3.3 The load does not contact any obstructions. A “dry run” shall be conducted in areas where clearance is limited.
- 7.5.8.4 Cranes shall not be used for side pulls except when specifically authorized by an appointed person who has determined that the stability of the crane is not endangered and that load-bearing parts of the crane will not be overstressed.
- 7.5.8.5 Avoid carrying loads over people.
- 7.5.8.6 Each time a load approaching the rated capacity is handled, test the hoist brakes by raising the load a few inches and applying the brakes. Any slippage or downward motion is unacceptable.
- 7.5.8.7 Do not lower the hook below the point where less than two full wraps of rope remain on the hoisting drum.
- 7.5.8.8 When the load or hook approaches personnel, sound the warning signal.
- 7.5.8.9 Tag lines should be used as required to guide, snub, or otherwise control the load.
- 7.5.8.10 Do not leave a suspended load unattended unless specific precautions have been instituted and are in place.
- 7.5.8.11 Work on suspended loads is prohibited under normal conditions. If the supervisor believes it is necessary to work on a suspended load, guidelines for safe operation shall be established through consultation with the appropriate safety organization. Suspended loads that must be worked on shall be secured against unwanted movement.

7.5.9 Ordinary Lifts

- 7.5.9.1 The requirements of paragraph 7.5.1 through 7.5.8 also apply to ordinary lifts.
- 7.5.9.2 An appointed person shall classify each lift into one of the AEDC categories (ordinary, critical, or non-standard) before the lift is planned.
- 7.5.9.3 Hoisting and rigging operations for ordinary lifts require a Designated Leader who shall be present at the lift site during the entire lifting operation. If the lift is being made by only one person, that person assumes all responsibilities of the Designated Leader.
- 7.5.9.4 Leadership designation may be by written instructions, specific verbal instructions for the particular job, or clearly defined responsibilities within the assigned craftsmen’s organizational structure.
- 7.5.9.5 The Designated Leader’s responsibility shall include the following:
 - 7.5.9.5.1 Ensure that personnel involved understand how the lift is to be made.

7.5.9.5.2 Ensure that the weight of the load is determined, that proper equipment and accessories are selected, and that rated capacity is not exceeded.

7.5.9.5.3 Survey the lift site for hazardous/unsafe conditions.

7.5.9.5.4 Ensure that equipment is properly set up and positioned.

7.5.9.5.5 Ensure that a **Qualified Signal Person** is assigned, if required, and is identified to the operator.

7.5.9.5.6 Direct the lifting operation to ensure that the job is done safely and efficiently.

7.5.9.5.7 Stop the job when any potentially unsafe condition is recognized.

7.5.9.5.8 Direct operations if an accident or injury occurs.

7.5.9.6 The operator, or a designated person, shall ensure that the crane is still within the inspection interval.

7.5.9.7 The operator, or a designated person, shall visually examine the crane in accordance with paragraph 7.2.4.

7.5.10 Critical Lifts

See Chapter 2, “Critical Lifts,” for critical-lift requirements.

Exhibit 7.1 Bridge, Wall, Gantry Crane Load Test Sample Form

LOAD TEST CHECKLIST		
Date:	Crane ID # _____	
Supervisor:	Badge # _____	Signature: _____
Latest Crane Inspection Date: _____		
Purpose of Load Test:	1. Special Test Before Critical Lift. _____ 2. Test Before Returning to Service. _____ 3. Rated Load Test. _____	
Rated Capacity	Test Weight(s) Used _____	
Step	Actions	Initials
1	Position the trolley to bridge's midspan, position the bridge at a location that provides convenient access to the test load (weight(s)).	
2	Rig and raise the test load approximately one foot above the floor (ground) to ensure the test load is supported by the crane and held by the brakes. Use tag lines as appropriate.	
3	Hold the test load at the raised position for five minutes. The test load should not rotate on the load block.	
4	Verify that the hoist operates properly and holds the test load without slippage of more than 0.5 inch.	
5	Verify that there is no rotation of the cable drum during the test.	
6	Raise the test load an additional distance, not less than three feet above the floor (ground).	
7	Lower the test load at full speed and stop abruptly. Verify the brake application is positive and effective.	
8	Raise the test load for ample clearance and transport the test load by means of the trolley for the full length of the bridge or as practical when obstructions are present. Verify smooth starting, running and stopping.	
9	With the trolley as close as practical to the right-hand end of the crane, transport the test load by means of the bridge the full length of the runway in one direction and in the other direction with the trolley as close as practical to the left-hand end of the crane. Verify smooth starting, running and stopping.	
10	Return the bridge to the starting position and lower the test load to approximately one foot above the floor (ground) and stop and hold the load for three minutes with the brakes.	
11	Verify that the hoist operates properly and holds the test load without slippage of more than 0.5 inch.	
12	Verify that there is no rotation of the cable drum during the test.	
13	Lower the test load, disconnect the rigging.	
14	Verify that no visible load-bearing part (e.g., gearing, shafting, bearing, rope or chain end-connections, brake component) has been adversely affected by the test.	
15	Send this document to AEDC Crane System Engineer for filing in hoist's maintenance file.	

Page 1 of 3**NOTE:** Test loads shall not be more than 125% of the rated load, unless recommended by the manufacturer.

DEFECTIVE/OK/NA

- _____ a. Bridge track
- _____ b. Bridge wheels
- _____ c. Trolley track
- _____ d. Trolley wheels
- _____ e. Gears
- _____ f. Magnetic brakes
- _____ g. Blocks.

Visually inspect rope in accordance with Chapter 11, "Wire Rope and Slings."

- _____ a. Rope diameter: (Previous) _____ (Present) _____
- _____ b. Wear
- _____ c. Kinks
- _____ d. Broken wires
- _____ e. Other signs of deterioration.

Visually inspect the rope drum for:

- _____ a. Wear
- _____ b. Deformation
- _____ c. Deterioration.

INITIAL

_____ 10. Qualified inspector shall perform nondestructive tests on hook by visual examination, liquid penetrant examination, or magnetic-particle examination. Acceptance: No cracks, linear indications, laps, or seams.

Hooks with more than 5% normal (new hook) throat opening, not to exceed ¼ inch shall be replaced. Hooks with any visibly apparent bend or twist from the normal (new hook) plane of the hook shall be replaced. Hooks having more than 10% wear in the throat section or 5% elongation of the shank shall be replaced. Lubricate hook bearing and latch pin as applicable.

Establish two marks, A and B with center punch. For ease in measuring, set distances on an even number of inches.

BEFORE LOAD TEST

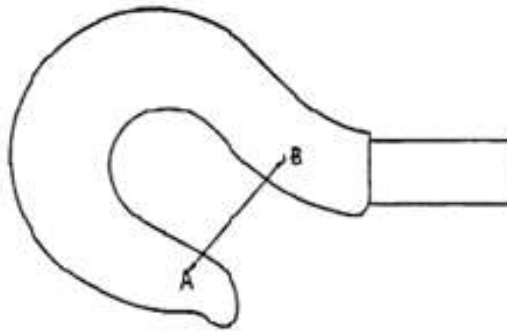
Length AB _____ in.

AFTER LOAD TEST

Length AB _____ in.

Check for:

1. Wear and deformation
2. Cracks and twisting
3. Signs of opening between Point A and Point B



Load Test Inspection Date _____

Qualified Inspector _____

Operated By _____

Actual Load Test _____ lb

8.0 CHAPTER 8 - HOISTS

This chapter provides safety standards for inspecting, testing, and operating hoists not permanently mounted on overhead cranes and implements the requirements of ASME B30.11, B30.16, and B30.21.

8.1 GENERAL

Hoists described in this chapter include hand-powered, air-powered, and electric-powered hoists that are not permanently mounted on overhead cranes. This chapter applies to the following types of equipment (Figures 8-1 through 8-6): Overhead hoists (underhung); Jib cranes/hoists (floor and wall mounted); Monorail systems. Manual-lever-operated hoists (wire rope, chain, and web-strap types).

8.1.1 Prohibited Use.

Wire-rope ratchet and pawl lever-operated hoists should not be used for lifting service (Figures 8-7 and 8-8).

8.1.2 Special Considerations

Systems used for transporting personnel and specially insulated hoists used for handling electrically energized power lines require special considerations and are not included in this chapter.

8.1.3 Operator Training/Qualification

Hoist operators shall be trained and qualified according to requirements found in Chapter 6.

8.1.4 Marking

8.1.4.1 The rated capacity shall be permanently marked on the hoist or load block.

8.1.4.2 Electric-powered hoists shall be marked with:

8.1.4.2.1 Name of manufacturer.

8.1.4.2.2 Manufacturer's model or serial number.

8.1.4.2.3 Voltage of AC or DC power supply and phase/frequency of AC power supply.

8.1.4.2.4 Circuit ampacity.

8.1.4.3 Air-powered hoists shall be marked with:

8.1.4.3.1 Name of manufacturer.

8.1.4.3.2 Manufacturer's model or serial number.

8.1.4.3.3 Rated air pressure.

8.1.4.4 Hand-chain-operated hoists shall be marked with:

8.1.4.4.1 Name of manufacturer.

8.1.4.4.2 Manufacturer's model or serial number.

8.1.4.5 Manual-lever-operated hoists shall be marked with:

8.1.4.5.1 Name of manufacturer.

8.1.4.5.2 Manufacturer's model or serial number

8.1.5 Warning Labels

8.1.5.1 Electric- or Air-Powered Hoists

8.1.5.1.1 Labels shall be affixed to the hoist, load block, or controls that display the word WARNING or other legend designed to bring the label to the attention of an operator.

8.1.5.1.2 The label shall contain cautionary language against any of the following:

- Lifting more than the rated load.
- Operating a hoist when the load is not centered under the hoist.
- Operating a hoist with twisted, kinked, or damaged chain or wire rope.
- Operating a damaged or malfunctioning hoist.
- Lifting personnel or lifting loads above personnel.
- Operating a wire-rope hoist with a wire rope that is not properly seated in its grooves.
- Removing or obscuring warning labels.

8.1.5.2 Hand-Chain-Operated or Manual Lever-Operated Hoists

8.1.5.2.1 Labels shall be affixed to the hoist or load block and shall display the word WARNING or other legend designed to bring the label to the attention of an operator.

8.1.5.2.2 The label shall contain cautionary language against any of the following:

- Lifting more than the rated load.
- Operating a hoist when it is restricted from forming a straight line with the direction of loading.
- Operating the hoist with twisted, kinked, or damaged wire rope, chain, or webbing strap.
- Operating damaged or malfunctioning hoists.
- Lifting personnel or lifting loads above personnel.
- Operating a hoist with lever extensions (for lever-operated hoists).
- Operating hoists with other than manual power (for hand-chain-operated hoists).
- Removing or obscuring warning labels.

8.1.6 Design Standards

At a minimum, safety features and operation shall meet the provisions of ASME B30.16 and B30.21. Mechanical, electrical, and structural components of hoist design shall meet accepted hoist design standards contained in ASME HST-1M, -2M, -3M, -4M, -5M, and -6M.



Figure 8-1. Hand-operated chain-hoists.

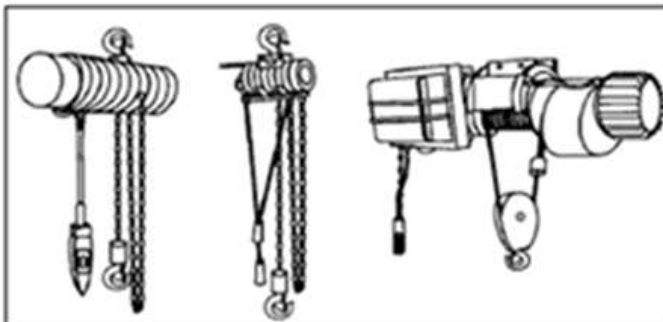


Figure 8-2. Electric/air-powered chain and wire-rope hoists.

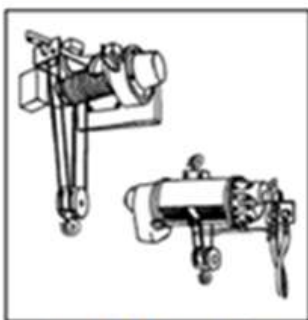


Figure 8-3. Electric/air-powered wire-rope hoists.



Figure 8-4. Manual-lever-operated hoist – wire-rope



Figure 8-5. Manual-lever-operated hoist – wire-rope

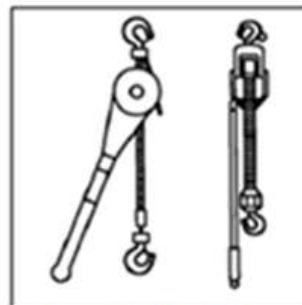


Figure 8-6. Manual-lever-operated hoist – web-strap

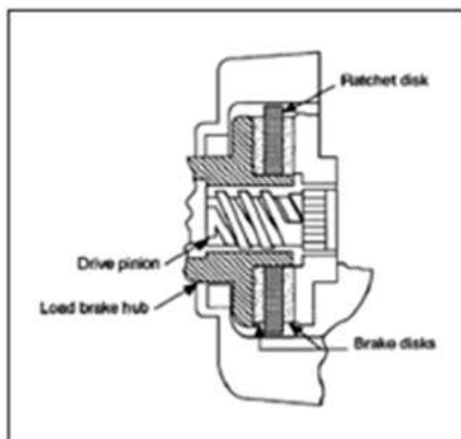


Figure 8-7. Recommended – hoists with friction brake type load-controlling

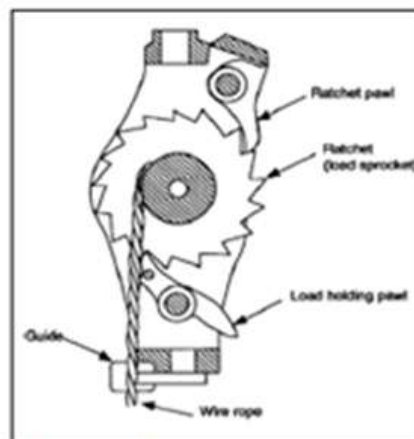


Figure 8-8. Not recommended – hoists with ratchet and pawl load-controlling mechanisms.

8.1.7 Design Factors

For electric or air-powered hoists, load-suspending parts of powered hoists shall be designed so that the static stress calculated for the rated load will not exceed 20% of the average ultimate material strength. This requirement is commonly reflected by quoting a minimum design factor of 5:1. For hand-chain-operated and manual-lever-operated hoists, load-suspending parts shall be designed so that the static stress calculated for the rated load will not exceed 25% of the average ultimate strength. This requirement is commonly reflected by quoting a minimum design factor of 4:1.

8.1.8 Load-Braking/Load-Controlling Mechanisms

8.1.8.1 Electric-Powered Hoists

8.1.8.1.1 Under normal operating conditions with rated load and under test conditions with test loads up to 125% of rated load, the braking system shall perform the following functions:

- Stop and hold the load hook when controls are released.
- Limit the speed of the load during lowering, with or without power, to a maximum of 120% of the rated lowering speed for the load being handled.
- Stop and hold the load hook in the event of a complete power failure.

8.1.8.1.2 The braking system shall have thermal capacity for the frequency of operation required by the service.

8.1.8.1.3 The braking system shall have provision for adjustments, where necessary, to compensate for wear.

8.1.8.2 Air-Powered Hoists

8.1.8.2.1 Under normal operating conditions with rated load and under test conditions with test loads up to 125% of rated load, the braking system shall perform the following functions:

- Stop and hold the load hook when controls are released.
- Prevent an uncontrolled lowering of the load in the event of a loss of air pressure.

8.1.8.2.2 The braking system shall have thermal capacity for the frequency of operation required by the service.

8.1.8.2.3 The braking system shall have provision for adjustments, where necessary, to compensate for wear.

8.1.8.3 Hand-Chain-Operated Hoists

The Hoist shall be designed so that when the actuating force is removed, it will automatically stop and hold any test load up to 125% of the rated load.

8.1.8.4 Manual-Lever-Operated Hoists

8.1.8.4.1 The hoist shall be equipped with a load-controlling mechanism.

8.1.8.4.2 The load-controlling mechanism shall perform the following functions under normal operating conditions with test loads up to 125% of rated capacity:

- Stop and hold the load when the lever force is removed and the lever stroke is completed.
- Provide for incremental movement of the load when lifting or lowering.

8.1.8.4.3 The friction brake mechanism shall have provision for adjustment where necessary to compensate for wear.

8.1.9 Wire Rope

8.1.9.1 Wire rope shall be of a construction specified by the hoist manufacturer or by a qualified person.

8.1.9.2 If a load is supported by more than one part of wire rope, the tension on the parts shall be equalized.

8.1.9.3 Socketing shall be done in the manner specified by the manufacturer of the assembly or the rope.

8.1.9.4 Eye splices shall be made in a manner recommended by a qualified person. Rope thimbles shall be used in the eye.

8.1.9.5 Swaged or compressed fittings shall be applied as recommended by the rope, hoist, or fitting manufacturer or a qualified person.

8.1.9.6 Use rope having an independent wire-rope, wire-strand core, or other temperature-damage-resistant core if the rope will be exposed to ambient temperatures greater than 180° F (82° C).

8.1.9.7 The rope ends should be attached to the hoist in a manner to prevent disengagement throughout rated hook travel. No less than two wraps of rope shall remain on the anchorage of the hoist load sprocket (drum) when the hook is in its fully extended position, unless a lower-limit device is provided, in which case one wrap shall remain on each anchorage of the drum hoist.

8.1.10 Load Chain

8.1.10.1 Electric-Powered, Air-Powered, And Manual-Lever-Operated Hoists

8.1.10.1.1 Load chain may be either roller or welded link type (Figure 8-9). Chain shall be pitched (calibrated) to pass over all load sprockets without binding.

8.1.10.1.2 The load chain shall be proof-tested by the chain or hoist manufacturer with a load at least equivalent to 1.5 times the hoist's rated load divided by the number of chain parts supporting the load.

8.1.10.1.3 If a load is supported by more than one part of load chain, the tension on the parts shall be equalized.

8.1.10.2 Hand-Chain-Operated Hoists

8.1.10.2.1 The hand chain shall be of a shape and pitch to fit the hand-chain wheel without binding or jamming under normal operating conditions.

8.1.10.2.2 The hand chain shall be guarded to prevent disengagement from the hand-chain wheel.

8.1.10.2.3 The hand chain shall withstand, without permanent distortion, a force of three times the pull required to lift the rated load.

8.1.11 Web Strap

The following applies for manual-lever-operated hoists:

8.1.11.1 Web strap should be nylon, polyester, or similar synthetic material.

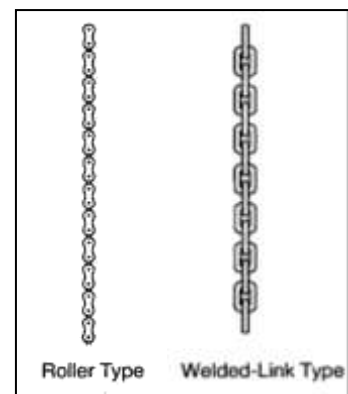


Figure 8-9. Load chain

- 8.1.11.2 If a load is supported by more than one part of web strap, the tension on the parts shall be equalized.
- 8.1.11.3 End terminations shall be done in the manner specified by the manufacturer of the assembly or the web strap.
- 8.1.11.4 Eyes shall be made in a manner recommended by the hoist manufacturer or a qualified person.
- 8.1.11.5 Nylon and polyester web straps shall not be exposed to an ambient temperature greater than 200° F (93° C).
- 8.1.11.6 The web strap shall be attached to the hoist in a manner to prevent disengagement throughout rated hook travel; no less than two wraps of web strap shall remain on the hoist load sprocket (drum) when the hook is extended to its full rated lift length.

8.1.12 Overtravel Protection

8.1.12.1 Upper-Limit Switches/Devices

For electric- or air-powered hoists, the hoist shall be designed and constructed so that the load hook, either loaded or empty, shall not exceed the upper limit of travel. In lieu of a limit switch, a mechanism such as a slip clutch may be used.

8.1.12.2 Lower-Limit Switches/Devices

- 8.1.12.2.1 For electric-or air-powered hoists, the hoist shall not be installed where, during normal operating conditions, the hook can be lowered beyond rated hook travel unless the hoist is equipped with a lower-limit device. Lower-limit devices should be provided for hoists where the load block enters pits or hatchways in the floor.
- 8.1.12.2.2 For hand-chain-operated and manual-lever-operated hoists, before the load chain can be completely run out of the hoist, it shall be restrained in its fully extended position. The restraint shall be such that the unloaded hoist can withstand a lowering hand chain or operating lever force equivalent to twice the pull required to lift the rated load, or with the rated load on the hoist, a hand chain or operating lever force equivalent to the pull required to lift the rated load.

8.1.13 Travel Warning Devices

On cab- and remote-operated carriers, an audible or visual warning means shall be provided, unless it is impossible for personnel to work on the floor below the hoist.

8.1.14 Support

Support structures, including trolleys and monorails, shall have a rated capacity at least equal to that of the hoist.

8.1.15 Location

The hoist shall be installed only in locations that will permit the operator to remain clear of the load at all times. Clearances shall be provided and maintained at the curves of a monorail system to allow for the swing of the load when negotiating the curve. The amount of clearance shall be determined by giving due consideration to the size, weight, and speed of the carrier and the radius of the track curve.

8.1.16 Load Rating

The rated capacity shall not be exceeded except for properly authorized tests (paragraph 8.3.1).

8.1.17 Stops and Lugs

8.1.17.1 Stops on Jib Cranes and Monorails: Stops shall be provided at the ends of carrier travel. Stops or forks shall be provided at open ends of monorail track, track openers, and track switches. Stops shall be an integral part of a movable monorail track to prevent a carrier from running off either end of the movable track when the movable track is not in alignment with the stationary tracks.

8.1.17.2 Lugs on Jib Cranes and Monorail Carriers: Lugs or other means shall be provided to limit the drop of the carrier frame to 1 inch in case of wheel or axle failure, and shall be on both flanges of the track.

8.1.18 Sheave Guards

Sheaves carrying ropes, which can be momentarily unloaded, shall be provided with close-fitting guards, or other devices, to guide the rope back into the groove when the load is reapplied. Sheaves in the load block shall be equipped with close-fitting guards that will minimize the possibility of ropes becoming fouled when the load block is lying down with the ropes loose.

8.1.19 Hook Mousing and Throat Latches

Latch-equipped hooks shall be used for hoisting and rigging (H&R) operations unless the application makes use of the latch impractical or unsafe. The absence of a hook throat latch is not allowed (see paragraph 13.1.3).

8.1.20 Electrical Equipment Code Compliance

Wiring and equipment shall comply with NFPA 70, *National Electrical Code*, Article 610, "Cranes and Hoists." When electric hoists are used in locations other than general indoor applications, control enclosures should be selected per NEMA ICS-6, *Enclosures for Industrial Control and Systems*.

8.1.20.1 Pendant Controls

8.1.20.1.1 Pushbutton Station: A pendant pushbutton station shall be supported so that the electrical conductors are protected from strain.

8.1.20.1.2 Pendant Construction: Makeshift field-fabricated pendants shall not be used. The voltage at pendant push-buttons shall not exceed 150 volts for AC and 300 volts for DC. Pendant control boxes shall be constructed to prevent electrical shock.

8.1.20.1.3 Spring Return and Marked Pushbuttons: Pushbuttons (except on/off buttons) shall spring return to the off position when pressure is released by the operator. Buttons shall be clearly marked to identify their function.

8.1.20.1.4 Resultant Motion: To the extent possible, each control shall be marked to indicate the direction of resultant motion.

8.1.20.2 Electrical Supply, Hoist and Monorail Systems

The electrical supply for hoists and monorail systems shall be controlled by a lockable switch or circuit breaker located on a fixed structure accessible from the floor. For temporarily installed hoists, a standard electrical connection (plug) that can be readily disconnected by the operator meets this requirement.

8.1.20.3 Monorail Conductors

Monorail conductors shall be guarded or located to minimize inadvertent contact with the conductor.

8.1.21 Modifications

8.1.21.1 Monorail Systems: A monorail system may be modified or rerated, provided such modifications and the supporting structure are analyzed by a qualified person or the manufacturer of the equipment. A rerated system or one whose load-supporting components have been modified shall be subjected to a load test (see paragraph 8.3.2). The new rated load shall be displayed in accordance with paragraph 8.3.

8.1.20.2 Manual- or Power-Operated Hoists: Modifications to upgrade, rerate, or modernize hoist equipment shall be authorized only by the original equipment manufacturer or a qualified person. The new rated load shall be displayed in accordance with paragraph 8.1.2. See paragraph 8.3.2, regarding load test requirements.

8.1.21.3 Documentation for Modifications: Documentation supporting rerating and modifications shall be retrievable and readily available to authorized personnel.

8.1.22 Inspection Records

Inspection records shall be kept for the life of the equipment. Following is a summary of inspection record requirements.

8.1.22.1 Initial Inspection: A record of the initial inspection shall be made.

8.1.22.3 Periodic Inspection: The most recent records, dated and signed by a qualified inspector, shall be retained in the maintenance file.

8.2 INSPECTIONS

Hoist service is defined as follows:

8.2.1 Hoist Service

8.2.1.1 Normal service: Operation with randomly distributed loads within the rated load limit, or uniform loads less than 65% of rated load for not more than 15% of the time for manual-lever-operated hoists or for not more than 25% of the time for electric- or air-powered hoists.

8.2.1.2 Heavy service: Operation within the rated capacity that exceeds normal service.

8.2.1.3 Severe service: Operating at normal or heavy service under abnormal operating conditions, (i.e., extreme temperatures, corrosive atmospheres).

8.2.2 Initial Inspection

Prior to their initial use, all new, repaired, or modified hoists shall be inspected by a qualified inspector to ensure compliance with the applicable provisions of ASME B30.11, B30.16, and B30.21. Dated and signed inspection records shall be kept on file and shall be readily available.

8.2.3 Daily Inspection

8.2.3.1 Operators or other designated personnel shall visually inspect items such as the following at the start of each shift or prior to first use if the hoist has not been in regular service (records are not required):

8.2.3.1.1 Controls and operating mechanisms for proper operation.

8.2.3.1.2 Hoist upper-limit switch, as applicable, for proper operation.

8.2.3.1.3 Lines, valves, and other parts of air systems for leakage.

8.2.3.1.4 Hooks for cracks, deformation, and damage from chemicals (Chapter 13, “Load Hooks,” for additional hook requirements).

8.2.3.1.5 Hoist rope for kinking, crushing, bird caging, and corrosion.

8.2.3.1.6 Hoist chain for nicks, gouges, distortion, wear, cracks, and corrosion.

8.2.3.1.7 Synthetic web strap for abrasive wear, knots, cuts, or tears, broken stitching, acid or caustic burns, melting or charring, or weld splatter.

8.2.3.1.8 Hook latch, if used, for proper operation.

8.2.3.2 Operators or other designated personnel shall examine deficiencies and determine whether they constitute a safety hazard.

8.2.4 Frequent Inspection

8.2.4.1 Operators or other designated personnel shall visually inspect the hoist at the following intervals (records are not required):

8.2.4.1.1 Normal service – monthly.

8.2.4.1.2 Heavy service – weekly to monthly.

8.2.4.1.3 Severe service – daily to weekly.

8.2.4.2 In addition to the requirements listed above in Daily Inspection, these inspections shall include the following:

8.2.4.2.1 Hoist braking system for proper operation.

8.2.4.2.2 Hoist rope or chain reeving for compliance with hoist manufacturer’s recommendations.

8.2.4.2.3 Lever for bends, cracks, and the like.

8.2.4.2.4 Observations during operation.

8.2.4.3 Examine deficiencies and determine whether a more detailed inspection is required. If deficiencies are found, contact the **AEDC Crane System Engineer**.

8.2.5 Periodic Inspection

8.2.5.1 General

8.2.5.1.1 A qualified inspector shall perform a complete inspection at the following intervals:

- Normal service – yearly.
- Heavy service – semiannually.
- Severe service - quarterly

8.2.5.1.2 The qualified inspector shall examine deficiencies and determine whether they constitute a safety hazard and whether disassembly is required.

8.2.5.1.3 Dated and signed inspection records shall be kept on file and shall be readily available.

8.2.5.2 Hoists

In addition to the requirements listed in paragraph 8.2.4, “Frequent Inspection,” periodic inspections of hoists shall include the following:

- 8.2.5.2.1 Bolts, rivets, nuts, and pins for being loose or absent.
- 8.2.5.2.2 Check for suspect/counterfeit parts (Terminology and Definitions, Chapter 1).
- 8.2.5.2.3 Cracked or worn drums or sheaves.
- 8.2.5.2.4 Worn, corroded, cracked, or distorted parts such as pins, bearings, shafts, gears, rollers locking, and clamping devices.
- 8.2.5.2.5 Excessive wear on motor or load brakes.
- 8.2.5.2.6 Excessive wear of chains, ropes, synthetic web strap, load sprockets, drums, sheaves, and chain stretch.
- 8.2.5.2.7 Deterioration or damage of end connections and terminations of wire rope, load chains, and synthetic web.
- 8.2.5.2.8 Hooks having more than 5% in excess of normal throat opening not to exceed ¼ inch, or any visibly apparent bend or twist from the plane of the unbent hook (Chapter 13 for additional hook requirements).
- 8.2.5.2.9 Hook-retaining nuts or collars and pins, welds, or riveting used to secure the retaining members.
- 8.2.5.2.10 Suitable crack-detecting inspections for hooks, such as dye-penetrant or magnetic-particle inspections (performed when required by the inspector).
- 8.2.5.2.11 Electrical apparatus for signs of pitting or any deterioration of controller contactors, limit switches, and push-button switches.
- 8.2.5.2.12 Supporting structures and trolleys, if used, for continued ability to support imposed loads.
- 8.2.5.2.13 Warning labels for illegibility or absence.

8.2.5.3 Wire Rope

- 8.2.5.3.1 A qualified inspector shall inspect running rope at least annually. This inspection shall include examination of the entire length of rope, without detaching it from the hoist drum. More frequent intervals shall be determined by a qualified person and shall be based on such factors as expected rope life as determined by experience on the particular installation or similar installations, severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. The qualified inspector shall carefully note any deterioration, such as described below, resulting in appreciable loss of original strength and determine whether further use of the rope constitutes an acceptable risk.
 - Reduction from nominal diameter of more than 5%.
 - A number of broken outside wires and the distribution or concentration of such broken wires.
 - Worn outside wires.
 - Sections of rope that are normally hidden during inspection or maintenance procedures, such as parts passing over sheaves (these are points most subject to deterioration).
 - Corroded or broken wires at end connections.
 - Corroded, cracked, bent, worn, or improperly applied end connections.
 - Kinking, crushing, cutting, or unstranding.

8.2.5.3.2 No precise rules can be given for determining the exact time to replace wire rope because many factors are involved. Safety depends largely on the use of good judgment by an appointed person in evaluating remaining strength in a used rope, after allowance for deterioration disclosed by inspection. Safety of rope operation depends on this remaining strength.

8.2.5.3.3 Conditions such as the following shall be reason for questioning rope safety and considering replacement:

- In hoist ropes, 12 randomly distributed broken wires in one rope lay, or 4 broken wires in one strand in one rope lay.
- Wear of one-third of the original diameter of outside individual wires.
- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
- Evidence of heat damage from any cause.
- Reductions from nominal diameter greater than 5%.

8.2.5.3.4 The qualified inspector shall give special attention to end fastenings and shall examine ropes frequently at socketed fittings; on the development of two broken wires adjacent to this point, resocket or replace the rope. Resocketing shall not be attempted if the resulting rope length will be insufficient for proper operation. Those portions of the rope subjected to reverse bends and operation over small-diameter drums or sheaves shall be closely examined.

8.2.5.3.5 Replacement rope and connections shall have a strength rating at least as great as the original rope and connections furnished by the hoist manufacturer. Any deviation from the original size, grade, or construction shall be specified by a rope manufacturer, the hoist manufacturer, or a qualified person.

8.2.5.3.6 Never use discarded rope for slings.

8.2.5.4 Welded-Link Chain

A qualified inspector shall do the following during periodic inspections:

8.2.5.4.1 Operate the hoist under load in raising and lowering directions, and observe the operation of the chain and sprockets. The chain should feed smoothly into and away from the sprockets.

8.2.5.4.2 Make sure that, if the chain binds, jumps, or is noisy, first clean and properly lubricate it. If the trouble persists, inspect the chain and mating parts for wear, distortion, or other damage.

8.2.5.4.3 The chain should be cleaned before inspection. Examine visually for cracks, gouges, nicks, weld spatter, corrosion, and distorted links. Slacken the chain and move adjacent links to one side to inspect for wear at the contact points. If you observe wear or suspect stretching, measure the chain according to the hoist manufacturer's instructions. If instructions are not available, proceed as follows:

- Select an unworn, unstretched length of the chain (e.g., at the slack end).
- Suspend the chain vertically under tension and, using a tool, measure the outside length of any convenient number of links approximately 12 in. (305 mm) to 14 in. (356 mm) overall.
- Measure the same number of links in the used sections and calculate the percentage of increase in length.
- If the used chain exceeds a hoist manufacturer's recommended length, or in the absence of such a recommendation, if the used chain is 1.5% longer than the unused chain for powered hoists or is 2.5% longer than the unused chain for hand-operated hoists, replace the chain.

- Examine the chain for gouges, nicks, corrosion, weld spatter, or distorted links. Any of these conditions shall be sufficient reason for questioning safety and considering replacement. Safety in this respect depends largely on the use of good judgment by an appointed person in evaluating the degree of damage.

8.2.5.4.4 No one except the chain manufacturer shall repair the load chain by welding or any other means.

8.2.5.4.5 Ensure that replacement chain is the same size, grade, and construction as the original chain furnished by the hoist manufacturer, unless otherwise recommended by the hoist manufacturer due to working conditions.

8.2.5.4.6 Load-chain links that pass over the hoist-load sprocket on edge (alternate to those that lie flat in the pockets) should be installed with the welds away from the center of the sprocket. This precaution is not required on idler sprockets, which change the direction but not the tension in the chain.

8.2.5.4.7 Ensure that replacement chain is installed without any twist between the hoist and an anchored end on either the loaded side or the slack side.

8.2.5.4.8 When a chain is replaced, disassemble and inspect the mating parts (sprockets, guides, stripper) for wear, and replace if necessary.

8.2.5.4.9 Never use discarded load chain for slings.

8.2.5.5 Roller Chain

A qualified inspector shall do the following during periodic inspections:

8.2.5.5.1 Test the hoist under load in raising and lowering directions, observing the operation of the chain and sprockets. If the chain binds, jumps, or is noisy; clean and properly lubricate it. If the trouble persists, inspect the chain and mating parts for wear, distortion, or damage.

8.2.5.5.2 If you observe wear or suspect stretching, measure the chain according to the hoist manufacturer's instructions. If instructions are not available, proceed as follows:

- Suspend the hoist in normal position and apply a light load of approximately 100 lb (46 kg).
- Select a 12-in. (305 mm) section of chain that normally travels over the load sprocket.
- Determine elongation by measuring with a tool, from the edge of one chain pin to the corresponding edge of another pin. If elongation exceeds ¼ in. (6.3 mm) in 12 in. (305 mm) compared to new or unstretched chain values, replace the chain.
- Inspect for twists. Replace if the twist in any 5-ft (1.52 m) section exceeds 15°.
- Check for straightness in a plane perpendicular to the plane of the rollers. Replace if the chain has a bow exceeding ¼ in. (6.3 mm) in any 5-ft (1.52 m) section.

8.2.5.5.3 Make additional inspections by removing the chain from the hoist and cleaning it thoroughly. Carefully examine deficiencies such as those listed below and determine whether they constitute a safety hazard. Any deficiencies are reason for questioning chain safety and considering its replacement.

- Pins turned from original position.
- Rollers that do not run freely with light finger pressure.
- Joints that cannot be flexed by easy hand pressure.
- Side plates that are spread open.

- Corrosion, pitting, or discoloration.
- Gouges, nicks, or weld spatter.

8.2.5.5.4 Do not attempt to repair roller chain by welding or heating.

8.2.5.5.5 Ensure that replacement chain is the same size, grade, and construction as the original chain furnished by the hoist manufacturer unless otherwise recommended by the hoist manufacturer due to working conditions.

8.2.5.5.6 Never use discarded or new roller chain for slings.

8.2.5.6 Synthetic-Web Strap

8.2.5.6.1 No precise rules can be given for determining the exact time to replace web strap. Safety depends largely on the use of good judgment by an appointed person in evaluating remaining strength in a used web, after allowance for deterioration disclosed by inspection.

8.2.5.6.2 Conditions such as the following shall be reason for questioning continued use of the web strap or increasing the frequency of inspection:

- Severely worn end connections.
- Distortion of the web-strap structure.
- Evidence of any heat damage.

8.2.5.6.3 The web strap shall be removed from service when damage such as the following is discovered:

- Melting or charring.
- Acid or caustic burns.
- Weld spatter.
- Broken stitching.
- Cuts or tears.
- Damaged eyes or fittings.
- Abrasive wear.
- Knots

8.2.6 Hoists Not in Regular Service

8.2.6.1 A hoist that is not in regular service (idle for a period of 1 month or more, but less than 1 year) shall be inspected before being placed in service according to the requirements listed above in paragraph 8.2.4, "Frequent Inspection."

8.2.6.2 A hoist that is not in regular service (idle for a period of 1 year or more) shall be inspected before being placed in service according to the requirements listed above in paragraph 8.2.5, "Periodic Inspection."

8.2.6.3 The determination supporting these alternate inspection frequencies and procedures shall be made by a qualified person for each affected hoist. Documentation supporting this determination shall be kept readily available.

8.3 TESTING

8.3.1 Operational Tests

8.3.1.1 General

- 8.3.1.1.1 All new hoists shall be tested by the hoist manufacturer. All modified or repaired hoists or hoists that have not been used within the preceding 12 months shall be tested before being placed in service. All tests shall be done by a qualified inspector or under the direction of that inspector as detailed in the following paragraphs.
- 8.3.1.1.2 Scheduled periodic load tests are not routinely required. If a load test is conducted, the test load shall not be less than 100% of the rated load of the hoist or more than 125% of the rated load of the hoist unless otherwise recommended by the hoist manufacturer or a qualified person. For hoists that frequently make critical lifts, especially if lifts are at or near rated capacity, a scheduled load-test program may be implemented. Such periodic load-tests shall not exceed the rated capacity. If a scheduled load-test program is implemented, a 5-year frequency is recommended.
- 8.3.1.1.3 No hoist shall be loaded beyond its rated load except for test purposes or for special overrated lifts as provided in 8.3.1.4.
- 8.3.1.1.4 Planned engineered lifts are outlined in the ASME B30 standards. No such lift shall be made without the authorization of the AEDC Crane System Engineer. This authorization will only be granted after the AEDC Structural Engineer has reviewed the design of the crane-supporting structure, has inspected the structure as required by ASME B 30 standards and has approved its use for the intended lift.

8.3.1.2 Electric- or Air-Powered Hoists

- 8.3.1.2.1 Check lifting and lowering (testing through complete rated lift length is not required).
- 8.3.1.2.2 Check operation of brakes.
- 8.3.1.2.3 Determine the trip setting of limit devices by tests under no-load conditions. Conduct tests first by hand, if practical, and then under slowest speed obtainable. Test with increasing speeds up to maximum speed.

8.3.1.3 Hand-Chain-Operated Hoists

- 8.3.1.3.1 Check all functions of the hoist, including lifting and lowering, with the hoist suspended in an unloaded state.
- 8.3.1.3.2 After testing unloaded, apply a load of at least 50 lb (23 kg) multiplied by the number of load-supporting parts of chain to the hoist to check proper load control.

8.3.1.4 Manual-Lever-Operated Hoists

- 8.3.1.4.1 Check all functions of the hoist with the hoist suspended in an unloaded state.
- 8.3.1.4.2 After testing unloaded, apply a load of at least 100 lb (46 kg) multiplied by the number of load-supporting parts of load line to the hoist to check proper load control.

8.3.2 Load Test

Test anchorages or suspensions shall be approved by a qualified person.

8.3.2.1 Electric- or Air-Powered Hoists

- 8.3.2.1.1 The manufacturer shall dynamically test new hoists as specified in paragraph 8.3.1.2, ("Electric- or Air-Powered Hoists"), steps 8.3.1.2.1 and 8.3.1.2.2, with a test load of not less than 125% of the rated load. If the manufacturer cannot test the hoist, the user shall be notified and the test

shall be accomplished at another location or job site by a qualified inspector or under the direction of that inspector. If a load test is conducted, the test load shall not be less than 100% of the rated load of the hoist or more than 125% of the rated load of the hoist unless otherwise recommended by the hoist manufacturer or a qualified person.

- 8.3.2.1.2 A qualified inspector shall test hoists in which load suspension parts have been modified, replaced, or repaired as specified in paragraph 8.3.1.2, steps a. and b., by or under the direction of a qualified inspector, and a record of the test should be made. A designated or authorized person shall determine if repairs made to a hoist are extensive, and require a rated load test, or routine maintenance and require only an operational test. The applied test load shall not be less than 100% of the rated capacity of the hoist, or more than 125% of the rated capacity of the hoist unless otherwise recommended by the manufacturer or a qualified person. The replacement of load chain and rope is specifically excluded from this hoist test; however, a functional test of the hoist under a normal operating load should be made in accordance with 8.3.1, “Operational Tests,” prior to putting the hoist back in service.

8.3.2.2 Hand-Chain-Operated or Manual-Lever-Operated Hoists

- 8.3.2.2.1 The manufacturer shall dynamically test new hoists with a test load of at least 125% of the rated capacity. If the manufacturer cannot test the hoist, the user shall be notified and the test shall be accomplished at another location or job site by a qualified inspector or under the direction of that inspector.
- 8.3.2.2.2 Hoists in which load suspension parts have been modified, replaced, or repaired shall be tested statically or dynamically by or under the direction of a qualified inspector and a record of the test should be kept. A designated or authorized person shall determine if repairs made to a hoist are extensive and require a rated load test or are routing maintenance and require only an operational test. The applied test load shall not be less than 100% of the rated capacity of the hoist or more than 125% of the rated capacity of the hoist, unless otherwise recommended by the manufacturer or a qualified person. The replacement of load chain is specifically excluded from this hoist load test; however, a functional test of the hoist should be made in accordance with paragraph 8.3.1.2, or 8.3.1.3, “Hand-Chain-Operated Hoists,” and “Manually Lever-Operated Hoists,” respectively, prior to putting the hoist back in service.
- 8.3.2.2.3 A sample load test and inspection form is included as Exhibit 8.1, which appears at the end of this chapter. This form is intended to be a sample only, and is not intended to be mandatory.

8.3.3 Load Test Procedure

Load tests shall be conducted in accordance with a written step-by-step procedure. A hold point shall be included in the load-test procedure to verify that inspection and maintenance is up to date. Load tests should be made where no critical items are installed, stored, or being worked on. The following guidelines are for information. Actual conditions may require changes to meet different situations and equipment configurations. Use Exhibit 8.5, Hoist, Jib Cranes and Monorail Systems Load Test Checklist, to document this test. This will become the load test report.

- 8.3.3.1 Verify that hoist inspection and maintenance is up to date.
- 8.3.3.2 State the type of load test. Example: “Special Test Before Critical Lift,” “Test Before Returning to Service,” or a “Rated Load Test.”
- 8.3.3.3 State test loads used.
- 8.3.3.4 Lift the test load a few inches and hold for 5 minutes; from this position, lift an additional distance, not less than 3 feet above the floor (ground), and hold for 5 minutes. Then slowly lower

the load; stop about 1 foot above the floor (ground), and hold for 5 minutes. At intermediate levels during hoisting and lowering, verify that the hoist operates properly and holds the load without slippage of more than 0.5 inch.

- 8.3.3.5 For electric- or air-powered hoists, at least once in a raising and once in a lowering condition, at a height of no more than 1 foot, disconnect the electric or air power source. The load shall stop immediately with less than 0.5-inch movement. There should be no slippage of the load or overheating of the brakes after 5 minutes of power off. The holding brakes should control the load throughout the test, and the load should not drop more than 0.5 inch when the lifting motion is again initiated.
- 8.3.3.6 For monorail and jib cranes, transport the test load with the carrier (trolley) over the trolley's entire range. For jib cranes, rotate the jib boom over the full range of motion while the carrier is at the outside end of the boom. Load transporting should be done with the test load approximately 1 foot or less above the floor (ground) or obstructions.
- 8.3.3.7 The test load should not rotate on the load block. Use taglines as appropriate. If the hook has power rotation, rotate the load through the full range of motion.
- 8.3.3.8 The hoist and carrier (trolley) shall function smoothly, without sticking or binding.
- 8.3.3.9 Following the load test, verify that no visible load-bearing part (e.g., gearing, shafting, bearing, rope or chain end-connection, brake components) has been adversely affected by the test.
- 8.3.3.10 Place the load test report in the maintenance file.

8.4 MAINTENANCE

8.4.1 Preventive Maintenance

- 8.4.1.1 A preventive maintenance program shall be established and be based on the hoist manufacturer's recommendations. If equipment maintenance procedures deviate from published manufacturer's recommendations, the alternate procedures shall be approved in advance by the manufacturer or another qualified person and be kept readily available. Dated maintenance records shall be retained in the maintenance file and readily available to appointed personnel.
- 8.4.1.2 Replacement parts shall be at least equal to the original manufacturer's specifications

8.4.2 Maintenance Procedure

CAUTION: Adhere to established fall-protection requirements (guardrail system, safety net system, or personal fall-arrest system) when positioned on a walking or working surface with an unprotected side or edge that is 6 ft (2 m) or more above a lower level. Consult with your supervisor or occupational safety representative for specific details. The following precautions shall be taken as applicable.

- 8.4.2.1 The hoist, monorail crane, or carrier (trolley) to be repaired shall be moved to a location where it will cause minimum interference with other equipment. Equipment that cannot be readily moved from its operating location can be maintained at the operating location, providing precautions are taken to ensure the safety of maintenance personnel and other personnel.
- 8.4.2.2 All controllers shall be placed in the off condition.
- 8.4.2.3 If the equipment is electrically powered, the main or emergency switch on the line feeding the hoist or monorail system shall be locked in the de-energized position, except as required to perform the maintenance. **Lock and tag procedures shall be strictly followed.**

- 8.4.2.4 If air-powered, the supply shall be disconnected or the valve on the air line feeding the hoist or monorail system shall be closed, except as required to perform the maintenance. **Lock and tag procedures shall be strictly followed.**
- 8.4.2.5 Effective markings and barriers shall be used where work creates a hazardous area on the floor beneath the equipment. “Warning” or “out of order” signs should be placed on the hoist. If personnel can access the equipment and signs are not visible from the floor beneath, warning signs should be visible from the floor.
- 8.4.2.6 Only properly trained personnel shall work on energized equipment. Extra caution is required when working on energized equipment.
- 8.4.2.7 For monorail systems:
- 8.4.2.7.1 Where other carriers are operating on the same monorail track, temporary stops should be provided to prevent interference with the idle equipment.
- 8.4.2.7.2 Where temporary stops are not possible or practical, a signal person shall be placed at a vantage point for observing the approach of an active unit and warning its operator when it reaches a safe distance from the idle unit.
- 8.4.2.8 After adjustments and repairs have been made, the equipment shall not be restored to service until all guards have been reinstalled, safety devices reactivated, and maintenance equipment removed.

8.4.3 Adjustments and Repairs

- 8.4.3.1 Any hazardous conditions disclosed by inspection or during operation shall be corrected before normal hoist operation is resumed. Adjustments and repairs shall be done only by designated personnel.
- 8.4.3.2 Adjustments shall be maintained to ensure correct functioning of components. The following are examples of functional operating mechanisms:
- 8.4.3.2.1 Limit devices
- 8.4.3.2.2 Control systems
- 8.4.3.2.3 Brakes.
- 8.4.3.3 Repairs or replacements shall be made as needed. The following are examples:
- 8.4.3.3.1 Hooks showing indications described in Chapter 13.
- 8.4.3.3.2 All critical parts that are cracked, broken, bent, or excessively worn.
- 8.4.3.3.3 Pitted or burned electrical contacts should be corrected only by replacement and in sets. Controller parts should be lubricated as recommended by the manufacturer.
- 8.4.3.3.4 Function labels on pendant control stations shall be kept legible.
- 8.4.3.4.5 If repairs of load-sustaining members are made by welding, materials shall be identified and appropriate welding procedures shall be assigned by a qualified welding engineer, and welds shall be made by a qualified welding operator.

8.4.4 Preoperational Check after Adjustments or Repairs

A preoperational check shall be performed to verify the proper function of activities such as motion controls and interlocks. Special attention shall be given to those areas likely to have been affected by maintenance or repair.

8.5 OPERATION

The following shall apply to all personnel involved in hoist operations. At the initial stage of the planning process, an appointed person shall classify each lift into one of the AEDC-specified categories (ordinary, critical or non-standard).

8.5.1 Conduct of Operator

Operators must do the following:

- 8.5.1.1 Never engage in any practice that will divert attention while engaged in operating the hoist.
- 8.5.1.2 Never operate equipment when physically or mentally unfit.
- 8.5.1.3 Become familiar with the equipment and its proper care. If adjustments or repairs are necessary, or any damage is known or suspected, report it promptly to the appointed person. Notify the next operator of the problem upon changing shifts. Correct deficiencies before resuming normal operation.
- 8.5.1.4 Test all controls before beginning a shift. If any controls do not operate properly, adjust or repair them before beginning operations.
- 8.5.1.5 Be responsible for those operations under their direct control. Whenever there is doubt as to safety, consult responsible management before handling the load.
- 8.5.1.6 Never operate a hoist that bears an out-of-order sign or is otherwise tagged out-of-service.
- 8.5.1.7 Follow AEDC SHE Standard B2, Lockout/Tagout (LOTO) if there is a tag, sign, or lock on electric- or air-powered equipment. Do not energize the equipment until the tag, sign, or lock is removed by the person who placed it there or by an authorized person.
- 8.5.1.8 Never close the main line disconnect device on powered equipment until certain that no one is on or adjacent to the hoist or carrier.

8.5.2 Size of Load

Know the weight of the load and do not load the hoist beyond the rated capacity, except as provided for in paragraph 8.3, "Testing."

8.5.3 Attaching the Load

- 8.5.3.1 The supporting structure or anchoring means shall have a load rating at least equal to that of the hoist.
- 8.5.3.2 Use hoists only in areas that will allow you to be clear of the load.
- 8.5.3.3 Do not wrap the hoist rope or chain around the load.
- 8.5.3.4 Attach the load to the hook using slings or other approved devices.
- 8.5.3.5 Do not use chain or wire rope as a ground for welding.
- 8.5.3.6 Do not touch a welding electrode to the chain, wire rope, or any other part of the hoist or monorail system.
- 8.5.3.7 Operate hand-chain-operated hoists with hand power only and with no more than one operator per hand chain.
- 8.5.3.8 Do not use a lever extension ("cheater") on manual-lever-operated hoists.

8.5.3.9 Properly seat the slings or other approved devices in the saddle of the hook before carrying out hoisting operations.

8.5.4 Moving the Load

8.5.4.1 Take care in hoisting to be certain that:

8.5.4.1.1 Hoist ropes or chains are not kinked or twisted.

8.5.4.1.2 The load does not contact any obstructions.

8.5.4.1.3 Multiple-part ropes or chains are not twisted around each other.

8.5.4.2 Before starting to hoist, ensure that the rope or chain is properly seated on the drum, sheaves, or sprockets.

8.5.4.3 Before starting the hoist, be certain that all personnel are clear of the equipment.

8.5.4.4 Do not operate hoists until the hook is positioned above the center of gravity of the load, except when specifically authorized by an appointed person who has determined that the components of the hoist and its mounting will not be overstressed.

8.5.4.5 Do not move or lift a load more than a few inches until it is well balanced in a sling or lifting device.

8.5.4.6 Do not lift, lower, or travel the hoist while anyone is on the load or hook.

8.5.4.7 Avoid carrying loads above personnel.

8.5.4.8 Test the brakes each time a load approaching the rated capacity is handled by raising the load just enough to clear the floor or supports and checking for brake action. Continue the lift only after you are sure that the braking system is operating properly.

8.5.4.9 Do not lower a loaded wire-rope hoist drum beyond the point where less than two full wraps of wire rope remain on the drum.

8.5.4.10 Inch the hoist into engagement with a load, and avoid unnecessary stops and starts.

8.5.4.11 Do not perform side pulls with hoists except as specifically authorized by a qualified person.

8.5.4.12 If power goes off during operation of cab-operated equipment, immediately place all controllers in the OFF position. Before reuse, check operating motions for proper direction.

8.5.4.13 Do not leave a suspended load unattended unless specific precautions have been instituted and are in place.

8.5.4.14 Tag lines should be used as required to guide, snub, or otherwise control the load.

8.5.4.15 Take signals from only one **qualified signal** person using the standard hand signals shown in Chapter 7, "Overhead and Gantry Cranes." *Obey a STOP signal regardless of who gives it.*

8.5.4.16 Lift the hoist load block above head level for storage when the equipment is not in use.

8.5.5 Hoist-Limit Switch

8.5.5.1 At the beginning of a shift, test the upper-limit switch of each hoist under no load conditions. If the hoist has a lower-limit switch, test it with no load before lowering any load that could bring the lower-limit switch into operation. Exercise extreme care; inch the block into the limit switch or run in at slow speed. If the limit switch does not operate properly, notify the designated person immediately.

8.5.5.2 If a lift is in progress during a shift change, this testing requirement is considered to have been satisfied for the completion of that lift. However, test the limit switch again before the next lift.

8.5.5.3 Never use the hoist-limit switch that controls the upper limit of travel of the load block as an operating control.

8.5.6 Ordinary Lifts

8.5.6.1 Hoisting and rigging operations for ordinary lifts require an Designated Leader. The Designated Leader shall be present at the lift site during the entire lifting operation. If the lift is being made by only one person, that person assumes all responsibilities of the Designated Leader.

8.5.6.2 Leadership designation may be by written instructions, specific verbal instructions for the particular job, or clearly defined responsibilities within the assigned craftsmen's organizational structure.

8.5.6.3 The Designated Leader's responsibility shall include the following:

8.5.6.3.1 Ensure that personnel involved understand how the lift is to be made.

8.5.6.3.2 Ensure that the weight of the load is determined, that proper equipment and accessories are selected, and that rated capacity is not exceeded.

8.5.6.3.3 Survey the lift site for hazardous/unsafe conditions.

8.5.6.3.4 Ensure that equipment is properly set up and positioned.

8.5.6.3.5 Ensure that a Qualified Signal Person is assigned, if required, and is identified to the operator.

8.5.6.3.6 Direct the lifting operation to ensure that the job is done safely and efficiently.

8.5.6.3.7 Stop the job when any potentially unsafe condition is recognized.

8.5.6.3.8 Direct operations if an accident or injury occurs.

8.5.6.4 The operator or other designated person shall visually examine the hoist in accordance with the requirements for a daily inspection described in paragraph 8.2, "Inspections."

8.5.6.5 A qualified person shall examine any deficiencies and determine whether they constitute a hazard. Correct these deficiencies before operating the hoist.

8.5.6.6 Load lines shall be checked after strain is put on them, before the load is lifted clear of the ground. If not plumb, the slings or equipment shall be repositioned so that the lines are plum before continuing.

8.5.7 Critical Lifts

See Chapter 2, "Critical Lifts," for critical-lift requirements.

Exhibit 8.1 Hoist Load Test (Sample Form)

HOIST LOAD TEST		Page 1 of 2
INSPECTED BY: _____		DATE: _____
HOIST ID#: _____		LOCATION: _____
<p>Notes:</p> <p>1. Load test prior to initial use, at 125 percent of rated capacity, all new hoists or hoists in which load-sustaining parts have been modified, repaired, or replaced. Test weights shall be accurate to within -5%, +0% of stipulated values. Load test at 100% of rated capacity hoists with overload devices. Test the function of the overload device.</p> <p>2. Qualified inspector shall verify all steps as listed below.</p> <p>3. Craftsmen will initial all tests, work, and inspections completed below.</p>		
_____	1. Perform the annual periodic inspection. Check unit for proper operation.	
_____	HAND-CHAIN-OPERATED HOISTS ONLY. Check brake mechanism for work glazed, or contaminated disks, worn pawls, cams, or ratchets. Check for broken, corroded, or stretched pawl springs. Repair as needed.	
_____	2.	
_____	3. ELECTRIC- AND AIR-POWERED HOISTS. Check:	
_____	3a. All functional operating mechanisms for misadjustment interfering with proper operation	
_____	3b. Limit switches or devices for proper operation	
_____	3c. External evidence of damage or excessive wear of load sprockets, idler sprockets, and drums or sheaves	
_____	3d. External evidence of wear on motor or load brake	
_____	3e. Electrical apparatus for signs of pitting or any deterioration of visible controller contacts	
_____	3f. All anchorage or hoist suspensions.	
_____	4. Set hoist up for load test and inspection.	
_____	Perform load test using the required test weights (See Note 1, Exhibit 8.5) and appropriate slings. Measure a length of the load chain under tension; measure a length of 15 links. If wire rope is used, measure the diameter.	
_____	5.	
IF HOIST IS EQUIPPED WITH A TROLLEY:		
_____	1. Mount hoist on a monorail.	
_____	2. Rig test weight to load hook (see step 4 above).	
_____	Perform load test moving weight along monorail. Observe hoist and trolley. Observe performance of all load-bearing components.	
_____	3.	
_____	Lower test weight to floor. Note performance of hoist during lowering operation.	
_____	4. Remove rigging.	

HOIST LOAD TEST

Page 2 of 2

At the completion of the load test, inspect the following items.

1. Visually inspect and re-measure the load chain and/or hoist rope after the load test. Check for deformed or broken links, stretch, etc.
2. Inspect load hook and suspension hook for bending or twisting.

LOAD HOOKPREVIOUSPRESENT

Qualified Inspector Verify _____

Throat Opening _____

Qualified Inspector Verify _____

Hook Twist _____

SUSPENSION HOOKPREVIOUSPRESENT

Qualified Inspector Verify _____

Throat Opening _____

Qualified Inspector Verify _____

Hook Twist _____

- Qualified inspector shall perform nondestructive tests on hook by visual examination, liquid penetrant examination, or magnetic particle examination.
- Acceptance: No cracks, linear indications, laps, or seams.
- Hooks with more than 5% normal (new hook) throat opening, not to exceed 1/4 inch, shall be replaced.
- Hooks with any visibly apparent bend or twist from the normal (new hook) plane of the hook shall be replaced. Hooks having more than 10% wear in the bowl section or 5% elongation of the shank shall be replaced. Lubricate hook bearing and latch pin as applicable.

Establish two marks, A and B with a center punch. For ease in measuring, set distances on an even number of inches.

BEFORE LOAD TEST

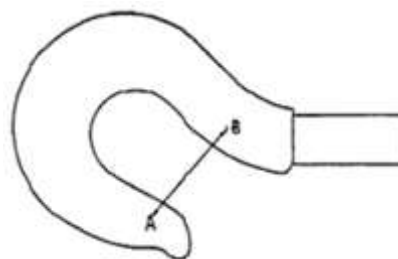
Length AB _____ Inches

AFTER LOAD TEST

Length AB _____ Inches

Check for:

1. Wear and deformation
2. Cracks
3. Signs of opening between Point A and Point B.



Actual Load Test _____ Lbs.

Equipment Operator _____

Date _____

Qualified Inspector Verify Load Test _____

Date _____

Exhibit 8.2 Underhung Hoist Periodic Inspection Report (Sample form)

UNDERHUNG HOIST PERIODIC INSPECTION REPORT				Page 1 of 2	
HOIST # :		MODEL:		LOCATION:	
STATUS CODE: [- O.K., A – Adjusted, R – Repaired, NR – Needs Repair, N/A – Not Applicable					
<u>CODE</u>		<u>COMMENT</u>		<u>CODE</u>	
<u>Housing</u>			<u>Cable</u>		
Distortion			Broken Wires		
Cracks			End Connections		
Loose Hardware			Excess Wear		
Warning Label			Kinked or Distorted		
			Corrosion		
			Heat Damage		
<u>Support Structure</u>					
- Worn or distorted Trolley					
- Load Beam Condition					
- End Stops					
<u>Internal Inspection</u>			<u>Chains</u>		
- Brake Pad Condition			Binding		
- Lubrication			Cracked		
- Excess Oil			Twisted		
- Sheaves			Distorted		
			Corroded		
			Excess Wear		
			Worn Chain Guide		

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Exhibit 8.3. Inspection Requirements For Electric- Or Air-Powered Hoists.

Item	Normal service		Heavy service		Severe service	
	Visual monthly ^a	Record yearly ^b	Visual weekly ^a	Record semiannually ^c	Visual daily ^a	Record quarterly ^c
Frequent inspections (see Para 8.2.4)						
All functional operating mechanisms for maladjustment and unusual sounds	X		X		X	
Limit devices for operation	X		X		X	
Air lines, valves, and other parts for leakage	X		X		X	
Hooks in accordance with Chapter 13	X		X		X	
Hook latch operation, if used	X		X		X	
Hoist rope in accordance with Para 8.2.4	X		X		X	
Load chain in accordance with Para 8.2.5.4	X		X		X	
Rope or load chain reeving for compliance with hoist manufacturer's recommendations	X		X		X	
Periodic inspections (see Para 8.2.5)						
Requirements of frequent inspection		X		X		X
Hoist rope in accordance with Para 8.2.5.3		X		X		X
Evidence of loose bolts, nuts, or rivets		X		X		X
Evidence of worn, corroded, cracked, or distorted parts such as load blocks, suspension housing, chain attachments, clevises, yokes, suspension bolts, shafts, gears, bearings, pins, rollers, and locking and clamping devices		X		X		X
Evidence of damage to hook retaining nuts or collars and pins, and welds or rivets used to secure the retaining members		X		X		X
Evidence of damage or excessive wear of load sprockets, idler sprockets, and drums or sheaves		X		X		X
Evidence of excessive wear on motor or load brake		X		X		X
Electrical apparatus for signs of pitting or any deterioration of visible controller contacts		X		X		X
Evidence of damage to supporting structure or trolley		X		X		X
Warning label required by Para 8.1.3.1		X		X		X
End connections of load chain		X		X		X

^aBy operator or other designated personnel with records not required.^bVisual inspection by a qualified inspector making records of conditions to provide the basis for a continuing evaluation.^cAs in b unless conditions indicate that disassembly should be done to permit detailed inspection.

Exhibit 8.4. Minimum Inspection Requirements For Hand Operated Or Lever-Operated Hoists--Chain Type.

Item	Normal service		Heavy service		Severe service	
	Visual monthly ^a	Record yearly ^b	Visual weekly to monthly ^a	Record semiannually ^c	Visual daily to weekly ^a	Record quarterly ^c
Frequent inspections (see Para 8.2.4)						
All functional mechanisms for maladjustment interfering with proper operation	X		X		X	
Hoist support for damage	X		X		X	
Hooks and latches for deformation, chemical damage, cracks, and wear (See Chapter 13)	X		X		X	
Hook latch operation, if used	X		X		X	
Load chain in accordance with Para 8.2.5.4	X		X		X	
Load chain reeving for compliance with the recommendations of the hoist manufacturer or a qualified person	X		X		X	
Lever for problems such as bends or cracks	X		X		X	
Periodic inspections (see Para 8.2.5)						
Requirements of frequent inspection		X		X		X
Evidence of loose bolts, nuts, or rivets		X		X		X
Evidence of worn, corroded, cracked, or distorted parts such as load blocks, suspension housing, levers, chain attachments, clevises, yokes, suspension bolts, shafts, gears, bearings, pins, rollers, and locking and clamping devices		X		X		X
Evidence of damage to hook retaining nuts or collars, and pins and welds or rivets used to secure the retaining members		X		X		X
Evidence of damage or excessive wear of load sprockets or idler sprockets		X		X		X
Evidence of worn, glazed, or oil- contaminated friction disks; worn pawls, cams, or ratchet; corroded, stretched, or broken pawl springs in brake mechanism		X		X		X
Evidence of damage to the supporting structure or trolley, if used		X		X		X
Warning label required by Para 8.1.3.2		X		X		X
End connections of load chain, including over-travel restraints		X		X		X

^aBy operator or other designated personnel with records not required.^bVisual inspection by a qualified inspector making records of conditions to provide the basis for a continuing evaluation.^cAs in b, unless conditions indicate that disassembly should be done to permit detailed inspection.

Exhibit 8.5 Hoist, Jib Cranes And Monorail Systems Load Test Checklist

Date: _____ Crane ID # _____

Supervisor: _____ Badge # _____ Signature: _____

Latest Crane Inspection Date: _____

Purpose of Load Test: _____

1. Special Test Before Critical Lift. _____
2. Test Before Returning to Service. _____
3. Rated Load Test. _____

Rated Capacity: _____ Test Weight(s) Used: _____

Step	Actions	Initials
1	Position the hoist at a location that provides convenient access to the test weight(s).	
2	Rig and raise the test load a few inches. Use tag lines as appropriate.	
3	Hold the test load at the raised position for five minutes. The test load should not rotate on the load block.	
4	Verify that the hoist operates properly and holds the load without slippage of more than 0.5 inch.	
5	If the hook has power rotation, rotate the load through full range of motion.	
6	Raise the load an additional distance, not less than three feet above the floor (ground), and hold for five minutes.	
7	Verify that the hoist operates properly and holds the load without slippage of more than 0.5 inch.	
8	Slowly lower the test load; stop approximately one foot above the floor (ground), and hold the load for 5 minutes.	
9	Verify that the hoist operates properly and holds the load without slippage of more than 0.5 inch.	
9a	For Monorail and Jib cranes: transport the test load over the trolley's entire range.	
9b	For Jib cranes: rotate the jib boom over the full range of motion while the carrier is at the outside end of the boom.	
9c	For Electric or Air Operated Hoist: Disconnect the electric or air power source for five minutes.	
9c1	Verify the load stops immediately with less than 0.5 inch movement.	
9c2	Verify that there is no slippage of the load or overheating of the brakes after the five minutes of power off.	
9c3	Verify that the load does not drop more than 0.5 inch when lifting motion is again initiated.	
10	Lower the test load and disconnect the rigging.	
11	Verify that no visible load-bearing part (e.g., gearing, shafting, bearing, rope or chain end-connections, brake component) has been adversely affected by the test.	
12	Tag and stow hoist.	
13	Send this document to AEDC Crane System Engineer for filing in hoist's maintenance file.	

NOTE: Test loads shall not be less than 100 percent of the rated load of the equipment or more than 125 percent of the rated load of the equipment, unless otherwise recommended by the manufacturer.

9.0 CHAPTER 9 - MOBILE CRANES

This chapter specifies operation, inspection, maintenance, and testing requirements for the use of mobile cranes and implements the requirements of ASME B30.5, PCSA-4 (“Mobile Power Crane and Excavator Standards and Hydraulic Crane Standards”), SAE J376-85 (“Load-Indicating Devices in Lifting Crane Service”), SAE J765 (“Crane Load Stability Test”), SAE J874 (“Center of Gravity Test Code”) and SAE J987 (“Crane Structure, Method of test”). Only equipment built to appropriate design standards shall be used at AEDC.

9.1 GENERAL

This chapter applies to commercial truck-mounted cranes; crawler cranes; locomotive cranes; wheel-mounted cranes, multiple control stations; wheel-mounted cranes, single control station; and any variation that retains the same fundamental characteristics. These cranes have a superstructure capable of rotating 360° mounted on a carrier and have boom raising and lowering capabilities.

9.1.1 Operator Training/Qualification

Operators of mobile cranes shall be trained and qualified in accordance with the requirements of Chapter 6, “Personnel Qualification and Training.”

9.1.2 Load Limits

9.1.2.1 Since the load rating for mobile cranes may be based on stability and hydraulic or structural competence, load ratings established by manufacturers shall not be exceeded in operational application.

9.1.2.2 No crane shall be loaded beyond its rated capacity, except for load test purposes as described in Section 9.3, “Testing.”

9.1.2.3 When loads are to be handled that are limited by hydraulic or structural competence rather than by stability, the appointed person shall ensure that the weight of a load approaching rated capacity has been determined within -10%, +0% before it is lifted.

9.1.3 Load Rating Chart

9.1.3.1 A durable rating chart with legible letters and figures shall be provided with each crane and attached in a location accessible to the operator while at the controls. Table 9-1 (next page) provides a sample load rating chart. The data and information to be provided on these charts shall include, but not be limited to, the following:

9.1.3.1.1 A full and complete range of manufacturer’s crane load ratings at all stated operating radii, boom angles, work areas, and all stated boom lengths and configurations, jib lengths and angles (or offset), as well as alternate ratings for use and nonuse of optional equipment on the crane, such as outriggers and extra counterweights, that affect ratings.

9.1.3.1.2 A work area chart for which capacities are listed in the load rating chart [Figure 9-1 (which follows Table 9-1)].

9.1.3.1.3 Where ratings are limited by structural, hydraulic, or factors other than stability, the limitations shall be shown and emphasized on the rating charts.

9.1.3.1.4 In areas where no load is to be handled, the work area figure and load rating chart shall state that information.

9.1.3.1.5 Recommended reeving for the hoist lines shall be shown.

9.1.3.2 In addition to the data required on the load rating chart, the following information shall be shown either on the rating chart or in the operating manual:

9.2.3.2.1 Recommended parts of the hoist reeving, and size and type of rope for various crane loads.

9.2.3.2.2 Recommended boom hoist reeving diagram, where applicable; size, type, and length of rope.

9.2.3.2.3 Tire pressure, where applicable.

9.2.3.2.4 Cautionary or warning notes relative to limitations on equipment and operating procedures, including indication of the least stable direction.

9.2.3.2.5 Position of the gantry and requirements for intermediate boom suspension, where applicable.

9.2.3.2.6 Instructions for boom erection and conditions under which the boom, or boom and jib combinations, may be raised or lowered.

9.2.3.2.7 Whether the hoist-holding mechanism is automatically controlled or manually controlled, whether free-fall is available, and whether any combination of those exists.

9.2.3.2.8 The maximum telescopic travel length of each boom telescopic section.

9.2.3.2.9 Whether sections are telescoped with power or manually.

9.2.3.2.10 The sequence and procedure for extending and retracting the telescopic boom section.

9.2.3.2.11 Maximum loads permitted during actual boom-extending operation and any limiting conditions or cautions.

9.2.3.2.12 Hydraulic relief valve settings specified by the manufacturer.

9.1.4 Load Hoist Brakes

When power-operated brakes that have no continuous mechanical linkage between the actuating and braking means are used, an automatic means shall be provided to set the brake to prevent the load from falling in event of loss of brake-actuating power.

9.1.5 Power-Controlled Lowering

A power-controlled lowering system shall be provided and shall be capable of handling rated loads and speeds as specified by the manufacturer of the crane.

9.1.6 Booms

9.1.6.1 Booms, boom sections, and jibs shall be clearly identified and shall be used only for the purpose recommended by the manufacturer.

9.1.6.2 Lattice booms shall meet the performance requirements of SAE J987, "Crane Structure, Method of Test" (Chapter 17, "References").

Table 9-1. Sample Load Rating Chart

This table is an example of the type of load rating chart that should be included in each crane.

Manitowoc Model 3900 Lift Crane Extra-Heavy Boom								
Working Radius	50'	60'	70'	80' lbs.	90'	100'	120'	140'
12	120,000	120,000						
14	111,200	110,800	109,000					
16	104,200	103,600	102,700	100,000	95,000			
18	97,800	97,400	97,000	96,600	92,500	90,000		
20	93,200	92,400	91,600	90,600	89,600	86,000	83,000	
22	87,800	86,800	85,800	84,800	83,800	82,800	80,000	
24	<u>83,400</u>	81,200	80,300	79,400	78,700	77,800	75,200	66,500
26	75,900	<u>75,500</u>	<u>74,700</u>	<u>73,900</u>	<u>73,200</u>	<u>72,600</u>	70,500	63,100
28	68,100	67,700	67,300	66,900	66,400	65,800	64,000	59,800
30	61,700	61,300	60,900	60,500	60,000	59,400	<u>58,500</u>	<u>56,400</u>
32	56,500	56,100	55,700	55,300	54,800	54,200	53,300	52,300
34	52,000	51,600	51,200	50,800	50,300	49,700	48,800	47,800
36	48,100	47,700	47,300	46,900	46,400	45,800	44,900	43,900
38	44,700	44,300	43,900	43,500	43,000	42,400	41,500	40,500
40	41,700	41,300	40,900	40,500	40,000	39,400	38,500	37,500
42	39,100	38,700	38,300	37,900	37,400	36,800	35,900	34,900
44	36,800	36,400	36,000	35,600	35,100	34,500	33,600	32,600
46	34,700	34,300	33,900	33,500	33,000	32,400	31,500	30,500
48	32,900	32,500	32,100	31,700	31,200	30,600	29,700	28,700
50		30,800	30,400	30,000	29,500	28,900	28,000	27,000
52		29,300	28,900	28,500	28,000	27,400	26,500	25,500
54		27,900	27,500	27,100	26,600	26,000	25,100	24,100
56		26,500	26,100	25,700	25,200	24,600	23,700	22,700
58		25,300	24,900	24,500	24,000	23,400	22,500	21,500
60			23,800	23,400	22,900	22,300	21,400	20,400
65			21,300	20,900	20,400	19,800	18,900	17,900
70				18,900	18,400	17,800	16,900	15,900
75	<u>31,200</u>			17,100	16,600	16,000	15,100	14,100
80					15,200	14,600	13,700	12,700
85		<u>24,200</u>			13,900	13,300	12,400	11,400
90			<u>19,300</u>			12,100	11,200	10,200
95				<u>15,700</u>		11,100	10,200	9,200
100					<u>12,700</u>		<u>9,300</u>	<u>8,300</u>
110						<u>10,200</u>	6,800	5,600
120							4,500	3,840

NOTES: Above ratings are maximum recommended working loads.

Loads between solid lines are computed at 75% of tipping load across treads; with machine on firm, level ground.

Loads outside solid lines are limited by strength of boom.

For booms 80 ft and longer, use cambered center section; for booms 100 ft and longer, use deep section inserts.

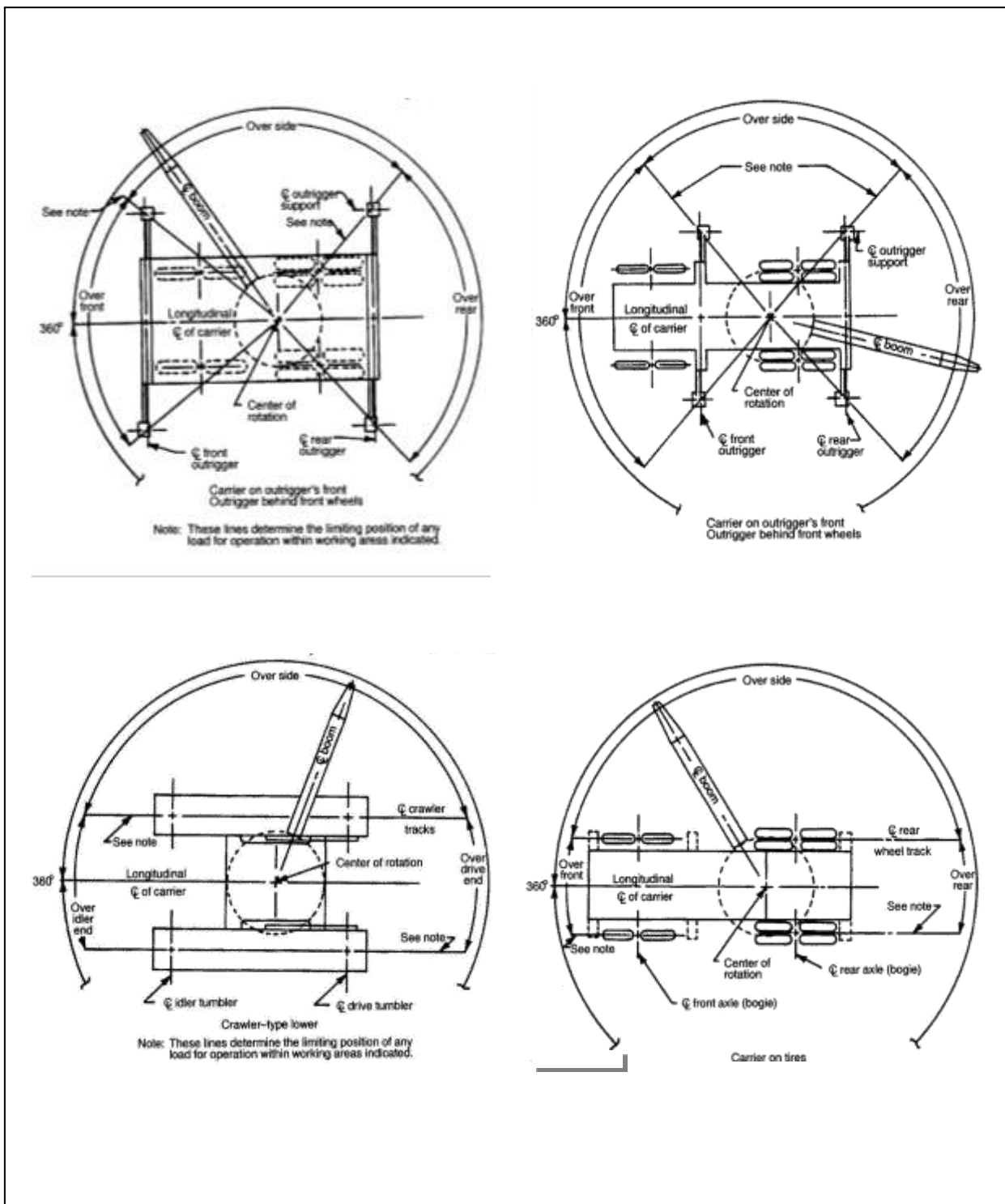


Figure 9-1. Sample work area chart

9.1.7 Counterweight

9.1.7.1 Cranes shall not be operated without the ballast or counterweight being in place as specified by the crane manufacturer. Under specific conditions, such as during crane assembly, unusual boom configurations, etc., the crane manufacturer's recommendations for ballast or counterweight shall be adhered to.

9.1.7.2 Ballast or counterweight as specified by the manufacturer shall not be exceeded.

9.1.8 Rerating

9.1.8.1 Cranes may be modified or rerated providing such modifications are analyzed thoroughly by a qualified engineer or manufacturer of cranes. Such action must be approved by the **base operating contractor's** safety office.

9.1.8.2 When rerated, crawler, truck, and wheel-mounted cranes shall be tested in accordance with SAE J765, "Crane Load Stability Test Code."

9.1.8.3 A rerating test report shall be readily available.

9.1.8.4 No cranes shall be rerated in excess of the manufacturer's original load ratings.

9.1.9 Maintenance History

9.1.9.1 The crane maintenance file is a compilation of various documents and records relating to operation, maintenance, inspection, testing, evaluating and repair of the equipment. The intent of the crane maintenance files are to provide the user with evidence of a safe and reliable maintenance program. Inspection records should be retained in a format and location that provides for ease in accessibility. Maintenance file information should provide a source for comparing present conditions with past conditions to determine whether existing conditions show a trending pattern of wear, deterioration, or other comparable factors that may compromise safe, continued use of the equipment.

9.1.9.1.1 The master file shall be located in the **AEDC crane library**. A secondary file may be centrally located or proportioned into satellite holding areas.

9.1.9.2 The maintenance history of the crane shall be retained throughout its service life. Maintenance records shall be retained in the crane master file, or an electronic record keeping system may be used. If a computer system is used, and maintenance records are not retained in the crane history file, the crane history file shall state where the electronic maintenance records are available.

9.1.9.3 The crane maintenance file shall contain, as a minimum, the required current dated periodic inspection records and other documentation to provide the user with evidence of a safe and reliable maintenance program. Maintenance file information should provide a source for comparing present conditions with past conditions to determine whether existing conditions show a trending pattern of wear, deterioration, or other comparable factors that may compromise safe, continued use of the equipment.

9.1.9.4 Crane maintenance files shall contain the following documentation, as applicable:

9.1.9.4.1 All documented inspection records.

9.1.9.4.2 Load test reports.

9.1.9.4.3 Documentation of altered, replaced, or repaired load-sustaining parts.

9.1.9.4.4 Records of special inspections on safety related items such as brakes, crane hooks, ropes, hydraulic and pneumatic cylinders, and hydraulic and pneumatic relief pressure valves.

9.1.9.4.5 Copies of waivers, exemptions, hostile environment plans, or similar documentation applicable to the crane (to include manufacture's safety bulletins, safety alerts, and product recall information).

9.1.9.4.6 Documentation for replacement ropes (see Chapter 11, "Wire Rope and Slings")

9.1.9.4.7 Wire rope manufacture's certification for replacement ropes.

9.1.9.4.8 Records of inspection on load indicating devices, anti-two block, two-block warning, and two-block damage prevention systems.

NOTE: Although complete maintenance information for old cranes may not be available, the **AEDC Crane System Engineer** should acquire as much of the pertinent information as possible.

9.1.10 Design Standards

9.1.10.1 Structural, mechanical, and electrical components of the crane design shall meet accepted crane design standards, such as PCSA-4, "Mobile Power Crane and Excavator Standards and Hydraulic Crane Standards."

9.1.10.2 The safety features and operation shall conform, at a minimum, to the provisions of ASME B30.5, "Mobile and Locomotive Cranes."

9.1.11 Riding the Hook or Load

Personnel are not permitted to ride the bare hook, hook ball or a suspended load. (For personnel lifting, see Chapter 4)

9.1.12 Outrigger pads

Cribbing / blocks / mats / dunnage / pads shall be used under outrigger floats at all times and shall meet the following conditions:

9.1.12.1 Have sufficient strength to prevent crushing, bending, or shear failure.

9.1.12.2 Be of adequate size and thickness to completely support the float, transmit the load to the supporting surface, and prevent shifting, toppling, or excessive settlement under load.

9.1.12.3 Use blocking only under the bearing surface of the outrigger float.

9.1.13 Adverse Weather

Wind speed and other weather conditions shall be considered. Do not attempt lifts if weather conditions are adverse to safe load-handling operations. Contact the AEDC Operations Center for current local weather conditions.

9.1.13.1 Refer to manufacturers written operating instructions for any wind speed limitations. However, without directorate approval, all operations will be ceased when winds are in excess of 30 mph.

9.1.13.2 Cease operations when electrical storms are within 10 miles.

9.1.14 Minimum Three Wraps on Drums

AEDC has adopted the policy that neither the load nor the boom shall be lowered below the point where less wraps of rope remain on the respective drums than manufacturer's instructions and in no case will the wraps be less than three full wraps. This requirement is applicable to mobile cranes only.

9.1.15 Operating Manual

An operating manual, supplied by the manufacturer, shall be readily available to the operator at all times.

9.1.16 Sheaves

- 9.1.16.1 Sheave grooves shall be smooth and free from surface defects that could cause rope damage. The cross-sectional radius at the bottom of the groove shall form a close-fitting saddle for the size of rope used.
- 9.1.16.2 Sheaves carrying ropes, which can be momentarily unloaded, shall be provided with close-fitting guards or other devices to guide the rope back into the groove when the load is reapplied. The sheaves in the lower load block shall be equipped with close-fitting guards that will prevent ropes from becoming fouled when the block is lying on the ground with loose ropes.

9.1.17 Load Hooks, Ball Assemblies and Load Blocks

Load hooks, ball assemblies, and load blocks shall be of sufficient weight to overhaul the line from the highest hook position. Hook and ball assemblies and load blocks shall be labeled with their rated capacity and weight.

9.1.18 Hook Mousing and Throat Latches

Latch-equipped hooks shall be used for hoisting and rigging (H&R) operations unless the application makes use of the latch impractical or unsafe. The absence of a hook throat latch is not allowed (see paragraph 13.1.3).

9.1.19 Booms and Jibs

- 9.1.19.1 Jibs shall be restrained from backward overturning.
- 9.1.19.2 A boom-angle indicator, readable from the operator's station, shall be provided.
- 9.1.19.3 A boom length indicator, readable from the operator's station, shall be provided for telescoping booms unless the load rating is independent of the boom length.
- 9.1.19.4 A boom-hoist disconnect, shutoff, or hydraulic relief shall be provided to automatically stop the boom hoist when the boom reaches a predetermined high angle.

9.1.20 Miscellaneous Equipment Requirements

- 9.1.20.1 Telescopic boom cranes manufactured after February 28, 1992, shall be equipped with an anti-two-block device or a two-block damage prevention feature for all points of two-blocking. Telescopic boom cranes manufactured before February 28, 1992, should be equipped with a two-block warning feature(s), a two-block damage prevention feature, or an anti-two-block device for all points of two-blocking (i.e., jibs, boom extensions, etc.).
- 9.1.20.2 Lattice boom cranes manufactured after February 28, 1992, shall be equipped with an anti-two-block warning feature, which functions for all points of two-blocking. Lattice boom cranes manufactured before February 28, 1992, should be equipped with a two-block warning feature which functions for all points of two-blocking.
- 9.1.20.3 Cranes used to lift suspended personnel platforms shall have an anti-two-block device or a two-block damage prevention feature. A two-block warning feature and/or assigning a person to

watch for, and guard against, two-blocking provides insufficient safety for personnel lifting and is not allowed.

9.1.20.4 All cranes with a maximum load capacity of 3 tons or more shall have a load indicator (Mfg after 1993), rated load capacity indicator, or rated capacity (load) limiter (Mfg after 2005).

9.1.20.5 An audible horn or signal device shall be provided. The control for the device shall be within reach of the operator.

9.1.20.6 Means shall be provided for the operator to visually determine the levelness of the crane.

9.1.20.7 If a seat belt is provided with a wheel-mounted, single-control station crane, it shall be used during transit and travel.

9.2 INSPECTIONS

9.2.1 General

Equipment shall operate with a smooth, regular motion without any hesitation, abnormal vibration, binding, gross shimmy, or irregularity. There shall be no apparent damage, excessive wear, or deformation of any load-bearing part of the equipment. All safety devices, load indicators, boom angle and radius indicators, controls, and other operating parts of the equipment shall be checked during each inspection and shall be in good working order.

9.2.2 Initial Inspection

Prior to initial use, all new or modified cranes shall be inspected as required in paragraph 9.2.6, "Periodic Inspection," by a qualified inspector to ensure compliance with the applicable provisions of this chapter. Dated and signed inspection reports shall be kept on file and shall be readily available.

9.2.3 Frequent Inspections

9.2.3.1 Operators or other designated personnel shall visually inspect items such as the following each day or prior to use if the crane has not been in regular service (records are not required). Any deficiencies shall be carefully examined and a determination made as to whether they constitute a hazard.

9.2.3.1.1 All control mechanisms for maladjustment, excessive wear, and contamination by lubricants or other foreign matter that could interfere with proper operation: daily, when used.

9.2.3.1.2 Hooks and latches for deformation, chemical damage, cracks, and wear: daily when used.

9.2.3.1.3 Hydraulic systems for proper oil level: daily when used.

9.2.3.1.4 Hydraulic hoses, particularly those that flex in normal operation of crane functions, should be visually inspected once every working day, when used.

9.2.3.1.5 Operational aids for malfunction: daily, when used.

9.2.3.1.6 Anti-two-block, two-block warning, and two-block damage prevention systems for proper operation: daily, when used.

9.2.3.1.7 Boom sections for damaged, deformed, or missing structural members or parts: daily when used.

9.2.3.1.8 Rope reeving for noncompliance with crane manufacturer's recommendations: daily when used.

9.2.3.1.9 Hoist ropes for kinking, bird caging, and corrosion: daily when used

9.2.3.1.10 Electrical apparatus for malfunctioning, signs of excessive deterioration, and accumulation of dirt or moisture.

9.2.3.1.11 Tires for recommended inflation pressure.

9.2.4 Periodic Inspections

Complete inspections of the crane shall be performed by a qualified inspector at 1- to 12-month intervals, depending on the crane's activity, severity of service, and environment. These inspections shall include the requirements of paragraph 9.2.3 and the following items. Any deficiencies shall be examined and determination as to whether they constitute a hazard.

9.2.4.1 Deformed, cracked, or corroded members in the crane structure and entire boom.

9.2.4.2 Loose bolts or rivets.

9.2.4.3 Cracked or worn sheaves and drums.

9.2.4.4 Worn, cracked, or distorted parts such as pins, bearings, shafts, gears, rollers, and locking devices.

9.2.4.5 Excessive wear on brake and clutch system parts, linings, pawls, and ratchets.

9.2.4.6 Any significant inaccuracies of operational aids.

9.2.4.7 Lack of performance and compliance with safety requirements of gasoline, diesel, electric, or other power plants.

9.2.4.8 Excessive wear of chain drive sprockets and excessive chain stretch.

9.2.4.9 Cracked crane hooks.

9.2.4.10 Malfunctioning travel steering, braking, and locking devices.

9.2.4.11 Excessively worn or damaged tires.

9.2.4.12 Hydraulic and pneumatic hose, fittings, and tubing.

9.2.4.12.1 Evidence of leakage at the surface of the flexible.

9.2.4.12.2 Hose or its junction with the metal and couplings.

9.2.4.12.3 Blistering or abnormal deformation of the outer covering of the hydraulic or pneumatic hose.

9.2.4.12.4 Leakage at threaded or clamped joints that cannot be eliminated by normal tightening or recommended procedures.

9.2.4.12.5 Evidence of excessive abrasion or scrubbing on the outer surface of a hose, rigid tube, or fitting. Means shall be taken to eliminate the interference of elements.

9.2.4.13 Hydraulic and pneumatic pumps and motors.

9.2.4.13.1 Loose bolts or fasteners.

9.2.4.13.2 Leaks at joints between sections.

9.2.4.13.3 Shaft seal leaks.

9.2.4.13.4 Unusual noises or vibration.

9.2.4.13.5 Loss of operating speed.

9.2.4.13.6 Excessive heating of the fluid.

9.2.4.13.7 Loss of pressure.

9.2.4.14 Hydraulic and pneumatic valves.

9.2.4.14.1 Cracks in valve housing.

9.2.4.14.2 Improper return of spool to neutral position.

9.2.4.14.3 Leaks at spools or joints.

9.2.4.14.4 Sticking spools.

9.2.4.14.5 Failure of relief valves to attain correct pressure setting.

9.2.4.14.6 Relief valve pressures as specified by the manufacturer.

9.2.4.15 Hydraulic and pneumatic cylinders.

9.2.4.15.1 Drifting caused by fluid leaking across the piston.

9.2.4.15.2 Rod seals leakage.

9.2.4.15.3 Leaks at welded joints.

9.2.4.15.4 Scored, nicked, or dented cylinder rods.

9.2.4.15.5 Dented case (barrel).

9.2.4.15.6 Loose or deformed rod eyes or connecting joints.

9.2.4.16 Hydraulic filters

9.2.4.16.1 Evidence of rubber particles on the filter element, which may indicate hose, “O” ring, or other rubber component deterioration. Metal chips or pieces on the filter may denote failure in pumps, motors, or cylinders. Further checking will be necessary to determine the origin of the problem before corrective action can be taken.

9.2.5 Cranes Not in Regular Use

9.2.5.1 A crane that has been idle for a period of 1 month or more, but less than 6 months, shall be given an inspection by a qualified person conforming to the requirements of paragraphs 9.2.3 and 9.2.6 before being placed in service.

9.2.5.2 A crane that has been idle for a period of over 6 months shall be given a complete inspection by a qualified person conforming to the requirements of paragraphs 9.2.3, 9.2.4, and 9.2.6 before being placed in service.

9.2.5.3 Standby cranes shall be inspected by a qualified person at least semiannually in accordance with the requirements of paragraphs 9.2.3 and 9.2.6. Cranes that are exposed to adverse environmental conditions should be inspected more frequently.

9.2.5.4 The determination supporting these alternate inspection frequencies and procedures shall be made by the AEDC Crane System Engineer for each affected crane. Documentation supporting this determination shall be kept readily available.

9.2.6 Wire Rope

9.2.6.1 A qualified inspector shall inspect wire ropes at least annually. More frequent intervals shall be determined by a qualified person and shall be based on such factors as expected rope life as determined by severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. The qualified inspector shall carefully note any deterioration, such as described below, that results in appreciable loss of original strength and determine whether

further use of the rope constitutes an acceptable risk. This inspection shall include examination of the entire rope length without detaching it from the drum.

9.2.6.1.1 Reduction from nominal diameter of more than 5%.

9.2.6.1.2 The number and distribution or concentration of broken outside wires.

9.2.6.1.3 Worn outside wires.

9.2.6.1.4 Corroded or broken wires at end connections.

9.2.6.1.5 Corroded, cracked, bent, worn, or improperly applied end connections.

9.2.6.1.6 Kinking, crushing, cutting, or unstranding.

9.2.6.2 The qualified inspector shall take care when inspecting running rope where rapid deterioration could occur, such as in the following:

9.2.6.2.1 Sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited.

9.2.6.2.2 Sections of the rope at or near terminal ends where corroded or broken wires may protrude.

9.2.6.3 The qualified inspector shall take care when inspecting certain ropes such as the following:

9.2.6.3.1 Rotation-resistant ropes, because of their higher susceptibility to damage. The internal deterioration of rotation-resistant ropes may not be readily observable.

9.2.6.3.2 Boom hoist ropes, because of the difficulties of inspection and the important nature of these ropes.

9.2.6.4 No precise rules can be given for determining the exact time to replace wire rope because many factors are involved. Safety in this respect depends largely on the use of good judgment by an appointed person in evaluating remaining strength in a used rope, after allowance for deterioration disclosed by inspection. Safety of rope operation depends on this remaining strength.

9.2.6.5 Conditions such as the following shall be sufficient reason for questioning wire-rope safety and for considering replacement:

9.2.6.5.1 In running ropes, six (6) randomly distributed broken wires in one rope lay, or three (3) broken wires in one strand in one rope lay.

9.2.6.5.2 In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

9.2.6.5.3 In rotation resistant ropes, two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in thirty rope diameters.

9.2.6.5.4 One outer wire broken at the point of contact with the core of the rope that has worked its way out of the rope structure and protrudes or loops out from the rope structure; additional inspection of this part of the rope is required.

9.2.6.5.5 Wear of one-third the original diameter of outside individual wires.

9.2.6.5.6 Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.

9.2.6.5.7 Evidence of heat damage from any cause.

9.2.6.5.8 Reduction from nominal diameter greater than 5%.

9.2.6.6 All rope that has been idle for a month or more due to shutdown or storage of a crane on which it is installed shall be inspected before it is placed in service. This inspection shall be for all types

of deterioration and shall be performed by an appointed person whose approval shall be required before further use of the rope. A written and dated report of the rope condition shall be filed.

9.2.6.7 In order to establish data as a basis for judging the proper time for replacement, a continuing inspection record shall be maintained.

9.2.6.8 Replacement rope shall be the same size, grade, and construction as recommended by the crane manufacturer, unless otherwise recommended by a rope or crane manufacturer due to actual working-condition requirements.

9.2.6.9 Never use discarded wire rope for slings.

9.2.7 Load Hooks/Load Blocks

Load hooks/load blocks that have been changed out shall be inspected by a qualified inspector before returning the crane to service. Inspection records shall be retained per 9.1.9.

9.3 TESTING

9.3.1 Operational Tests

The following shall be tested during an initial test:

9.3.1.1 Load lifting and lowering mechanisms.

9.3.1.2 Boom lifting and lowering mechanisms.

9.3.1.3 Boom extension and retraction mechanism.

9.3.1.4 Swinging mechanism.

9.3.1.5 Travel mechanism.

9.3.1.6 Safety devices.

9.3.2 Load Test

9.3.2.1 Prior to initial use, all cranes in which load-sustaining parts have been modified, replaced, or repaired shall be load-tested by a qualified inspector or under the direction of that inspector. A designated or authorized person shall determine if repairs made to a crane are extensive and require a rated load test, or if repairs are routine maintenance and require only operational testing. The replacement of rope is excluded from this requirement. However, a functional test of the crane under a normal operating load should be made prior to putting it back in service.

9.3.2.2 Test weights shall not exceed 110% of the rated capacity and shall be accurate to within –5%, +0% of stipulated values.

NOTE: Load tests shall not be conducted in locations where the lift meets the definition of a critical lift (see Chapter 1, “Terminology and Definitions”).

9.3.2.3 A written report shall be furnished by the inspector showing test procedures and confirming the adequacy of repairs or alterations. Test reports shall be kept on file and shall be readily available to appointed personnel.

9.3.2.4 After a load test is completed, the load-test report shall be signed and dated by the Person-In-Charge of conducting the load test. The Person-In-Charge shall ensure that the test is forwarded to the AEDC Crane System Engineer so that it can be placed in the crane maintenance file. Use

Exhibit 9.5 “AEDC Mobile Crane Load Test Checklist” to document this test. This will become the load test report.

9.4 MAINTENANCE

9.4.1 Preventive Maintenance

9.4.1.1 A preventive maintenance program, based on the recommendations of the crane manufacturer, shall be established. If equipment maintenance procedures deviate from published manufacturer's recommendations, the alternate procedures shall be approved in advance by the manufacturer or another qualified person and be kept readily available. Dated maintenance records shall be kept where readily available to appointed personnel.

9.4.1.2 Replacement parts shall be at least equal to the original manufacturer's specifications.

9.4.1.3 All moving parts of the crane for which lubrication is specified shall be regularly lubricated. Lubricating systems should be checked for proper delivery of lubricant. Operators and maintenance personnel shall follow the manufacturer's recommendations as to the points and frequency of lubrication, maintenance of lubricant levels, and types of lubricant to be used.

9.4.2 Maintenance Procedures

9.4.2.1 Before starting adjustments or repairs on a crane, maintenance personnel shall take the following precautions as applicable:

9.4.2.1.1 Place the crane where it will cause the least interference with other equipment or operations in the area.

9.4.2.1.2 Lower the lower load block to the ground or otherwise secure it against dropping.

9.4.2.1.3 Lower the boom to the ground, if possible, or otherwise secure it against dropping.

9.4.2.1.4 Place all controls in the OFF position and secure all operating features from inadvertent motion by brakes, pawls, or other means.

9.4.2.1.5 Ensure starting means are rendered inoperative.

9.4.2.1.6 Stop the power plant or disconnect it at the power takeoff.

9.4.2.1.7 Relieve hydraulic oil pressure from all hydraulic circuits before loosening or removing hydraulic components.

9.4.2.2 Warning or out-of-order signs shall be placed on the crane controls. Signs or flags shall be removed only by authorized personnel.

9.4.2.3 After adjustments and repairs have been made, the crane shall not be returned to service until all guards have been reinstalled, trapped air has been removed from the hydraulic system, safety devices are reactivated, and maintenance equipment is removed.

9.4.3 Wire Rope Maintenance

Personnel using wire rope shall ensure proper care by doing the following:

9.4.3.1 Store rope to prevent damage or deterioration.

9.4.3.2 Unreel or uncoil rope as recommended by the rope manufacturer and with care to avoid kinking or inducing a twist.

9.4.3.3 Before cutting a rope, use some method to prevent unlaying the strands. Heat-affected zones of flame cut wire rope shall not be allowed to bear load.

- 9.4.3.4 During installation, avoid dragging the rope in the dirt or around objects, which will scrape, nick, crush, or induce sharp bends in it.
- 9.4.3.5 Maintain rope in a well-lubricated condition to reduce internal friction and to prevent corrosion. Ensure that lubricant applied as part of a maintenance program is compatible with the original lubricant. Consult the rope manufacturer when in doubt. Lubricant applied shall be of the type that does not hinder visual inspection. Those sections of rope that operate over sheaves or are otherwise hidden during inspection and maintenance procedures require special attention when the rope is lubricated.
- 9.4.3.6 When an operating rope shows greater wear at its ends than on the remainder, its life can be extended (in cases where a reduced rope length is adequate) by cutting off the worn end, thus shifting the wear to different areas of the rope.
- 9.4.3.7 Wire rope clips shall be drop-forged steel of the single- or double-saddle type. Wire rope clips used in conjunction with wedge sockets shall be attached to the unloaded dead end of the rope only (see example below). Eye splices shall be made in a manner recommended by the rope or crane manufacturer, and rope thimbles should be used in the eye.

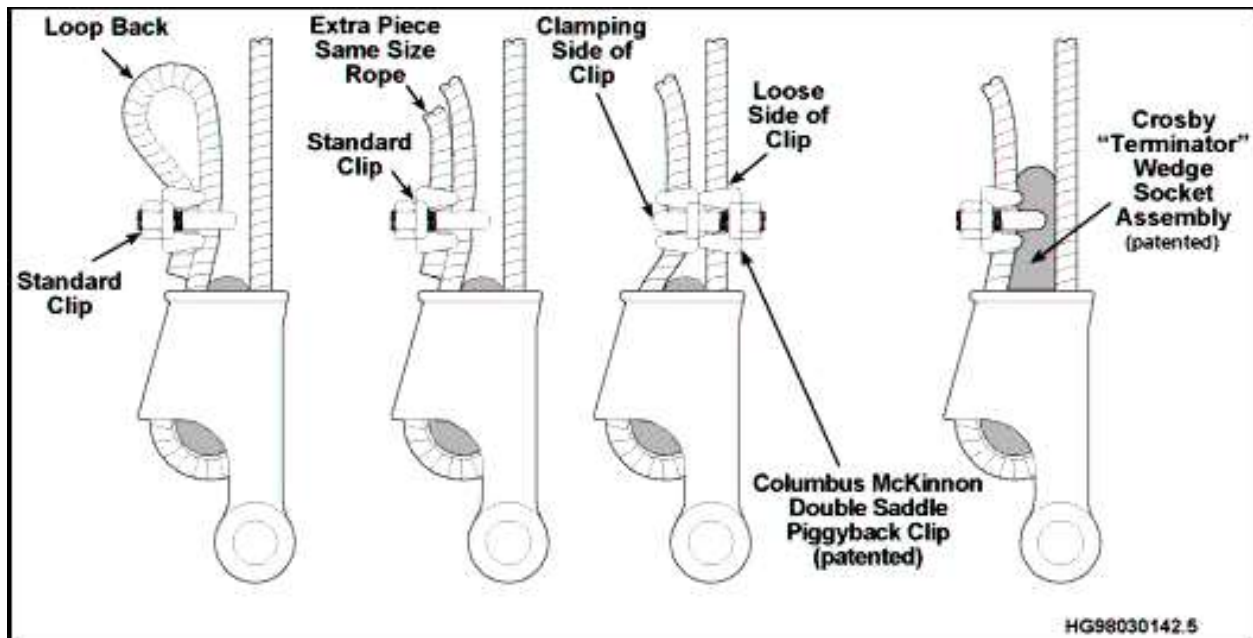


Figure 9.2 Typical wedge socket

- Notes:**
1. It is important that wedge socket assemblies consist of a wedge and a socket, matched pair of the correct size, and from the same manufacturer (Figure 9.2.).
 2. Crosby® Group, Inc., now manufactures a patented wedge socket assembly that clips the rope to the wedge. This product may be found on new cranes and is suitable as a replacement part on existing cranes.
 3. Tighten wire rope clips evenly to the recommended torque.
 4. Rope clip nuts should be checked monthly and tightened as necessary to compensate for any decrease in rope diameter during usage.
 5. Swaged, compressed, or wedge-socket fittings shall be applied as recommended by the rope, crane, or fitting manufacturer.

9.5 OPERATION

The following shall apply to all personnel involved in mobile crane operations: At the initial stage of the planning process, an appointed person shall classify each lift into one of the AEDC-specified lift categories (ordinary, critical or non-standard).

9.5.1 Conduct of Operator

9.5.1.1 General

- 9.5.1.1.1 Do not engage in any practice that will divert your attention while operating the crane.
- 9.5.1.1.2 Do not operate the crane if you do not meet the requirements contained in Chapter 6, or if you are experiencing a condition resulting in reduced physical or mental capabilities.
- 9.5.1.1.3 Keep the operating area free of water, snow, ice, oil, and debris that could cause your hands or feet to slip from the controls.
- 9.5.1.1.4 Keep the operating cab windshields clean and free of anything that obstructs vision. Replace broken windows.
- 9.5.1.1.5 Ensure proper functioning of tires, horn, lights, battery, controller, lift system (including load-engaging means, chains, hoist rope, and limit switches), brakes, and steering mechanisms. If at any time a lifting device is found to be in need of repair, is defective, or is in any way unsafe, report it immediately and take the unit out of service until it has been restored to safe-operating condition or a determination has been made by the **person in charge and a qualified engineer** that the deficiency will not adversely affect the safe operation of the unit.
- 9.5.1.1.6 When two or more cranes are used to lift one load, one designated person shall be responsible for the operation. That person shall analyze the operation and instruct all personnel involved in the proper positioning, rigging of the load, and the movements to be made. That person shall also determine the necessity to reduce crane ratings, position of load, boom location, ground support, and speed of movement.
- 9.5.1.1.7 Determine that no one is working on the crane or is close to it before starting the engine or beginning to operate the crane.
- 9.5.1.1.8 Barricade accessible areas within the swing radius of the rear of the rotating superstructure of the crane to prevent anyone from being struck or crushed by the crane.
- 9.5.1.1.9 Do not hoist two or more separately rigged loads in one lift, even though the combined load is within the crane's rated capacity.
- 9.5.1.1.10 When fueling the crane, stop the engine(s) and ensure that smoking or open flames are not permitted within 25 ft of the fueling area.
- 9.5.1.1.11 Ensure that a 10BC or larger fire extinguisher is installed at all operator stations. Fire extinguishers shall be maintained in a serviceable condition.
- 9.5.1.1.12 Do not store gasoline, acids, caustics, or cleaning solvents that emit toxic fumes in operating cabs. Store fuel in safety cans in safe locations.
- 9.5.1.1.13 Ensure that alternate egress routes are not locked on mobile units with operating enclosures.
- 9.5.1.1.14 Position the crane on a solid and level footing. It may be necessary in certain situations to use heavy timber mats to build a good working foundation.
- 9.5.1.1.15 When swinging the crane, watch out for centrifugal force. Swing the crane slowly to avoid an outward swing of the load. Attach a tag-line to the load if necessary to control the swing.

- 9.5.1.1.16 Watch for boom kickback. Never operate with the boom at a higher angle than shown on the capacity charts.
- 9.5.1.1.17 Use extreme caution when operating the crane near workers in elevated areas.
- 9.5.1.1.18 Use power lowering when lowering loads. When lowering heavy loads, keep the hoist brake as reserve. Use a safety pawl on the boom-hoist drum when not lowering.
- 9.5.1.1.19 Avoid two-blocking, caused when the hook block makes contact with boom-point sheaves. A continuing pull on the hoist lines can break the rope or pull the boom back over the cab on some types of booms. On hydraulically telescoping booms, be sure to play out the hoist line when extending and spool in the hoist line when retracting.
- 9.5.1.1.20 Lock carrier air brakes ON when operating, and check the pressure of the air brakes frequently.
- 9.5.1.1.21 Watch out for the carrier-cab on truck-mounted units when swinging the boom. Keep boom high enough to swing clear of cab.
- 9.5.1.1.22 In the absence of crane manufacturer's instructions regarding maximum wind speeds for operation, no operations shall be undertaken at wind speeds in excess of 30 mph without directorate approval.
- 9.5.1.1.23 When a crane is to be operated at a fixed radius, the boom-hoist pawl or other positive locking device shall be engaged.
- 9.5.1.1.24 On truck-mounted cranes, no loads shall be lifted over the front area, except as approved by the crane manufacturer.
- 9.5.1.1.25 Crane cabs, necessary clothing and personal belongings shall not interfere with access or operations.
- 9.5.1.1.26 Tools, oil cans, waste, extra fuses, and other necessary articles shall be stored in the tool box, and shall not be permitted to lie loose in or about the cab.

9.5.1.2 Traveling the Machine

When traveling the machine:

- 9.5.1.2.1 Secure the boom and hook block.
- 9.5.1.2.2 Check bridges before crossing; make sure they will support the weight of the machine.
- 9.5.1.2.3 Check river depths before fording.
- 9.5.1.2.4 Check clearances under overpasses, overhead lines, or any overhead obstruction; when side clearances are tight, install a barrier or post a lookout, and make certain there is sufficient clearance for tail swing.
- 9.5.1.2.5 When traveling with a load, snub the load to prevent swaying if possible; never travel with near-capacity loads.
- 9.5.1.2.6 Never travel a rubber-tired unit with a load over the side.
- 9.5.1.2.7 On soft surfaces, always move with the load behind; it helps to raise the leading end of the crawlers, and makes traveling safer. (for crawler cranes)
- 9.5.1.2.8 Always set swing brakes when the unit is idle or holding loads for a period of time, especially on slopes; if swinging during travel is necessary, engage swing-jaw clutch before releasing brakes.
- 9.5.1.2.9 Never back up until it is determined that everyone is clear of the machine.

9.5.1.2.10 Position the boom in the direction of travel for long moves.

9.5.1.2.11 Block treads when moving uphill; be sure they are blocked to prevent downhill movement before shifting steering clutches.

9.5.1.2.12 Lock the turntable before traveling on a highway. Use a house lock or swing brake, and lower boom into the rack to prevent swing.

9.5.1.2.13 When loading machine on the trailer, always use a ramp.

9.5.1.3 Making Adjustments or Repairs

9.5.1.3.1 When making adjustments or repairs:

- Stop the machine.
- Lower the boom or secure it against dropping.
- Neutralize all controls.
- Remove ignition key to make the machine inoperative.
- Display proper warning signs on controls of machine.
- Keep hands, feet, and clothing away from gears, ropes, drums, and sheaves.
- Never put hands on wire rope when climbing to the top of the cab.
- Use a bar or stick to guide wire rope onto drums.
- Keep hands well away from the fan drive while engine is running.
- Safeguard the crane oiler; do not resume operation until a positive ALL CLEAR signal has been given.
- Replace all guards and shields before resuming operation.

9.5.1.3.2 Place blocking or other adequate supports under the boom before beginning boom disassembly operations. Never stand under or on the boom during this work.

9.5.1.3.3 Before disconnecting oil lines, if machine has hydraulic controls, be sure to place boom on the ground or in the boom rest; then move the pedals and control levers to equalize pressures within the cylinders. Always release any air supercharge on the hydraulic reservoir and shut off the engine (or declutch pumps) before disconnecting oil lines.

9.5.1.3.4 Do not reach into hydraulic-boom holes unless the sections are securely anchored together.

9.5.1.4 Ensuring Stability

9.5.1.4.1 Know the rated capacity of the crane and the weight of the load. A safe lift depends on many factors including boom length, boom angle, and load radius. Follow these requirements to avoid buckling the boom or tipping:

- Know the radius of the load; the radius is measured from center of rotation, not from the boom foot pin.
- Always operate within the rated capacity of the machine.
- The gross capacity includes weight of hook, block, and any material-handling devices, (i.e., slings, concrete bucket, magnet lifter, etc.); subtract the weight of all these to find the true weight (net capacity) the crane can handle safely.

- Ratings are based on operating the machine on firm, level ground; outriggers should be properly extended and lowered before operation.
- Avoid fast swings, hoists, or sudden braking; these can cause overloads.
- Do not handle large, heavy loads in strong winds; the wind can catch the load and create an unstable condition.

9.5.1.4.2 Test stability before lifting heavy loads. Check outrigger footing. Lift load slightly off the ground and stop. Check the machine for movement and check to be sure the brakes hold with the load elevated.

9.5.1.4.3 Never use machine stability to determine capacity.

9.5.1.4.4 If there are any indications of tipping, the machine is already overloaded for that working radius.

9.5.1.4.5 Do not back crane away from the load while carrying a maximum load; this may cause the crane to tip.

9.5.1.4.6 Always use outriggers when making lifts (with pick-and-carry units), and never lift a load forward of the front outriggers, unless allowed on manufacturer's load chart.

9.5.1.4.7 Lower outrigger jacks until the tires clear the ground, and level the unit to reach the machine's full capacity. Recheck and, if necessary, reset outriggers between heavy lifts.

9.5.1.4.8 Outrigger beams shall be extended in accordance with manufacturer's instructions.

9.5.1.5 Observing Boom-Length Precautions

9.5.1.5.1 Always use the shortest boom possible.

9.5.1.5.2 Make only vertical lifts; never pull the load sideways.

9.5.1.5.3 Keep speed slow in lifting and lowering loads.

9.5.1.5.4 Swing carefully and slowly, and avoid boom or jib "whipping"; check counterbalance clearance.

9.5.1.5.5 Do not let the load strike the boom or outriggers.

9.5.1.5.6 Allow maximum clearance between the hook block and boom-point sheaves.

9.5.1.5.7 Keep near-capacity loads as close to the ground as possible.

9.5.1.5.8 Avoid hitting anything with the boom; an engineering analysis shall be made before putting the crane back in service if this occurs.

9.5.2 Operating Near Power Lines and Transmission Towers (see section 9.6)

9.5.3 Hoist Limit Switch

Check all limit switches, if supplied, without a load on the hook at the beginning of each work shift or the first time the crane is used that shift. Inch each motion into its limit switch to ensure that two-blocking does not occur during the test. If a lift is in progress during a shift change, this testing requirement is considered to have been satisfied for the completion of that lift. However, test the limit switch again before the next lift.

9.5.4 Standard Hand Signals

The standard hand signals for AEDC use shall be as specified in the latest edition of the ASME B30 standards for the particular type of crane or hoist being used (see Figure 9-7a/b below).

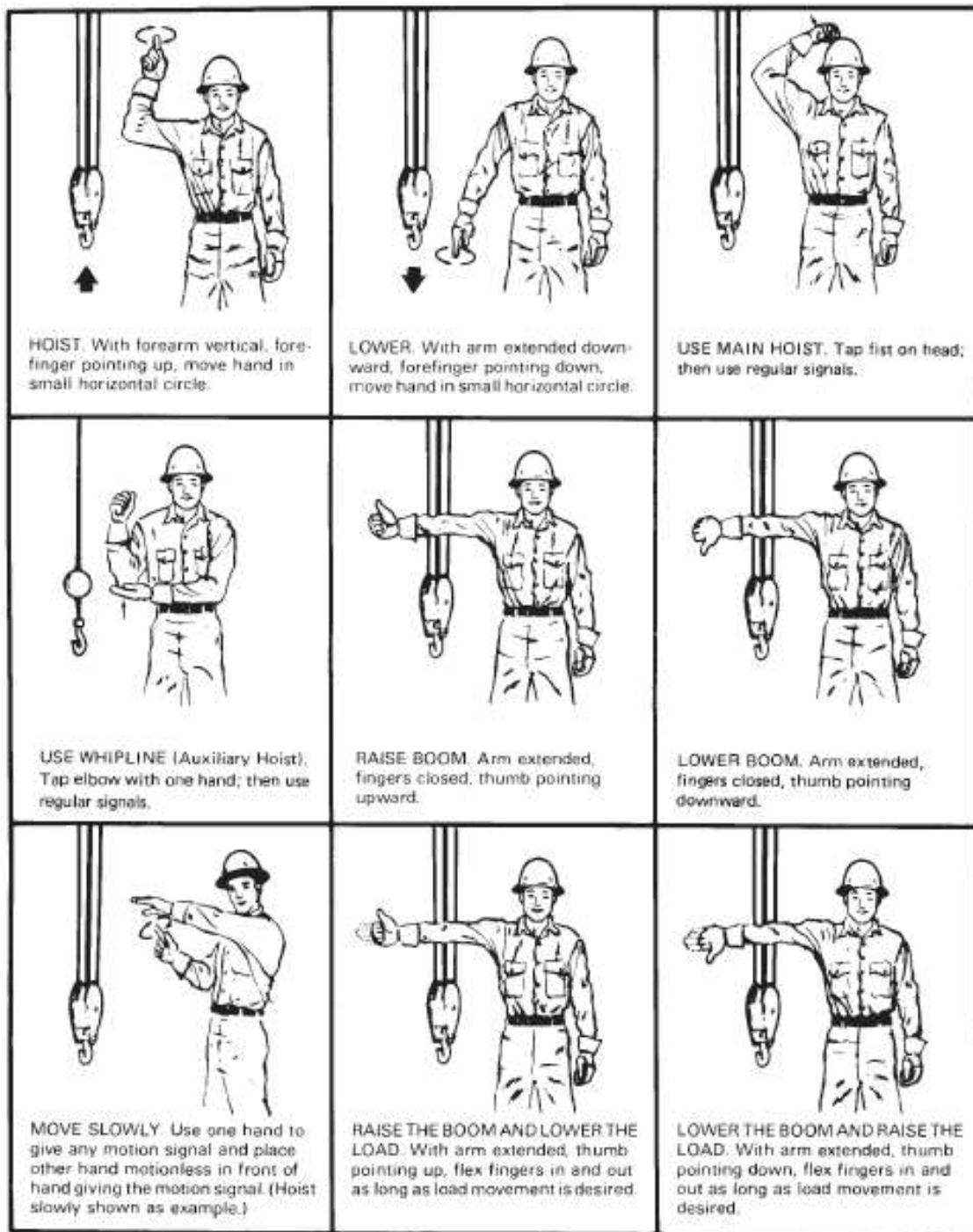


Figure 9-7a. Standard hand signals for controlling mobile crane operations.

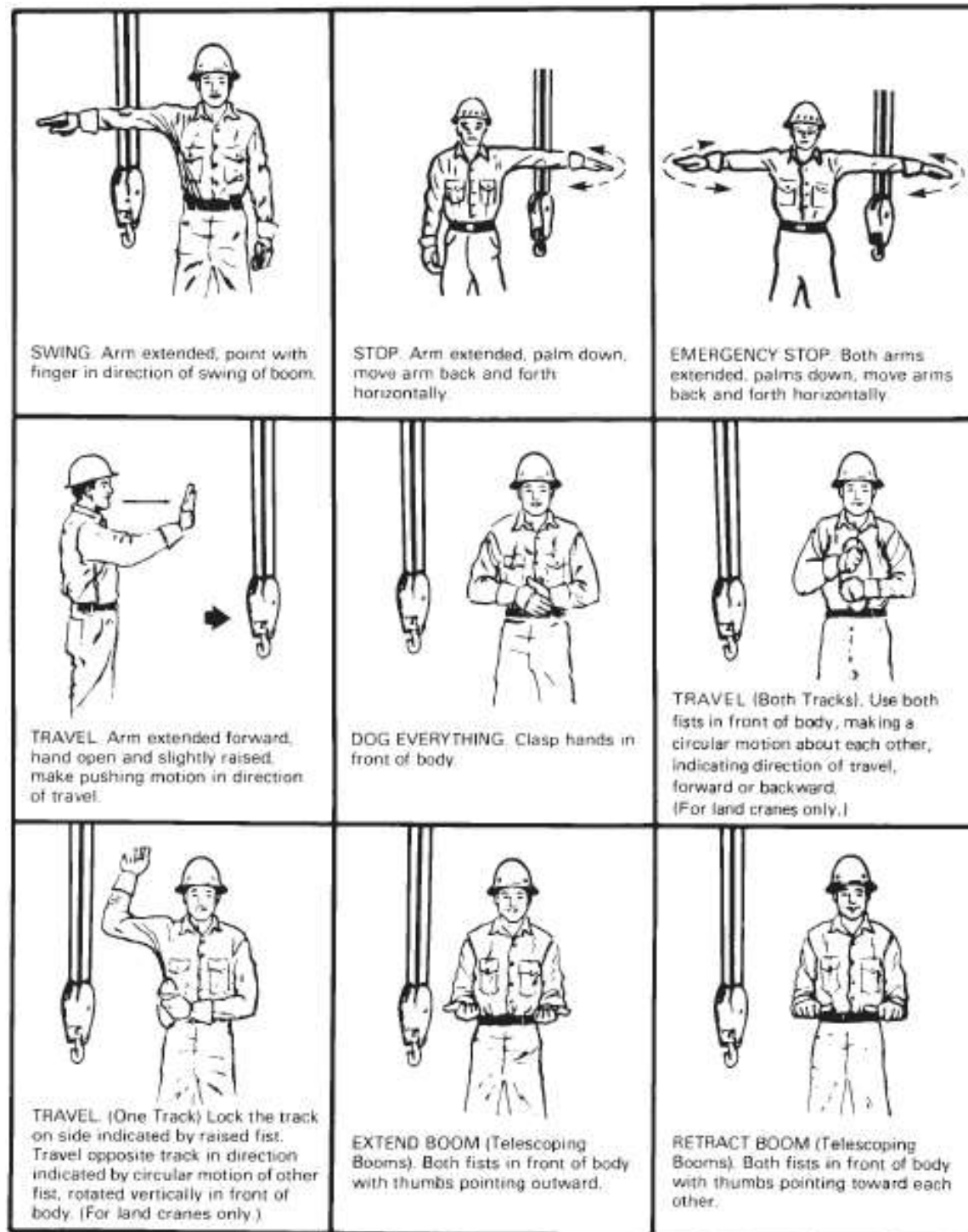


Figure 9-7b. Standard hand signals for controlling mobile crane operations.

9.5.5 Identification of Signalers

- 9.5.5.1 All personnel acting as signalers during crane operations shall be clearly identified to the crane operator before the lift is begun.
- 9.5.5.2 In those cases where the crane operator cannot see the signaler, a second qualified signal person shall be stationed where he or she can see both the signaler and the crane operator, and can relay the signals to the operator.
- 9.5.5.3 Where voice (direct or two-way radio) communication is used, the signaler shall communicate directly with the operator, not through a third person.
- 9.5.5.4 The operator shall obey signals only from the designated signal person. Obey a STOP signal no matter who gives it.

9.5.6 Size of Load

The crane shall not be loaded beyond its rated capacity, except of authorized testing described in paragraph 9.3.

9.5.7 Attaching the Load

- 9.5.7.1 Ensure hoist rope is free from kinks or twists. Do not wrap the hoist rope around the load.
- 9.5.7.2 Ensure load is attached to the load-block hook by means of slings or other approved devices.
- 9.5.7.3 Ensure load is well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches.
- 9.5.7.4 Make certain sling clears all obstacles.

9.5.8 Moving the Load

- 9.5.8.1 The appointed person directing the lift shall make certain that the load is well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches.
- 9.5.8.2 Before starting to hoist, note the following conditions:
 - 9.5.8.2.1 Hoist rope shall not be kinked.
 - 9.5.8.2.2 Multiple-part lines shall not be twisted around each other.
 - 9.5.8.2.3 The hook shall be positioned above the center of gravity of the load in such a manner as to minimize swinging when the load is lifted.
 - 9.5.8.2.4 Following any slack-rope condition, it should be determined that the rope is properly seated on the drum and in the sheaves.
 - 9.5.8.2.5 All personnel including the qualified rigger shall be clear of the load.
- 9.5.8.3 During hoisting, take care to ensure that:
 - 9.5.8.3.1 There is no sudden acceleration or deceleration of the moving load.
 - 9.5.8.3.2 Load does not contact any obstructions. A “dry run” shall be conducted in areas where clearance is limited.
- 9.5.8.4 Cranes shall not be used for side pulls, except when specifically authorized by a designated person who has determined that the stability of the crane is not endangered and that various parts of the crane will not be over stressed.

- 9.5.8.5 Do Not carry loads over people.
- 9.5.8.6 No hoisting, lowering, swinging, or traveling shall be done while anyone is on the load hook, except as noted in Chapter 4, "Lifting Personnel."
- 9.5.8.7 Test the brakes each time a load approaching the rated capacity is handled by raising the load a few inches and applying the brakes.
- 9.5.8.8 Do not lower load below the point where less than three full wraps of rope remain on the hoist drum.
- 9.5.8.9 Do not leave your position at the controls while the load is suspended, unless required to do so by an approved emergency procedure.
- 9.5.8.10 If the load hoist mechanism is not equipped with an automatic brake and the load must remain suspended for any considerable length of time, the operator shall hold the drum from rotating in the lowering direction by activating a positive controllable means from the operator's station.
- 9.5.8.11 Work on suspended loads is prohibited under normal conditions. When the supervisor believes that it is necessary to work on a suspended load, guidelines for ensuring safety of the work shall be established through consultation with the appropriate safety organization. Suspended loads that must be worked on shall be secured against unwanted movement.
- 9.5.8.12 Tag lines should be used as required to guide, snub, or otherwise control the load.

9.5.9 Ordinary Lifts

- 9.5.9.1 The requirements of preceding paragraphs under 9.5 also shall apply to ordinary lifts.
- 9.5.9.2 The PIC shall classify each lift into one of the AEDC categories (ordinary, critical or non-standard) before the lift is planned.
- 9.5.9.3 The Asset Owner shall appoint a Designated Leader who shall be present at the lift site during the entire lifting operation. If the lift is being made by only one person, that person assumes all responsibilities of the Designated Leader.
- 9.5.9.4 Leadership designation may be by written instructions, specific verbal instructions for the particular job, or clearly defined responsibilities within the assigned craftsmen's organizational structure.
- 9.5.9.5 The Designated Leader's responsibility shall include the following:
 - 9.5.9.5.1 Ensure that personnel involved understand how the lift is to be made.
 - 9.5.9.5.2 Ensure that the weight of the load is determined, that proper equipment and accessories are selected, and that rated capacity is not exceeded.
 - 9.5.9.5.3 Survey the lift site for hazardous/unsafe conditions.
 - 9.5.9.5.4 Ensure that equipment is properly set up and positioned.
 - 9.5.9.5.5 Ensure that a Qualified Signal Person is assigned, if required, and is identified to the operator.
 - 9.5.9.5.6 Direct the lifting operation to ensure that the lift is completed safely and efficiently.
 - 9.5.9.5.7 Stop the job when any potentially unsafe condition is recognized.
 - 9.5.9.5.8 Direct operations if an accident or injury occurs.
- 9.5.9.6 The Designated Leader shall inspect all cranes in use to ensure they are still within the inspection interval.

- 9.5.9.7 The Designated Leader shall inspect all lifting devices to ensure that the rated capacity of these items of equipment will not be exceeded.
- 9.5.9.8 The operator shall inspect for damage and defects in accordance with paragraph 9.2.3, including observations during operation. A qualified person shall examine deficiencies and determine whether they constitute a hazard.
- 9.5.9.9 Check hoist-limit switches, if provided, according to paragraph 9.5.3, “Hoist-Limit Switch.”
- 9.5.9.10 Ensure that basic operating instructions of power-operated equipment, together with charts, tables, or diagrams showing the rated capacity, boom angle, swing, and stability data are posted in convenient view of the operator.
- 9.5.9.11 Assure load lines are plumb by applying strain to them, but not enough to lift the load from the ground. If load lines are not plumb, reposition the slings or equipment before continuing.

9.5.10 Critical Lifts

In addition to the requirements of this chapter, see Chapter 2, “Critical Lifts,” for critical-lift requirements.

9.6 OPERATING NEAR POWER LINES

Note: This section completely replaces previously AEDC requirements with the mandatory OSHA requirements of 29 CFR 1926 subpart CC.

9.6.1 Voltage Information.

Where voltage information is required (e.g. Table 9-2), requested voltage information must come from the utility owner/operator of the power lines.

9.6.2 Power Lines Presumed Energized.

The employer must assume that all power lines are energized unless the utility owner/operator confirms that the power line has been and continues to be de-energized and visibly grounded at the worksite

9.6.3 Posting Of Electrocution Warnings.

There must be at least one electrocution hazard warning conspicuously posted in the cab so that it is in view of the operator and at least two on the outside of the equipment.

9.6.4 Operating Below Power Lines Is Prohibited.

No part of the equipment, load line, or load (including rigging and lifting accessories) is allowed below a power line unless the employer has confirmed that the utility owner/operator has de-energized and (at the worksite) visibly grounded the power line, except where one of the following exceptions applies:

- 9.6.4.1 The work is covered by 29 CFR 1926, Subpart V, *Power Transmission and Distribution*.
- 9.6.4.2 For equipment with non-extensible booms: The uppermost part of the equipment, with the boom at true vertical, would be more than **20 feet** below the plane of the power line or more than the Table 9-2 minimum clearance distance below the plane of the power line.
- 9.6.4.3 For equipment with articulating or extensible booms: The uppermost part of the equipment, with the boom in the fully extended position, at true vertical, would be more than **20 feet** below the

plane of the power line or more than the Table 9-2 of this section minimum clearance distance below the plane of the power line.

9.6.4.4 The employer demonstrates that compliance with this prohibition is infeasible and the work meets the requirements of paragraph 9.6.8, *Power Line Safety (all voltages) – equipment operation closer than Table 9-2 zone*.

9.6.5 Power line safety (up to 350 kV) during assembly and disassembly (Ref: 1926.1407)

Before assembling or disassembling equipment, determine if any part of the equipment, load line, or load (including rigging and lifting accessories) could get, in the direction or area of assembly/disassembly, closer than 20 feet to a power line during the assembly/disassembly process. If so, the requirements in Option (1), Option (2), or Option (3) under paragraph 9.5.2.6.2 must be followed.

Assembly/disassembly below power lines prohibited. No part of a crane/derrick, load line, or load (including rigging and lifting accessories), whether partially or fully assembled, is allowed below a power line unless the employer has confirmed that the utility owner/operator has de-energized and (at the worksite) visibly grounded the power line.

Assembly/disassembly inside Table 9-2 clearance is prohibited. No part of a crane/derrick, load line, or load (including rigging and lifting accessories), whether partially or fully assembled, is allowed closer than the minimum approach distance under Table 9-2 to a power line unless the PIC has confirmed that the utility owner/operator has de-energized and (at the worksite) visibly grounded the power line.

9.6.6 Power line safety (up to 350 kV) during equipment operation (ref: 1926.1408)

9.6.6.1 Training. The employer must train each operator and crew member assigned to work with the equipment per Chapter 6

9.6.6.2 Hazard Assessment. Before beginning equipment operations, the employer must conduct a hazard assessment to include:

9.6.6.2.1 Identify the work zone by either:

- Demarcating boundaries (such as with flags, or a device such as a range limit device or range control warning device) and prohibiting the operator from operating the equipment past those boundaries
- Defining the work zone as the area 360 degrees around the equipment, up to the equipment's maximum working radius

9.6.6.2.2 Determine if any part of the equipment, load line or load (including rigging and lifting accessories), if operated up to the equipment's maximum working radius in the work zone, could get closer than 20 feet to a power line. If so, the employer must meet the requirements in Option (1), Option (2), or Option (3), as follows:

- **Option (1)** – De-energize and ground. Confirm from the utility owner/operator that the power line has been de-energized and visibly grounded at the worksite.
- **Option (2)** - Maintain 20 foot clearance. Ensure that no part of the equipment, load line, or load (including rigging and lifting accessories), gets closer than 20 feet to the power line by implementing the encroachment precautions specified in paragraph 9.6.6.3.
- **Option (3)** – Maintain Table 9-2 clearance.

- Determine the line's voltage and the minimum approach distance permitted under Table 9-2.
- Determine if any part of the equipment, load line or load (including rigging and lifting accessories), while operating up to the equipment's maximum working radius in the work zone, could get closer than the minimum approach distance of the power line permitted under Table 9-2. If so, then the encroachment precautions in paragraph 9.6.6.3 are required to ensure that no part of the equipment, load line, or load (including rigging and lifting accessories), gets closer to the line than the minimum approach distance.

9.6.6.3 Preventing encroachment/electrocution. Where encroachment precautions are required, all of the following requirements must be met:

9.6.6.3.1 Conduct a planning meeting with the operator and the other workers who will be in the area of the equipment or load to review the location of the power line(s), and the steps that will be implemented to prevent encroachment/electrocution.

9.6.6.3.2 If tag lines are used, they must be non-conductive.

9.6.6.3.3 Erect and maintain an elevated warning line, barricade, or line of signs, in view of the operator, equipped with flags or similar high-visibility markings, at 20 feet from the power line (if using Option (2) of this section) or at the minimum approach distance under Table 9-2 (if using Option (3) of this section).

NOTE: If the operator is unable to see the elevated warning line, a dedicated spotter must be used as described below in paragraph 9.6.6.3.4 in addition to implementing another one of the other measures described in that paragraph.

9.6.6.3.4 Implement at least one of the following measures:

- A proximity alarm set to give the operator sufficient warning to prevent encroachment.
- A dedicated spotter who is in continuous contact with the operator. Where this measure is selected, the dedicated spotter must:
 - Be equipped with a visual aid to assist in identifying the minimum clearance distance. Examples of a visual aid include, but are not limited to: A clearly visible line painted on the ground; a clearly visible line of stanchions; a set of clearly visible line-of-sight landmarks (such as a fence post behind the dedicated spotter and a building corner ahead of the dedicated spotter).
 - Be positioned to effectively gauge the clearance distance.
 - Where necessary, use equipment that enables the dedicated spotter to communicate directly with the operator.
 - Give timely information to the operator so that the required clearance distance can be maintained.
- A device that automatically warns the operator when to stop movement, such as a range control warning device. Such a device must be set to give the operator sufficient warning to prevent encroachment.
- A device that automatically limits range of movement, set to prevent encroachment.
- An insulating link/device installed at a point between the end of the load line (or below) and the load.

9.6.6.3.5 The requirements of paragraph 9.6.6.3 above do not apply to work covered by OSHA 1926 Subpart V *Power Distribution and Transmission*.

TABLE 9-2—MINIMUM CLEARANCE DISTANCES

Voltage (nominal, kV, alternating current)	Minimum clearance distance (feet)
up to 50	10
over 50 to 200	15
over 200 to 350	20
over 350 to 500	25
over 500 to 750	35
over 750 to 1,000	45
	(as established by the utility owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution).
over 1,000	

Note: The value that follows "to" is up to and includes that value. For example, over 50 to 200 means up to and including 200kV.

9.6.7 Power line safety (over 350 kV). (ref:1926.1409)

9.6.7.1 For power lines at or below 1000 kV, wherever the distance "20 feet" is specified, the distance "50 feet" must be substituted; and

9.6.7.2 For power lines over 1000 kV, the minimum clearance distance must be established by the utility owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution.

9.6.8 Power line safety (all voltages)--equipment operations closer than the Table 9-2 zone. (Ref: 1926.1410)

Equipment operations in which any part of the equipment, load line, or load (including rigging and lifting accessories) is closer than the minimum approach distance under Table 9-2 to an energized power line is prohibited, **except where the employer demonstrates that all of the following requirements are met:**

9.6.8.1 **Proof of infeasible to do work outside the zone.** The employer determines that it is infeasible to do the work without breaching the minimum approach distance under Table 9-2.

9.6.8.2 **Proof of infeasible to de-energize.** The employer determines that, after consultation with the utility owner/operator, it is infeasible to de-energize and ground the power line or relocate the power line.

9.6.8.3 Minimum clearance distance established.

9.6.8.3.1 The power line owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution determines the minimum clearance distance that must be maintained to prevent electrical contact in light of the on-site conditions. The factors that must be considered in making this determination include, but are not limited to:

- Conditions affecting atmospheric conductivity;
- Time necessary to bring the equipment, load line, and load (including rigging and lifting accessories) to a complete stop;
- Wind conditions;

- Degree of sway in the power line;
- Lighting conditions;
- Other conditions affecting the ability to prevent electrical contact.

9.6.8.3.2 The requirements of paragraph 9.6.8.3.1 do not apply to power distribution and transmission work. (This means work covered by 29 CFR 1926, Subpart V, *Power distribution and Transmission*) instead, for such work, the minimum clearance distances specified in 1926.950 Table V-1 apply.

9.6.8.4 A **planning meeting** with the employer and utility owner/operator (or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution) is held to determine the procedures that will be followed to prevent electrical contact and electrocution. At a minimum these procedures must include:

9.6.8.4.1 **Automatic reenergizing features made inoperative.** If the power line is equipped with a device that automatically reenergizes the circuit in the event of a power line contact, before the work begins, the automatic reclosing feature of the circuit interrupting device must be made inoperative if the design of the device permits.

9.6.8.4.2 A **dedicated spotter** who is in continuous contact with the operator. The dedicated spotter must:

- Be equipped with a visual aid to assist in identifying the minimum clearance distance. Examples of a visual aid include, but are not limited to: A line painted on the ground; a clearly visible line of stanchions; a set of clearly visible line-of-sight landmarks (such as a fence post behind the dedicated spotter and a building corner ahead of the dedicated spotter).
- Be positioned to effectively gauge the clearance distance.
- Where necessary, use equipment that enables the dedicated spotter to communicate directly with the operator.
- Give timely information to the operator so that the required clearance distance can be maintained.

9.6.8.4.3 **An elevated warning line**, or barricade (not attached to the crane), in view of the operator (either directly or through video equipment), equipped with flags or similar high-visibility markings, to prevent electrical contact. However, this provision does not apply to work covered by subpart V of this part.

9.6.8.4.4 **Insulating link/device.** An insulating link/device installed at a point between the end of the load line (or below) and the load. For work covered by 29 CFR 1926, Subpart V, Power transmission and distribution, consult with the AEDC Crane System Engineer or base operating contractor safety for exceptions to this requirement (1926.1410(d)(4)(ii and iii).

9.6.8.4.5 **Nonconductive rigging** if the rigging may be within the Table 9-2 distance during the operation.

9.6.8.4.6 If the equipment is equipped with a **device that automatically limits range of movement**, it must be used and set to prevent any part of the equipment, load line, or load (including rigging and lifting accessories) from breaching the minimum approach distance established under paragraph (c) of this section.

9.6.8.4.7 **Nonconductive tag lines.** If a tag line is used, it must be of the nonconductive type.

9.6.8.4.8 **Barricades** forming a perimeter at least 10 feet away from the equipment to prevent unauthorized personnel from entering the work area. In areas where obstacles prevent the

barricade from being at least 10 feet away, the barricade must be as far from the equipment as feasible.

9.6.8.4.9 **Limit worker contact.** Workers other than the operator must be prohibited from touching the load line above the insulating link/device and crane. Operators remotely operating the equipment from the ground must use either wireless controls that isolate the operator from the equipment or insulating mats that insulate the operator from the ground.

9.6.8.4.10 Only personnel essential to the operation are permitted to be in the area of the crane and load.

9.6.8.4.11 The equipment must be properly grounded.

9.6.8.4.12 Insulating line hose or cover-up must be installed by the utility owner/operator except where such devices are unavailable for the line voltages involved.

9.6.8.5 **Written procedures** developed to comply with paragraph 9.6.8.4 must be documented and immediately available on-site.

9.6.8.6 The equipment user and utility owner/operator (or registered professional engineer) must meet with the equipment operator and the other workers who will be in the area of the equipment or load to review the procedures that will be implemented to prevent breaching the minimum approach distance established in paragraph 9.6.8.3 and prevent electrocution.

9.6.8.7 The procedures developed to comply with paragraph 9.6.8.4 must be implemented.

9.6.8.8 The utility owner/operator (or registered professional engineer) and all employers of employees involved in the work must identify one person who will direct the implementation of the procedures. The person identified in accordance with this paragraph must direct the implementation of the procedures and must have the authority to stop work at any time to ensure safety.

9.6.8.9 **If a problem occurs** implementing the procedures being used to comply with paragraph (d) of this section, or indicating that those procedures are inadequate to prevent electrocution, the employer must safely stop operations and either develop new procedures to comply with paragraph (d) of this section or have the utility owner/operator deenergize and visibly ground or relocate the power line before resuming work.

9.6.8.10 Devices originally designed by the manufacturer for use as a safety device, operational aid, or a means to prevent power line contact or electrocution, when used to comply with this section, must comply with the manufacturer's procedures for use and conditions of use.

9.6.8.11 The employer must train each operator and crew member assigned to work with the equipment in accordance with Chapter 6,

9.6.9 Power line safety--while traveling under or near power lines with no load. (Ref: 1926.1411)

This section establishes procedures and criteria that must be met for equipment traveling under or near a power line with no load. Equipment traveling with a load is governed by paragraphs 9.5.2.6 through 9.5.2.9 as appropriate.

9.6.9.1 The employer must ensure that:

9.6.9.1.1 The boom/mast and boom/mast support system are lowered sufficiently to meet the requirements of this paragraph.

9.6.9.1.2 The clearances specified in Table T of this section are maintained.

9.6.9.1.3 The effects of speed and terrain on equipment movement (including movement of the boom/mast) are considered so that those effects do not cause the minimum clearance distances specified in Table T of this section to be breached.

9.6.9.1.4 Dedicated spotter. If any part of the equipment while traveling will get closer than 20 feet to the power line, the employer must ensure that a dedicated spotter who is in continuous contact with the driver/operator is used. The dedicated spotter must:

- Be positioned to effectively gauge the clearance distance.
- Where necessary, use equipment that enables the dedicated spotter to communicate directly with the operator.
- Give timely information to the operator so that the required clearance distance can be maintained.

9.6.9.1.5 Additional precautions for traveling in poor visibility. When traveling at night, or in conditions of poor visibility, the employer must also ensure that:

- The power lines are illuminated or another means of identifying the location of the lines is used.
- A safe path of travel is identified and used.

TABLE 9-3—MINIMUM CLEARANCE DISTANCES WHILE TRAVELING WITH NO LOAD

Voltage (nominal, kV, alternating current)	While traveling—minimum clearance distance (feet)
up to 0.75	4
over .75 to 50	6
over 50 to 345	10
over 345 to 750	16
Over 750 to 1,000	20
Over 1,000	(as established by the utility owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution).

NOTE: Exhibit 9.1 thru 9.4 are intended to be a sample forms only. The equipment manufacturer's inspection/testing criteria supersede any other criteria. In cases where the equipment manufacturer does not include inspection/testing criteria, other forms developed to facilitate required inspection/testing are acceptable.

Exhibit 9.1 Mobile Crane Load Test (Sample Forms, 4 pages)**MOBILE CRANE LOAD TEST (page 1 of 4)**

LICENSE OR EQUIPMENT NO. _____ MAKE _____ DATE _____

HOUR METER-ODOMETER TOTAL _____ RATED _____ CAPACITY _____

LOAD TEST INSPECTION REPORT

The following checklist identifies the items to be inspected prior to the load test. Any unusual conditions observed during the inspection should be noted in the Remarks section. Equipment shall be inspected by maintenance personnel prior to load test.

- NOTES: 1. Qualified inspector shall verify the inspection is completed.
2. Craftsmen shall initial and date all tests, work, and inspections completed below.

NO.	CRANE ITEM	DEFECT	OK	NA	NO.	CRANE ITEM	DEFECT	OK	NA
1	Wire Rope				13	Hoist Clutch Lining			
2	Cracked or Worn Sheaves & Drums				14	Hoist Drum Brake Bands			
3	Limit Switch (Anti-Two-Blocking)				15	Open Gears			
4	Boom				16	Boom Jibs (Where Applicable)			
5	Master Clutch				NO.	CARRIER ITEM	DEFECT	OK	NA
6	Steering Clutches				1	Steering Gears and Connections			
7	Hydraulic Pump				2	Brakes (Service and Hand)			
8	Hydraulic Controls				3	Tires and Wheels			
9	Hydraulic Hoses				4	General Lubrication			
10	Mechanical Controls					OPERATING TEST			
11	Drive Chains					OVERALL CONDITION			
12	Swing Clutches								

REMARKS (Unusual conditions – noises, structural cracks, misalignment, etc.)

SAFETY ITEMS: (Fire extinguisher, signs, guards, etc.)

MOBILE CRANE LOAD TEST AND FOLLOW-UP CHECKS

NOTES: 1. Craftsman shall initial all steps completed below.

2. Qualified inspector shall verify all steps below.

- _____ 1. Set crane up for load test and inspection.
- _____ 2. Perform operations test without load to verify proper function of the following:
 - Load lifting and lowering mechanisms
 - Boom lifting and lowering mechanism
 - Boom extension and retraction mechanisms
 - Swinging mechanism
 - Travel mechanism
 - Safety devices.
- _____ 3. Test loads shall not exceed 110% of rated capacity. Refer to load chart for load test capacity at maximum and minimum working radius. Check boom angle indicators for accuracy.
- _____ 4. Rig test weights to hook using appropriate slings.
- _____ 5. Hoist the test load a sufficient distance to ensure that the load is supported by the crane and held by the hoist brakes. Hold the load for 10 min or the time required to check all primary load-bearing parts while under load without slippage, damage, or permanent deformation.
- _____ 6. At least once during the lifting portion of the hoisting cycle and once during the lowering cycle, power to the hoisting equipment shall be completely turned off. There shall be no slippage of the load or overheating of the brakes.
- _____ 7. Lower the load to approximately 2 in. off the ground to check for swing-roller operation and outrigger stability. Slowly swing test load between outrigger locations.
- _____ 8. Move the load back to the original position and slowly lower to ground.
- _____ 9. At the completion of the load test, inspect the following:

Visually inspect rope in accordance with Section 9.2.6.8.

MOBILE CRANE LOAD TEST AND FOLLOW-UP CHECKS

DEFECTIVE/OK/NA

- _____ a. Rope diameter: (Previous)_____ (Present) _____
- _____ b. Wear
- _____ c. Kinks
- _____ d. Broken wires
- _____ e. Other signs of deterioration.

Visually inspect the rope drum for:

- _____ a. Wear
- _____ b. Deformation
- _____ c. Deterioration
- _____ d. Have qualified inspector perform nondestructive tests on hook by visual examination, liquid penetrant examination, or magnetic-particle examination.
Acceptance: No cracks, linear indications, laps, or seams.

Hooks with more than 5% normal (new hook) throat opening, not to exceed ¼ inch, shall be replaced. Hooks with any visibly apparent bend or twist from the normal (new hook) plane of the hook shall be replaced. Hooks having more than 10% wear in the bowl section or 5% elongation of the shank shall be replaced. Lubricate hook bearing and latch pin, as applicable.

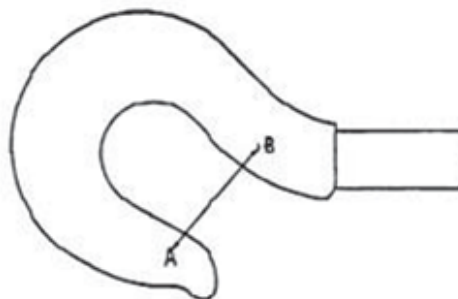
Establish two marks, A and B with a center punch. For ease in measuring, set distances on an even number of inches.

BEFORE LOAD TEST

Length AB _____ in

AFTER LOAD TEST

Length AB _____ in



Check for:

1. Wear and deformation
2. Cracks and twisting
3. Signs of opening between Point A and Point B

MOBILE CRANE LOAD TEST LOAD AND FOLLOW-UP CHECKS

This information should be retained with the equipment. Record the following:

BLOCK WEIGHT _____ lb.

TEST WEIGHT _____ lb. |

RADIUS/CENTER PIN TO LOAD _____ ft.

PARTS LINE _____ quantity

BOOM LENGTH _____ ft.

Load Test Inspection Date _____

Qualified Inspector _____

Operated By _____

Exhibit 9.2 Mobile Crane Pre-Operational Checklist (Sample Forms, 3 pages)

Page 1 of 3

MOBILE CRANE PRE-OPERATIONAL CHECKLIST

(Records Are Not Required)

STATUS CODE: SAT – Satisfactory <u>UNSAT</u> – Unsatisfactory R – Repaired N/A – Not Applicable		
EXTERNAL	CODE	COMMENT
Check Fuel Cap		
Crankcase Oil Level		
Cold Weather Starting Aid		
Radiator		
Antifreeze & Coolant		
Cleaners		
Fan Belts		
Pumps & Motors		
Battery		
Muffler		
Brake & Air System (Bleed)		
Hydraulic Reservoir		
Hydraulic Oil Filter		
All Hydraulic Hoses & Fittings		
Auto Transmission Oil Level		
Air Compressor Oil Level		
Outriggers & Boxes		
Outrigger Floats		
Tire Condition & Pressure		
Wheel Lugs		
Hoists		
Boom Attachments		
Lubrication/Grease or Oil Leaks		
All Sheaves Lubed		

MOBILE CRANE PRE-OPERATIONAL CHECKLIST
(Records Are Not Required)

EXTERNAL	CODE	COMMENT
Wire Rope Kinks or Breaks		
Wire Rope Dirt & Lube		
Hook & Hook Block		
Counterweight & Torque		
Handrails		
Lamps:		
• Turn Signals		
• Flashers		
• Headlamps		
• Cab		
• Boom		
• Backup		
Welds & Cracks:		
• Hoists		
• Boom		
• Sheaves		
• Sheaves		
• Hook		
• Block		
• Motor		
• Valves		
• Cylinders		
REMARKS		

MOBILE CRANE PRE-OPERATIONAL CHECKLIST
(Records Are Not Required)

INSIDE CAB	CODE	COMMENT
Fire Extinguisher Pressure		
Operator Manual & Load Chart		
Hand Signal Chart		
Glass		
Windshield Wiper		
GAUGES: Oil, Fuel, Amp		
Lights & Horn		
Backup Alarm		
Heater		
Boom Angle Indicator (PAT)		
Load Moment Indicator		
Anti Two Block		
Boom Stops		
Gearshift Control		
Foot & Parking Brakes		
Swing Brake		
Control Lever Linkage		
Throttle Linkage		
Engine RPM		
REMARKS		

Exhibit 9.3 Mobile Crane Frequent Inspection Report (Sample Forms, 2 pages)

Page 1 of 2

MOBILE CRANE FREQUENT INSPECTION REPORT

MODEL #: _____ SERIAL #: _____ HOUR METER: _____		
STATUS CODE: SAT – Satisfactory UNSAT – Unsatisfactory R – Repaired N/A – Not Applicable		
FREQUENT	CODE	COMMENT
Check Bolt Torque:		
• Transmission Mount		
• Turntable		
• Engine Mount		
• Hoist Mount		
• Axle Mount		
Engine RPM		
Muffler Connections		
Wiring harness		
Battery Cable		
Battery Water Level		
Master Cylinders		
Pump Drive Gearbox		
Swing Gearbox		
Axle Lockout		
Axle Differential		
Axle Planetary Oil		
Welds & Cracks		
• Hoist		
• Boom		
• Sheaves		
• Hook		
• Block		

This is an uncontrolled copy when printed.

MOBILE CRANE FREQUENT INSPECTION REPORT

FREQUENT	CODE	COMMENT
Motor		
• Valves		
• Cylinders		
Lamps:		
• Turn Signals		
• Headlamps		
• Cab		
• Boom		
• Backup		
Boom Sheaves		
Boom Alignment		
Jib Alignment		
Machine Structure		
Clean/Change:		
• Differential Breather		
• Fuel Filter Screen		
• Compressor Strainer		
• Transmission Filter		
Drum		
Wire Rope: Dirt/Lube/Kinks		
Hook & Latch		
Block & Sheaves		
Guards in Position		
Emergency Stop		
Comments: Note Any Potential Hazards or Malfunctions		

Exhibit 9.4 Mobile Crane Periodic Inspection Report (Sample Forms, 3 Pages)

Page 1 of 3

MOBILE CRANE PERIODIC INSPECTION REPORT

MODEL #: _____ SERIAL #: _____ HOUR _____ METER: _____		
STATUS CODE: SAT – Satisfactory <u>UNSAT</u> – Unsatisfactory R – Repaired N/A – Not Applicable		
PERIODIC	CODE	COMMENT
Check Bolt Torque:		
• Transmission Mount		
• Turntable		
• Engine Mount		
• Gearbox Mount		
• Axle Mount		
Engine RPM		
Muffler Connections		
Wiring harness		
Battery Cable		
Battery <u>Water</u> Level		
Master Cylinders		
Pump Drive Gearbox		
Swing Gearbox		
Axle Lockout		
Axle Differential		
Axle Planetary Oil		
Boom Sheaves		
Boom Alignment		
Jib Alignment		
Machine Structure		
Drum		
Wire Rope Dirt/Lube/Kinks		

This is an uncontrolled copy when printed.

MOBILE CRANE PERIODIC INSPECTION REPORT

PERIODIC	CODE	COMMENT
Clean/Change		
• Differential Breather		
• Fuel Filter Screen		
• Compressor Strainer		
• Transmission Filter		
Drum		
Wire Rope: Dirt/Lube/Size/Kink		
Hook & Latch		
Block & Sheave		
Guards in Position		
Emergency Stop		
Welds & Cracks:		
• Hoists		
• Boom		
• Sheaves		
• Hook		
• Block		
• Motor		
• Valves		
• Cylinders		
Lamps:		
• Turn Signals		
• Headlamps		
• Flashers		
• Cab		
• Boom		

MOBILE CRANE PERIODIC INSPECTION REPORT

PERIODIC	CODE	COMMENT
• Backup		
Paint		
Cracks or Leaks:		
• Swing Gearbox Case		
• Transmission Case		
• Pump Drive Box		
• Engine Intake		
Boom Wear Pads		
Brake Liners		
Axle Planetary Hubs		
Cleaner		
Clutch Release Bearing		
Gear Shift Control		
Steering System Oil		
Crankcase Breather		
Tie Rod Ball Joints		
Steering Knuckles		
Drag Link Ends		
Drag Link U-Joint		
Windshield Wiper		
Lever Indicator		
Emergency Brake		
Gages: Oil, Fuel, Amp		
<u>CIRCLE ONE:</u>	PASS	FAIL
INSPECTOR (Print): _____ Signature: _____ Date: _____		

Exhibit 9.5 AEDC Mobile Crane Load Test Checklist

Date: _____ Crane Type & ID/SN # _____

Latest Crane Inspection Date: _____ Rated Capacity: _____

Supervisor: _____ Badge # _____ Signature: _____

Purpose of Load Test: 1. Special Test Before Critical Lift.

Step	Actions	Initials
1	Determine Max or Min Boom angle for load test. Max: _____ deg. Min: _____ deg.	
2	Determine Radius for Max or Min Boom Angle. Max Angle Boom Radius: _____ ft Min Angle Boom Radius: _____ ft	
Determine what weight the crane is to be tested to:		
3	Capacity @ Max Boom Angle x 110 % Capacity @ Min Boom Angle x 110 % Max Boom Wt: _____ Min Boom Wt: _____	
4	Determine what type of load is to be used for the test and provide information below. If test weights use (4a), if dead weight and Dynamometer use (4b).	
4a	Test Weight Information: (Serial # & Weight) Max. Boom: # _____ W eight: _____ Min. Boom: # _____ Weight: _____	
4b	Dynamometer Serial Number and Calibration Date: SN#: _____ Cal Date: _____	
5	Determine if test is to be performed over the rear or over the side of mobile crane. Side _____ Rear _____	Max Min
6	Position the crane at pre-determined radius for boom angle.	
7	Fully extend outriggers. Outrigger pads may be necessary.	
Perform steps 8a or 8b and 9 thru 11 at the maximum and minimum allowable boom angles.		
8a	Rig and raise the test load a few inches. Use tag lines as appropriate. The test load should not rotate on the load block.	
8b	Rig the Dynamometer and apply upward pull until meter indicates desired weight.	
9	Hold the test load for five minutes.	
10	Verify that crane operates properly and brake holds the load without slippage.	
11	Lower the test load and disconnect the rigging.	
12	Verify that no visible load-bearing part (e.g., boom, sheaves, wire rope or chain end-connections, brake component) has been adversely affected by the test.	
13	Send a copy of this document to AEDC Crane Engineer for filing in crane's maintenance file. Retain a backup copy for your file.	

(Note: The load shall not exceed **110%** of manufacturer's load rating.)

10.0 CHAPTER 10 - FORKLIFT TRUCKS

This chapter implements the requirements of ANSI/ITSDF B56.1 (“Safety Standard for powered Industrial Trucks – Low Lift and High lift Trucks”) and B56.6 (“Rough Terrain Fork Lift Trucks”), and ANSI/UL 558 (“Internal-Combustion-Engine-Powered Industrial Trucks”) and 583 (“Electric-Battery-Powered Industrial Trucks”).

10.1 GENERAL

This chapter specifies operation, inspection, testing, and maintenance requirements for industrial trucks controlled by a riding or walking operator and powered by electric motors or internal-combustion engines. (See Exhibit 10.1 at the end of this chapter for examples of powered industrial trucks.) Guidelines may also be taken from this chapter regarding pallet trucks and other small miscellaneous non-powered lift trucks (see Exhibit 10.2 at the end of this chapter), but training, operating, maintenance, inspection, and testing requirements for non-powered equipment shall be based on the manufacturer’s instructions and recommendations.

10.1.1 Operator Training/Qualification

10.1.1.1 Summary

Only trained and authorized persons shall be permitted to operate a powered industrial truck. Operators of powered industrial trucks shall be qualified as to visual, auditory, physical, and mental ability to operate the equipment safely according to paragraph 10.1.1.2 and all other applicable parts of this chapter.

10.1.1.2 Operator Training

10.1.1.2.1 Personnel who have not been trained to operate powered industrial trucks may operate a truck for the purposes of training only, and only under the direct supervision of the trainer (OJT, see paragraph 6.2.2). This training should be conducted in an area away from other trucks, obstacles, and pedestrians. Management may allow previously qualified or experienced personnel to bypass OJT and undergo OJE.

10.1.1.2.2 The operator training program should include the user’s policies for the site where the trainee will operate the truck, the operating conditions for that location, and the specific truck the trainee will operate. The training program shall be presented to all new operators regardless of previous experience.

10.1.1.2.3 The training program shall inform the trainee of the following:

- The primary responsibility of the operator is to use the powered industrial truck safely following the instructions given in the training program.
- Unsafe or improper operation of a powered industrial truck can result in
 - Death or serious injury to the operator or others
 - Damage to the powered industrial truck or other property

10.1.1.2.4 The training program shall emphasize safe and proper operation to avoid injury to the operator and others and prevent property damage, and shall cover the following areas:

- Fundamentals of the powered industrial truck(s) the trainee will operate, including

- Characteristics of the powered industrial truck(s), including variations between trucks in the workplace
- Similarities to and differences from automobiles
- Significance of nameplate data, including rated capacity, warnings, and instructions affixed to the truck
- Operating instructions and warnings in the operating manual for the truck, and instructions for inspection and maintenance to be performed by the operator
- Type of motive power and its characteristics
- Method of steering
- Braking method and characteristics, with and without load
- Visibility, with and without load, forward and reverse
- Load handling capacity, weight and load center
- Stability characteristics with and without load; with and without attachments
- Controls-location, function, method of operation, identification of symbols
- Load handling capabilities, forks, attachments
- Hazards due to production of carbon monoxide by internal combustion engines and common initial symptoms of exposure
- Fueling and battery charging
- Guards and protective devices for the specific type of truck
- Other characteristics of the specific industrial truck
- Operating environment and its effect on truck operation, including
 - Floor or ground conditions including temporary conditions
 - Ramps and inclines, with and without load
 - Trailers, railcars, and dock boards (including the use of wheel chocks, jacks, and other securing devices)
 - Fueling and battery charging facilities
 - The use of “classified” trucks in areas classified as hazardous due to risk of fire or explosion, as defined in ANSI/NFPA 505
 - Narrow aisles, doorways, overhead wires and piping, and other areas of limited clearance
 - Areas where the truck may be operated near other powered industrial trucks, other vehicles, or pedestrians
 - Use and capacity of elevators
 - Operation near edge of dock or edge of improved surface
 - Other special operating conditions and hazards that may be encountered
- Operation of the powered industrial truck, including:

- Proper pre-shift inspection and approved method for removing from service a truck that is in need of repair
- Load handling techniques: lifting, lowering, picking up, placing, tilting
- Traveling, with and without loads; turning corners
- Parking and shutdown procedures
- Other special operating conditions for the specific application
- Operating safety rules and practices, including:
 - Provisions of this handbook in paragraph 10.5.1 to 10.5.4 address operating safety rules and practices
 - Provisions of this Standard in paragraph 10.3.3 address care of the truck
 - Other rules, regulations, or practices specified by the employer at the location where the powered industrial truck will be used
- Operational training practice, including:
 - If feasible, practice in the operation of powered industrial trucks shall be conducted in an area separate from other workplace activities and personnel
 - Training practice shall be conducted under the supervision of the trainer
 - Training practice shall include actual operation or simulated performance of all operating tasks such as load handling, maneuvering, traveling, stopping, starting, and other activities under the conditions that will be encountered in the use of the truck

10.1.1.3 Testing, Retraining, and Enforcement

10.1.1.3.1 On-the-job-evaluations, OJEs, shall be conducted by the designated On-The-Job Performance Evaluator (OJPE) (see paragraph 6.2.14). OJPEs shall evaluate each operator and certify in writing that the operator has demonstrated to them that they have the necessary knowledge, meeting the requirements of the ANSI/ITSDF B56.1, and skills to operate the equipment safely before deeming the operator qualified. This document shall become part of the operators training record. Contractors, facilities, and/or organizations may choose to implement facility-specific OJT and/or OJE requirements.

10.1.1.3.2 Operators shall be retrained when new equipment is introduced, existing equipment is modified, operating conditions are changed, or an operator's performance is unsatisfactory.

10.1.1.3.3 Operators qualification is for a period not to exceed 3 years, unless the qualification is revoked sooner by the employee's manager.

10.1.2 Rated Capacity

Rated capacity is the maximum weight the truck can transport and stack at a specified load center and for a specified load elevation. Trucks shall not be used or tested above their rated capacities.

10.1.3 Nameplate(s) and Marking

Every truck shall have appended to it a durable, corrosion-resistant nameplate(s), legibly inscribed with the following information:

10.1.3.1 Truck model and truck serial number.

10.1.3.2 Weight of truck.

10.1.3.3 Rated capacity.

10.1.3.4 Designation of compliance with the mandatory requirements of ASME B56.1, “Safety Standard for Low and High lift Trucks,” applicable to the manufacturer.

10.1.3.5 Type designation to show conformance with the requirements, such as those prescribed by Underwriters Laboratories, Inc., and Factory Mutual Research Corporation.

10.1.3.6 Batteries for use in electric trucks shall have the battery weight legible stamped on the battery tray near the lifting means as follows: Service Weight____lb (kg).

10.1.3.7 In addition to the above requirements, additional information is required (and allowed) on nameplates on high-lift trucks, electric trucks, and trucks intended for hazardous locations (see ASME B56.1, paragraph 7.5, “Nameplates and markings”).

10.1.3.8 Fork Arm Data: For forklift trucks purchased after December 1984, each fork arm shall be clearly stamped with its individual load rating in an area readily visible and not subject to wear; e.g., 4400 lbs (2000 kg) x 24 in (600 kg), meaning 4400 lbs (2 000 kg) load rating at 24 in (600 mm) load center.

10.1.4 Attachments

Attachments almost always affect rated capacity of the truck. When a forklift truck is equipped with an attachment, the rated capacity of the truck/attachment combination shall be established by the truck manufacturer. Capacity, operation, and maintenance instruction plates, tags, or decals shall be changed accordingly.

10.1.4.1 The rated capacity of an attachment/truck combination shall not be exceeded.

10.1.4.2 On every removable attachment (excluding fork extensions see paragraph 10.1.4.3), a corrosion-resistant nameplate with the following information is required:

10.1.4.2.1 Model number

10.1.4.2.2 Serial number on hydraulically actuated attachments

10.1.4.2.3 Maximum hydraulic pressure (on hydraulically actuated attachments)

10.1.4.2.4 Weight

10.1.4.2.5 Capacity

10.1.4.2.6 The following instructions (or equivalent); “Capacity of truck and attachment combination may be less than capacity shown on attachment. Consult truck nameplate.”

10.1.4.3 Fork extensions:

10.1.4.3.1 Should not be longer than 150% of the supporting fork’s length.

10.1.4.3.2 Each fork extension shall be capable of supporting a uniformly distributed, or equivalent load of three times its rated capacity when mounted on a fork of the specified size. No permanent deformation shall be produced by the application of this test load after having removed the effects of any local manufacturing irregularities by up to three preliminary applications of the test load.

10.1.4.3.3 For purpose of rating, the rated load center of the fork extension should be at 50% of the fork extension load supporting length.

10.1.4.3.4 Each fork extension shall be clearly stamped with its individual load rating and supporting fork size in an area readily visible and not subject to wear. For example, 4400 lbs (2000 kg) x 24 in (600 kg) – 3 in (80 mm) x 7 in (180 mm) x 32 in (800 mm) means a 4400 lb (2000 kg) load at a

24 in (600 mm) load center with a recommended supporting fork size of 3 in (80 mm) x 7 in (180 mm) and not less than 32 in (800 mm) long.

10.1.4.3.5 Fork extensions shall be designed to avoid unintentional disengagement from the forks. Lateral clearance shall not exceed .5 in (12 mm) between fork and extension.

NOTE: The above information concerning fork extensions should be provided by the attachment manufacturer.

10.1.5 Modifications

10.1.5.1 Except as provided in paragraph 10.1.5.2, no modifications or alterations to a powered industrial truck that may affect the capacity, stability, or safe operation of the truck shall be made without the prior written approval of the original truck manufacturer or its successor thereof. When the truck manufacturer or its successor approves a modification or alteration, appropriate changes shall be made to capacity plates, decals, tags, and operation and maintenance manuals.

10.1.5.2 If the truck manufacturer is no longer in business and there is no successor to the business, the user may arrange for a modification or alteration to a powered industrial truck, provided however, the user does the following:

10.1.5.2.1 Arranges for modification or alteration to be designed, tested, and implemented by an engineer(s) expert in industrial trucks and their safety

10.1.5.2.2 Maintains a permanent record of the design, test(s), and implementation of the modification or alteration

10.1.5.2.3 Makes appropriate changes to the capacity plate(s), decals, tags, and operation and maintenance manuals

10.1.5.2.4 Affixes a permanent and readily visible label on the truck stating the manner in which the truck has been modified or altered together with the date of the modification or alteration, and the name of the organization that accomplished the tasks

10.1.5.2.5 If the truck is equipped with a front-end attachment(s), including fork extensions, the user shall see that the truck is marked to identify the attachment(s), show the weight of the truck and attachment combination, and show the capacity of the truck with attachment(s) at maximum elevation with the load laterally centered. (Weight value to be accurate within 5%)

10.1.5.2.6 The user shall see that all nameplates and caution and instruction markings are in place and legible.

10.1.5.2.7 The user shall consider that changes in load dimension may affect truck capacity.

10.1.5.2.8 Fork extensions shall be designed for the application.

10.1.5.2.9 When modifications involve rebuild and repair of the basic unit, they shall be made in accordance with the manufacturer's established criteria and procedures (see paragraph 10.1.5.1).

10.1.5.2.10 Where steering must be accomplished with one hand using a steering hand wheel, a steering knob(s) or equivalent shall be used to promote safe and effective operation. The steering hand wheel and knob configuration shall be of a design that will minimize the hazard from a spinning hand wheel due to a road reaction feedback, or the steering mechanism shall be of a type that prevents road reactions from causing the steering hand wheel to spin. The steering knob(s) shall be within the periphery of the steering hand wheel.

10.1.5.2.11 Where steering can be accomplished with either hand, and the steering mechanism is of a type that prevents road reactions from causing the hand wheel to spin (power steering or equivalent),

steering knobs may be used. When used, steering knobs shall be of a type that can be engaged by the operator's hand from the top, and shall be within the periphery of the steering hand wheel.

10.1.5.2.12 Batteries used in electric trucks shall comply with the minimum/maximum battery weight range shown on the truck nameplate.

10.1.6 Warning Devices

10.1.6.1 Every truck shall be equipped with an operator-controlled horn, whistle, gong, or other sound-producing device(s).

10.1.6.2 The using organization shall determine if operating conditions require the truck to be equipped with additional sound-producing or visual devices (such as lights or blinkers), and shall be responsible for providing and maintaining such devices. Backup or motion alarms that sound continuously may be warranted in special cases, but generally are less effective than operator-controlled devices.

10.1.7 Overhead Guards

An overhead guard is intended to offer protection to the operator from falling objects, but it cannot protect against every possible impact. Therefore, it should not be considered a substitute for good judgment and care in load handling.

10.1.7.1 High lift rider trucks, including order picker trucks, shall be equipped with an overhead guard manufactured in accordance with ASME B56.1, unless the following conditions are met:

10.1.7.1.1 Vertical movement of the lifting mechanism is restricted to 72 in. (1800 mm) or less from the ground.

10.1.7.2 The truck will be operated only in an area where:

10.1.7.2.1 The bottom of the top tiered load is not higher than 72 in. (1800 mm) and the top is not more than 120 in. (3000 mm) from the ground where tiered.

10.1.7.2.2 Only stable (preferably interlocked, unitized or containerized) loads are handled.

10.1.7.2.3 There is protection against falling objects from adjacent high stack areas.

10.1.7.3 Rough terrain forklift trucks shall be fitted with an overhead guard manufactured in accordance with ASME B56.6.

10.1.8 Fire Hazard Areas

Powered forklift trucks for operation in fire hazard areas shall be of the type recommended in ANSI/NFPA 505 ("Powered Industrial Trucks, Type Designation and Areas of Use").

10.1.9 Work Atmosphere

10.1.9.1 The operation of forklift trucks may affect the concentrations of carbon monoxide and oxygen in the work location. Concentrations of these materials in the work location must meet Z-1 Limits for Air Contaminants, Occupational Safety and Health Standards for General Industry.

10.1.9.2 Where general lighting is less than 2 lumens per square foot, auxiliary directional lighting shall be provided on the truck.

10.2 TYPE DESIGNATION AND AREAS OF USE

10.2.1 Type Designation

It is essential to use proper equipment in hazardous (explosive) areas. Trucks approved for use in hazardous areas shall have the manufacturer's label or other identifying mark indicating approval for the intended use by a recognized national testing laboratory [e.g., Underwriters Laboratories (UL or Factory Mutual (FM)].

Durable markers indicating the designation of the type of truck for use in hazardous areas shall be applied to each side of the vehicle in a visible but protected area. These markers shall be distinctive in shape, as indicated in Figure 10.1 at right.

NOTE: The markers for EE, EX, and DY are 5 in. (12.7 cm) high. The rest are 4 in. (10 cm) square. The signs shall have black borders and lettering on a yellow background.

Hazardous-area signs shall be posted at the entrance to hazardous areas to identify the type of forklift truck permitted, see Figure 10.2 at right, or the truck shall be clearly marked as to the area(s) it is not to enter.

NOTE: The minimum width of the sign is 11 in. (28 cm); the minimum height is 16 in. (40 cm). The sign shall have the word "caution" in yellow letters on a black background. The body of the sign shall have black letters on a yellow background. A marker identical to the one used on the side of the truck as shown in Figure 10-1, shall be installed on the sign.

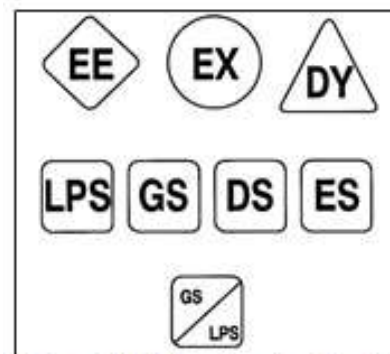


Figure 10.1 Markers to identify type of industrial truck



Figure 10.2 Signs for posting at entrance to hazardous areas.

10.2.1.1 Non-Hazardous Areas

The following types of forklifts are not suitable for use in hazardous areas since they include only minimum safeguards against inherent fire hazards:

TYPE	DESCRIPTION
D	Diesel-powered units having minimum acceptable safeguards against inherent fire hazards
E	Electrically powered units having minimum acceptable safeguards against inherent fire and electrical shock hazards
F	Gasoline-powered units having minimum acceptable safeguards against inherent fire hazards
LP	Liquefied-petroleum-gas-powered units having minimum acceptable safeguards against inherent fire hazards

10.2.1.2 Hazardous Areas

The following types of forklifts are suitable for use in hazardous areas since they are equipped with additional safeguards (i.e., special exhaust, fuel, or electrical systems) or other modifications against inherent fire hazards:

TYPE	DESCRIPTION
DS	Diesel-powered units that are provided with all the requirements for the type D units and that have additional safeguards to the exhaust, fuel, and electrical systems
DY	diesel-powered units that have all the safeguards of the type DS units except that they do not have any electrical equipment, including ignition; they are equipped with temperature-limitation features
ES	Electrically powered units that are provided with all the requirements for the type E units and that have additional safeguards to the electrical system to prevent emission of hazardous sparks and to limit surface temperatures
EE	Electrically powered units that are provided with all the requirements for the type E and ES units, and that also have electric motors and all other electrical equipment completely enclosed
EX	Electrically powered units that differ from type E, ES, or EE units in that the electrical fittings and equipment are designed, constructed, and assembled so that the units may be used in atmospheres containing specifically named flammable vapors, dusts, and, under certain conditions, fibers; type EX units are specifically tested and classified for use in Class I, Group D, or for Class II, Group G locations as defined in NFPA 70, <i>National Electrical Code</i> .
GS	Gasoline-powered units that, in addition to all the requirements for the type G units, are provided with additional safeguards to the exhaust, fuel, and electrical systems
LPS	Liquefied-petroleum-gas-powered units that, in addition to the requirements for the type LP units, are provided with additional safeguards to the exhaust, fuel, and electrical systems

10.2.2 Specific Areas of Use

The atmosphere or location where the powered forklift is to be used shall be classified. Location classifications are described below:

Class I	Locations in which flammable gases or vapors are present or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.
Class II	Locations that are hazardous because of the presence of combustible dust.
Class III	Locations where easily ignitable fibers or filings are present but are not likely to be suspended in quantities sufficient to produce ignitable mixtures.
Unclassified	Locations not possessing atmospheres defined as Class I, II, or III locations.

10.3 INSPECTIONS

10.3.1 Daily Pre-Operational Check

10.3.1.1 Instructions for pre-operational inspections shall be readily available to the operator. It is recommended that the instructions be attached to the equipment. Standard instructions will be suitable for most forklift trucks; however, operating conditions may require additional instructions. A sample Pre-operational inspection checklist is included as Exhibit 10.3, which appears at the end of this chapter.

10.3.1.2 Before operating the truck, check its condition, giving special attention to the following:

- Condition of the tires

- Tire inflation, if pneumatic tires
- Warning and safety devices
- Lights
- Battery
- Controls
- Lift and tilt systems
- Forks or other load-engaging means
- Chains and cables
- Limit switches
- Brakes
- Steering mechanism
- Fuel system(s)
- Additional items as specified by the manufacturer or that are unique to the facility at which the truck is operated

10.3.1.3 Conditions adversely affecting safety shall be corrected before the forklift truck is placed into service.

10.3.2 Initial Inspection of New and Rented Equipment

Prior to initial use, all new, or newly arrived rental equipment, or modified forklifts shall be inspected by a qualified inspector to ensure compliance with the provisions of this chapter. For new equipment, an initial inspection shall verify that requirements of the purchase order (or rental agreement) have been met and that the equipment is suitable for its intended use. This inspection shall be documented and should be retained in the forklift truck's history file. A sample load test and inspection form is provided as Exhibit 10.4, which appears at the end of this chapter. This form is intended to be a sample only and is not intended to be mandatory.

10.3.3 Inspection and Maintenance

Inspection and maintenance of powered forklift trucks shall be performed in conformance with the following practices:

- 10.3.3.1 The inspection and maintenance program shall follow the manufacturer's recommended procedures. If equipment maintenance or inspection procedures deviate from published manufacturer's recommendations, the alternate procedures shall be approved in advance by the manufacturer or another qualified person and be kept readily available.
- 10.3.3.2 Only trained and authorized personnel shall be permitted to inspect, maintain, repair, and adjust forklift trucks.
- 10.3.3.3 No repairs shall be made while the truck is in a hazardous (explosive/classified) area.
- 10.3.3.4 Inspect brakes, steering mechanisms, control mechanisms, warning devices, lights, governors, lift-overload devices, guards, and safety devices regularly and maintain them in a safe-operating condition.

- 10.3.3.5 Carefully inspect all parts of lift and tilt mechanisms and frame members and maintain them in a safe-operating condition.
- 10.3.3.6 Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).
- 10.3.3.7 For special trucks or devices designed and approved for operation in hazardous areas, ensure that the original, approved safe-operating features are preserved by maintenance.
- 10.3.3.8 Check fuel systems for leaks and for the proper condition of the parts. Give special consideration in the case of a fuel system leak. Take action to prevent use of the truck until the leak has been corrected.
- 10.3.3.9 Inspect and maintain all hydraulic systems. Check tilt cylinders, valves, and other similar parts to ensure that drift or leakage has not developed to the extent that it would create a hazard.
- 10.3.3.10 Maintain capacity, operation safety, and maintenance-instruction plates, tags, or decals in legible condition.
- 10.3.3.11 Inspect and maintain batteries, motors, controllers, limit switches, protective devices, electrical conductors, and connections. Pay special attention to the condition of electrical insulation.
- 10.3.3.12 Those repairs to the fuel and ignition systems of industrial trucks which involve fire hazards shall be conducted only in locations designated for such repairs.
- 10.3.3.13 Trucks in need of repairs to the electrical system shall have the battery disconnected prior to such repairs.
- 10.3.3.14 Water mufflers shall be filled daily or as frequently as is necessary to prevent depletion of the supply of water below 75% of the filled capacity. Vehicles with mufflers having screens or other parts that may become clogged shall not be operated while such screens or parts are clogged. Any vehicle that emits hazardous sparks or flames from the exhaust system shall immediately be removed from service, and not returned to service until the cause for the emission of such sparks and flames has been eliminated.
- 10.3.3.15 When temperature of any part of any truck is found to be in excess of its normal operating temperature, the vehicle shall be removed from service and not returned to service until the cause for such overheating has been eliminated.
- 10.3.3.16 Industrial trucks originally approved for the use of gasoline for fuel may be converted to liquefied petroleum gas fuel provided the complete conversion results in a truck which embodies the features specified for LP or LPS designated trucks. Conversion equipment and the recommended method of installation shall be approved by the manufacturer.
- 10.3.3.17 All parts that require replacement shall be replaced only with parts that are equivalent, in regards to safety, to those used in the original design.
- 10.3.3.18 Attachments shall be included in a scheduled maintenance/inspection program. Inspection steps shall be tailored for the attachment. Load-bearing components shall be examined for deformation and load-bearing welds shall be visually examined for cracks. Mechanical or hydraulic components shall be inspected and maintained in accordance with the manufacturer's instructions.
- 10.3.3.19 Attachments shall be inspected not less than annually and the inspection should be documented.
- 10.3.3.20 Hooks that are included as part of attachments shall be inspected as specified for hooks on cranes/hoists (see Chapter 13.0, "Load Hooks").

10.3.4 Forks

10.3.4.1 Fork Load Rating

Forks used in pairs (the normal arrangement) shall have a rated capacity of each fork at least half the manufacturer's truck rated capacity at the center distance shown on the forklift truck nameplate.

10.3.4.2 Fork Inspections

10.3.4.2.1 Forks in use (single shift operation) shall be inspected at intervals of not more than 12 months or whenever any defect or permanent deformation is detected. Severe use applications require more frequent inspection at an interval set by facility management.

10.3.4.2.2 Forks in use (single shift operation) shall be inspected at intervals of not more than 12 months or whenever any defect or permanent deformation is detected. Severe use applications require more frequent inspection at an interval set by facility management.

10.3.4.2.3 Fork inspection shall be carried out by a qualified inspector with the aim of detecting any damage, failure, deformation, or other condition that might impair safe use. A fork that shows any of the following defects shall be withdrawn from service, and shall not be returned to service until it is satisfactorily repaired by the fork manufacturer or an expert of equal competence. Fork inspection shall include the following:

- *Surface Cracks* – A thorough visual examination for cracks and, if considered necessary, non-destructive crack detection, with special attention to the heel and to the welds that attach the mounting components to the fork blank. Inspection for cracks shall include any mounting mechanisms of the fork blank to the fork carrier. Forks shall not be returned to service if surface cracks are detected.
- *Fork Tine Inspection* – Examination for straightness of blade and shank, fork angle (upper face of blade to load face of the shank), fork blade and shank wear. Difference in height of fork tips may vary from manufacturer to manufacturer and with tine length. For these reasons, fork tine inspections shall be done in accordance with manufacturer's requirements.
- *Positioning Lock* – Confirm that the Positioning Lock (when provided) is in good repair and in correct working order. If any fault is found, the fork shall be withdrawn from service until satisfactory repairs are made.
- *Fork Hooks Wear* – When fork hooks are provided, the support face of the top hook and the retaining faces of both hooks shall be checked for wear, crushing, and other local deformations. If clearance between the fork and the fork carrier becomes excessive, the fork shall not be returned to service until repaired in accordance with paragraph 10.3.4.3.

10.3.4.2.5 *Fork Marking* – When fork marking is not clearly legible, it shall be renewed. Marking shall be renewed per instructions from the original fork supplier.

10.3.4.3 Fork Repair

Only the manufacturer of the fork or an expert of equal competence shall decide if a fork may be repaired for continued use, and the repairs shall only be carried out by such authorities. Surface cracks or wear should not be repaired by welding. When resetting repairs are required, the fork shall be subject to heat treatment.

10.3.5 Battery Maintenance

10.3.5.1 Facilities shall be provided for flushing and neutralizing spilled electrolyte, for fire protection, for protecting charging apparatus from damage by trucks, and for adequate ventilation for dispersal of fumes from gassing batteries.

10.3.5.2 A conveyor, overhead hoist, or equivalent material handling equipment shall be provided for handling batteries.

10.3.5.3 Reinstalled batteries shall be properly positioned and secured in the truck.

10.3.5.4 A carboy tilter or siphon shall be provided for handling electrolyte.

10.3.5.5 When introducing electrolyte into batteries, acid shall be poured into water; water shall not be poured into acid.

10.3.5.6 Trucks shall be properly positioned and brake applied before attempting to change or charge batteries.

10.3.5.7 Care shall be taken to assure that vent caps are functioning. The battery (or compartment) cover(s) shall be open to dissipate heat.

10.3.5.8 Smoking shall be prohibited in the charging area.

10.3.5.9 Precautions shall be taken to prevent open flames, sparks or electric arcs in battery charging areas.

10.3.5.10 Tools and other metallic objects shall be kept away from the top of uncovered batteries

10.3.6 History File

10.3.6.1 A history file should be maintained for each forklift truck. The history file should contain information necessary to operate, maintain, test, and evaluate the forklift truck. A typical history file would contain the following types of documentation, as applicable:

10.3.6.1.1 Manufacturer's operation and maintenance manuals.

10.3.6.1.2 Waivers applicable to the forklift truck.

10.3.6.1.3 Documentation for replacement forks.

10.3.6.1.4 Documentation from the manufacturer authorizing modifications to the forklift truck.

10.3.6.1.5 Inspection procedures and inspections records.

10.3.6.1.6 Records of repair, modification, and overhaul.

10.3.6.1.7 Fork inspection records, including record of fork repair.

10.3.6.1.8 Authorization from truck manufacturer to use specifically identified attachments.

NOTE: For forklift trucks on rental, ensure that a suitable maintenance and inspection program is established for the duration of the rental period. For rental equipment onsite for 6 months or less, a history file is not recommended.

10.4 TESTING

10.4.1 Forklift Truck Load Test

Forklift truck load tests are not routinely required.

10.4.1.1 Load tests shall not be conducted until verification that inspection and maintenance is up to date.

10.4.1.2 Load tests shall be performed after major repair or modification to components that affect the load-carrying ability of the truck.

10.4.1.3 The manufacturer should be consulted if questions arise as to whether a load test is appropriate.

10.4.1.4 Forklift trucks shall be load tested by or under the direction of a qualified person and in accordance with the manufacturer's recommendations.

10.4.1.5 Test weights shall be accurate within -5%, +0% of stipulated values.

10.4.1.6 After a load test is performed, a written report shall be furnished by the qualified person that shows test procedures, and confirms the adequacy of repairs or alterations. Test reports shall be retained in the truck's history file.

10.4.2 Fork Load Test

A fork that has undergone repair, other than repair or replacement of positioning locks or marking, shall be subject to a load test as described in ASME B56.1, paragraph 7.26, "Forks," Item 3, which lists loading and method of test for forks; except for the test load, which shall correspond to 250% of the rated capacity marked on the fork.

10.4.3 Attachment Load Test

Load capacity of an attachment shall be verified by the manufacturer or by a load test at 100% capacity that is performed onsite. Load tests are not routinely required since a catalog cut, user's manual, decals on attachment, or other manufacturer's data serves as capacity verification.

10.5 OPERATIONS

10.5.1 Conduct of Operator

The following requirements shall be observed by the operator when operating forklift trucks:

10.5.1.1 General

10.5.1.1.1 Safe operation is the responsibility of the operator. Report all accidents and "near misses" promptly.

10.5.1.1.2 The operator shall develop safe working habits and also be aware of hazardous conditions in order to protect himself, other personnel, the truck, and other material.

10.5.1.1.3 The operator shall be familiar with the operation and function of all controls and instruments before operating the truck.

10.5.1.1.4 Before operating any truck, the operator shall be familiar with unusual operating conditions which may require additional safety precautions or special operating instructions.

10.5.1.1.5 Be certain the truck has successfully passed a pre-use inspection.

10.5.1.1.6 Do not start or operate the truck, any of its functions or attachments, from any place other than from the designated operator's position.

10.5.1.1.7 Keep hands and feet inside the operator's designated area or compartment. Do not put any part of the body outside the operator compartment of the truck.

10.5.1.1.8 Never put any part of the body within the reach mechanism of the truck or other attachments.

10.5.1.1.9 Avoid reaching through the mast for any purpose.

10.5.1.1.10 To safeguard pedestrians, understand the truck's limitations and observe the following precautions:

- Do not drive a truck up to anyone standing in front of an object.

- Ensure that personnel stand clear of the rear swing area before conducting turning maneuvers.
- Exercise particular care at cross aisles, doorways, and other locations where pedestrians may step into the path of travel of the truck.
- Do not allow anyone to stand or pass under the elevated portion of any truck, whether empty or loaded.

10.5.1.1.11 Do not permit passengers to ride on powered industrial trucks unless a safe place to ride has been provided by the manufacturer.

10.5.1.1.12 Ensure that fire aisles, access to stairways, and fire equipment is kept clear.

10.5.1.1.13 A powered industrial truck is considered unattended when the operator is more than 25 ft. (7.6 m) from the truck, which remains in his view, or whenever the operator leaves the truck and it is not in his view.

10.5.1.1.14 Before leaving the operator's position, the operator shall perform the following:

- Bring truck to a complete stop.
- Place directional controls in neutral.
- Apply the parking brake.
- Fully lower load-engaging means, unless supporting an elevated platform.

10.5.1.1.15 In addition, when leaving the truck unattended the operator shall perform the following:

- Stop the engine or turn off the controls.
- If the truck must be left on an incline, block the wheels.
- Fully lower the load-engaging means.

10.5.1.1.16 Maintain a safe distance from the edge of ramps, platforms, and other similar working surfaces. Do not move railroad cars with a powered industrial truck.

10.5.1.1.17 Do not use a truck for operating or closing railroad car doors except as follows:

- Unless the truck utilizes a device specifically designed for opening and closing railroad car doors and the operator is trained in its use.
- The design of the door-opening device shall require the truck to travel parallel to the railroad car, with the force applied in a direction parallel with the door travel.
- Care should be exercised when engaging the railroad car door with the door opening device, in order to prevent damage to the doors and/or fork truck by heavy impact forces.
- The entire door opening operation shall be in full view of the operator.
- The fork truck shall always be positioned to safeguard the dock attendant while removing the door lock pin.
- Whenever a railroad car door requires an abnormal force to open, the truck operator shall report the condition to his supervisor.

10.5.1.1.18 Wheel stops, hand brakes, or other recognized positive protection shall be provided to prevent railroad cars from moving during loading or unloading operations.

10.5.1.1.19 Consider both the truck and load weight when operating in railcars and semitrailers.

10.5.1.1.20 Inspect floors on trucks, boxcars, unfamiliar ramps, or platforms before start of operation.

10.5.1.1.21 Other workers should not be inside the truck when the forklift truck is performing loading or unloading operations. Load arrangements and spacing issues should be determined before the forklift enters the truck.

10.5.1.1.22 Fixed jacks or supports may be needed to prevent upending or corner dipping when powered industrial trucks are driven on and off semitrailers that are not coupled to the tractor.

10.5.1.1.23 The brakes of highway trucks shall be set and wheel chocks placed under the rear wheels to prevent the trucks from rolling while they are boarded.

10.5.1.1.24 Care shall be taken to not contact overhead installations such as lights, wiring, pipes, sprinkler systems, etc. If in doubt, measure.

10.5.1.1.25 Motorized hand trucks shall not be ridden unless they are of the hand/rider design.

10.5.1.2 Traveling

10.5.1.2.1 Observe all traffic regulations and under all travel conditions, operate the truck at a speed that will permit it to be brought to a stop in a safe manner. Unless facility-specific procedures state otherwise, the guideline is: within plant buildings – 5 mph; on plant roads – 15 mph. Drive slowly around curves.

10.5.1.2.2 Yield the right of way to pedestrians and emergency vehicles. Whenever possible, establish eye contact with approaching pedestrians or vehicle drivers before continuing.

10.5.1.2.3 Do not pass another truck traveling in the same direction at intersections, blind spots, or at other locations where vision is obstructed.

10.5.1.2.4 Slow down and sound horn at cross aisles and other locations where vision is obstructed.

10.5.1.2.5 Railroad tracks shall be crossed diagonally whenever possible.

10.5.1.2.6 Never travel with forks raised to unnecessary heights. Approximately 4 to 6 inches (10 to 15 cm) above floor level is adequate.

10.5.1.2.7 Do not park closer than 6 ft (1800 mm) to the nearest rail or a railroad track.

10.5.1.2.8 Face in the direction of travel, except if the load being carried obstructs forward view. In such cases, travel with the load trailing.

10.5.1.2.9 When ascending or descending grades, ramps, and inclines:

- In excess of 5% grade, drive loaded rider trucks with the load upgrade.
- Use low gear or slowest speed control.
- Operate unloaded trucks with the load-engaging means downgrade.
- The load and load-engaging means shall be tilted back, if applicable and raised only as far as necessary to clear the road surface.
- Avoid turning if possible, and normally travel straight up and down.

10.5.1.2.10 While turning, be cautious of rear end swing and keep clear of the edge of loading docks.

10.5.1.2.11 Make starts, stops, turns, or direction reversals in a smooth manner so as not to shift load and/or overturn the truck.

10.5.1.2.12 Do not indulge in stunt driving or horseplay.

10.5.1.2.13 Slow down for wet and slippery floors.

- 10.5.1.2.14 Before driving over a dock board or bridge plate, be sure that it is properly secured.
- 10.5.1.2.15 Drive carefully and slowly across the duckboard or bridge plate, and never exceed its rated capacity.
- 10.5.1.2.16 Do not drive trucks onto any elevator unless specifically authorized to do so. In cases operation are authorized:
- Do not exceed the capacity of the elevator.
 - Approach elevators slowly, and then enter squarely after the elevator car is properly leveled.
 - Once on the elevator, neutralize the controls, shut off the power, and set brakes.
 - It is advisable that all other personnel leave the elevator before truck is allowed to enter or leave.
- 10.5.1.2.17 Unless a towing hitch is supplied by the manufacturer, do not use forklift trucks as tow trucks. When a towing hitch is provided, use tow bars rather than wire rope for towing.
- 10.5.1.2.18 At the end of the operator's shift, return the forklift truck to its assigned parking place, set brakes, fully lower load-engaging means, place controls in neutral position, turn ignition off, and secure the key.
- 10.5.1.2.19 Seat belt use, while operating a lift truck, is mandatory.

10.5.2 Lifting of Personnel

Only the operator-up high lift trucks have been designed to lift personnel. If a work platform is used on forklift trucks designed and intended for handling materials, take the following precautions:

- 10.5.2.1 Use a lift platform manufactured for the purpose of lifting personnel with a forklift truck. The platform shall include:
- 10.5.2.1.1 A 4 in. (10 cm) minimum height toe plate provided on the work platform.
- 10.5.2.1.2 The floor of the platform located not more than 8 in. (20 cm) above the upper face of the supporting truck fork blade.
- 10.5.2.1.3 A restraining means such as a guard rail or a means for securing personnel such as a body belt or lanyard, whenever the platform can be elevated to a height greater than 48 inches (1200 mm).
- NOTE:** A guard rail shall have a height above the platform floor of 42 inches (1067 mm) nominal, around its upper periphery and include a midrail.
- 10.5.2.1.4 An access opening in the guard rail may be hinged or removable, or chains may be used if proper positioning is easily accomplished and secured condition is discernible.
- 10.5.2.1.5 Guard rails and access openings shall be capable of withstanding a concentrated force of 200 lb (91 kg) in any direction.
- 10.5.2.1.6 Means to securely attach the platform to the lifting carriage or forks in such a manner that it cannot slide or bounce off the forks.
- 10.5.2.1.7 Means to correctly locate the platform centered laterally on the truck.
- 10.5.2.1.8 Floor dimensions that neither exceed two times the load center distance listed on the truck nameplate, measured parallel to the longitudinal center plane of the truck, nor have a width

greater than the overall width of the truck (measured across the load bearing tires) plus 10 in. (25 cm) on either side.

10.5.2.1.9 The following information should be prominently indicated on the platform:

- Maximum load including personnel and equipment;
- Weight of empty platform;
- Minimum capacity of the truck on which the platform can be used.

10.5.2.2 The combined weight of the platform, load, and personnel shall not exceed one-half of the capacity as indicated on the nameplate of the truck on which the platform is used.

10.5.2.3 Whenever a truck (except for high-lift order-picker trucks) is equipped with vertical hoisting controls elevatable with the lifting carriage or forks, take the following additional precautions to protect personnel:

10.5.2.3.1 Means shall be provided whereby personnel on the platform can shut off power to the truck.

10.5.2.3.2 Means shall be provided to render inoperative all operating controls on the elevating platform, when the controls on the elevating platform have been selected for use; only one location of controls shall be capable of being operated at one time.

10.5.2.3.3 Emergency-lowering means available at ground level should be provided; such means shall be protected against misuse.

10.5.2.4 Take the following precautions whenever personnel are elevated with a forklift truck:

10.5.2.4.1 Ensure the truck has a firm and level footing.

10.5.2.4.2 Place all travel controls in neutral and set parking brake.

10.5.2.4.3 Before elevating personnel, mark area with cones or other devices to warn of work by elevated personnel.

10.5.2.4.4 Lift and lower personnel smoothly, with caution, and only at their request.

10.5.2.4.5 Avoid overhead obstructions and electric wires.

10.5.2.4.6 Keep hands and feet clear of controls other than those in use.

10.5.2.4.7 Move truck and/or platform slowly, only for minor adjustments in horizontal positioning when personnel are on the platform, and only at their request.

10.5.2.4.8 Ensure the mast is vertical – do not operate on a side slope.

10.5.2.4.9 The platform is horizontal and never tilted forward or rearward when elevated.

10.5.2.4.10 Personnel are to remain on the platform floor. The use of railings, planks, ladders, etc., on the platform for the purpose of achieving additional reach or height is prohibited.

10.5.2.4.11 Ensure approved fall protection equipment is used by personnel working from basket or platform.

10.5.2.4.12 Ensure personnel and equipment on the platform do not exceed the available space.

10.5.2.4.13 Lower platform to floor level for personnel to enter and exit. Do not climb on any part of the truck in attempting to enter or exit.

10.5.2.4.14 The operator shall remain in the control position of the forklift truck at all times.

10.5.2.4.15 Be certain that the lifting mechanism is operating smoothly throughout its entire lift height, both empty and loaded, and that lift limiting devices and latches, if provided, are functional.

10.5.2.4.16 Means shall be provided to protect personnel from moving parts of the forklift truck that present a hazard when the personnel platform is in the normal working position.

10.5.2.4.17 Overhead protection, as necessary for operating conditions, shall be provided.

10.5.2.4.18 Do not transport personnel from one location to another while they are on the work platform.

10.5.2.4.19 When not in the operating position, engage the parking brake and block the wheels.

10.5.2.4.20 Be certain that required restraining means such as railings, chains, cable, full body harness with lanyards, or deceleration devices, etc., are in place and properly used.

10.5.3 Refueling and Recharging

10.5.3.1 Refueling

10.5.3.1.1 Refueling of forklifts shall be conducted in areas with good ventilation and away from any ignition sources such as sparks, open flames, electrical arcs, etc.

10.5.3.1.2 Fire protection devices, such as fire extinguishers, shall be readily available in any refueling or recharging areas.

10.5.3.1.3 Smoking is not permitted at any refueling or recharging area.

10.5.3.1.4 Refueling of gas and diesel engine forklifts shall be conducted outdoors due to the possibility of spills and vapor accumulation.

10.5.3.1.5 Refueling shall not be conducted with the engine running. Properly dismount prior to refueling.

10.5.3.1.6 Connect the bonding wire if required; otherwise, ensure the pump nozzle makes contact the tank while filling. This will prevent static electricity that could cause a fire or explosion.

10.5.3.1.7 Avoid spillage. Spillage of oil or fuel shall be carefully washed away or completely evaporated and the fuel tank cap replaced before restarting engine.

10.5.3.1.8 Trained personnel shall conduct refueling of liquefied petroleum gas (LPG) forklifts. Always consult and follow the manufacturer's instructions for LPG cylinder change out. As a minimum:

- Close the main LPG cylinder valve.
- Restart the forklift and allow it to run out of fuel; this will purge all LPG and pressure from the lines.
- After the engine stops, turn the ignition off, close the LPG valve and disconnect the cylinder from the forklift.
- Remove and replace the cylinder.
- Reconnect the cylinder, open the LPG valve, and check for leaks.

10.5.3.2 Changing or Recharging Batteries

10.5.3.2.1 Trained personnel shall conduct battery charging and battery replacement. Always consult and follow the manufacturer's instructions for battery replacement or recharging.

10.5.3.2.2 Battery charging operations shall be conducted in adequately ventilated areas that are designated for that purpose.

10.5.3.2.3 Smoking is prohibited in battery charging areas. "No Smoking" signs shall be posted in plain view of incoming personnel.

- 10.5.3.2.4 Emergency eye/face and skin flushing and drenching facilities shall be provided.
- 10.5.3.2.5 Forklifts shall be properly positioned and dismounted before charging or replacing batteries.
- 10.5.3.2.6 Ensure vent caps are functioning properly. The battery compartment shall be open to dissipate heat.
- 10.5.3.2.7 Facilities shall be provided for flushing and neutralizing spilled electrolyte.
- 10.5.3.2.8 A carboy tilter or siphon shall be provided for handling electrolyte.
- 10.5.3.2.9 When charging batteries, acid shall always be poured into water. **Never pour water into acid.**
- 10.5.3.2.10 An adequate lifting device, such as an overhead hoist or conveyor shall be available for changing batteries.
- 10.5.3.2.11 Tools and other metallic objects shall be kept away from the top of uncovered batteries.
- 10.5.3.2.12 Precautions shall be taken to prevent open flames, sparks, or electric arcs in battery charging areas.

10.5.4 Standard Hand Signals

- 10.5.4.1 Standard hand signals for use at AEDC shall be as specified in the latest edition of the ANSI standards for the particular forklift being used (see Figure 10-5).
- 10.5.4.2 The operator shall recognize signals only from the designated signal person. However Obey a STOP signal no matter who gives it.
- 10.5.4.3 For operations not covered by standard hand signals, special signals shall be agreed on in advance by both the operator and the signal person, and should not conflict with the standard signals.

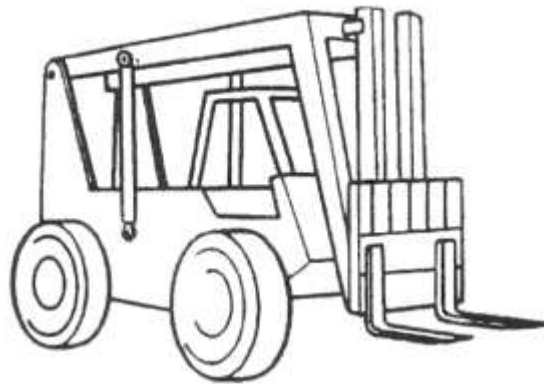
10.5.5 Critical Lifts

See Chapter 2, “Critical Lifts,” for critical-lift requirements

10.5.6 Equipment Qualification

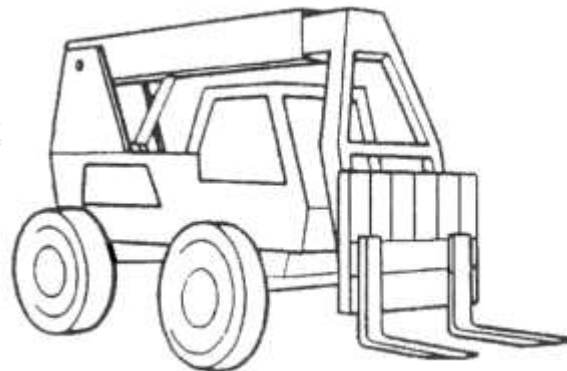
To qualify for operation, a forklift truck should have the following:

- 10.5.6.1 A record of successful inspections and maintenance.
- 10.5.6.2 A frequent (pre-use) inspection instruction available to the operator.
- 10.5.6.3 A qualified operator.
- 10.5.6.4 Proper type designation for working in a classified hazardous area, if applicable.

Exhibit 10.1 Types of Trucks. (sheet 1 of 6)

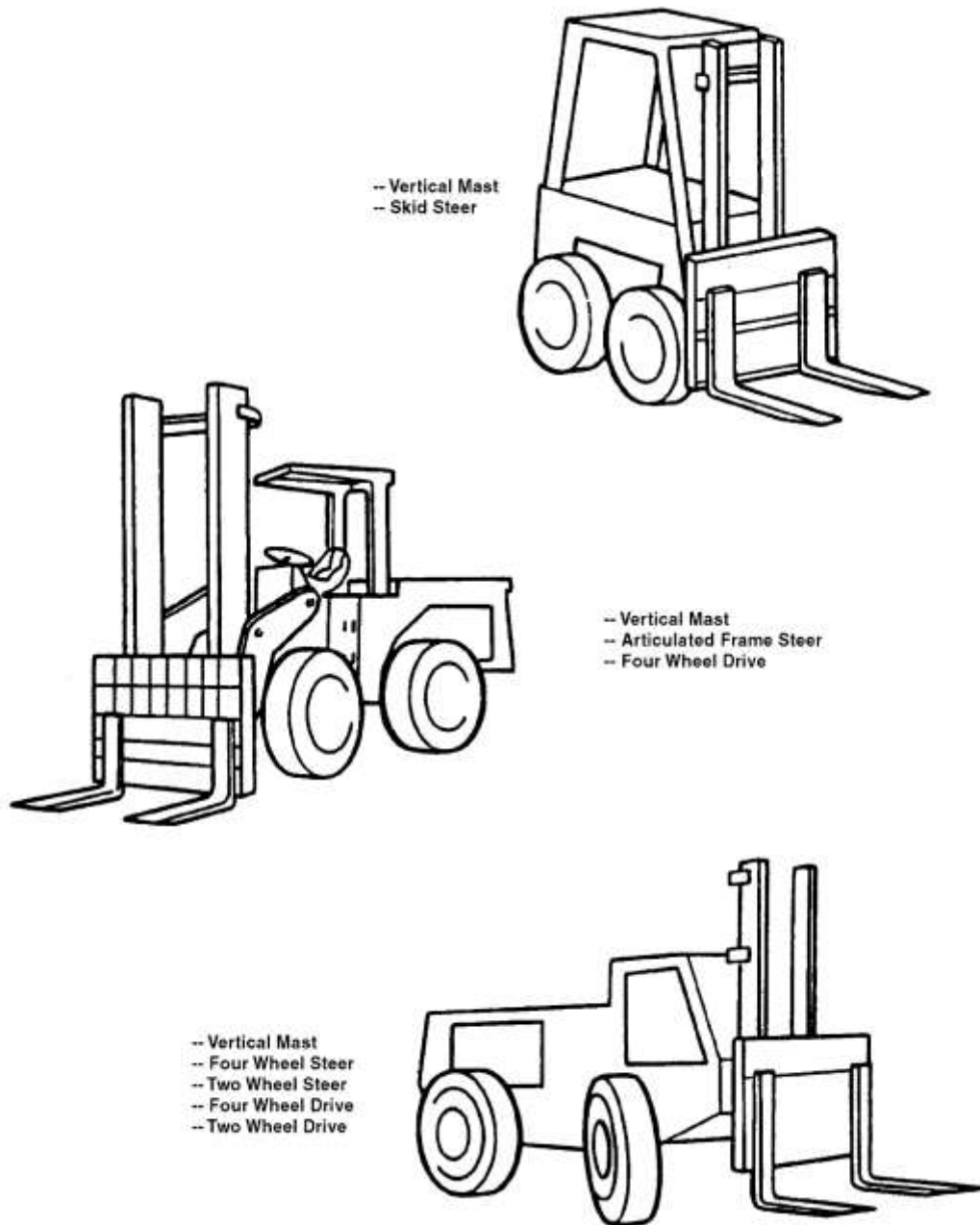
- Variable Reach Truck Linkage Type
- Four Wheel Steer
- Two Wheel Steer
- Four Wheel Drive
- Two Wheel Drive

- Variable Reach Truck Boom Type
- Four Wheel Steer
- Two Wheel Steer
- Four Wheel Drive
- Two Wheel Drive

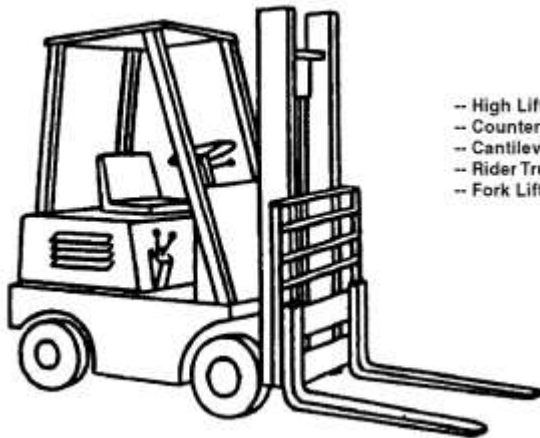


- Variable Mast
- Two Wheel Steer
- Two Wheel Drive

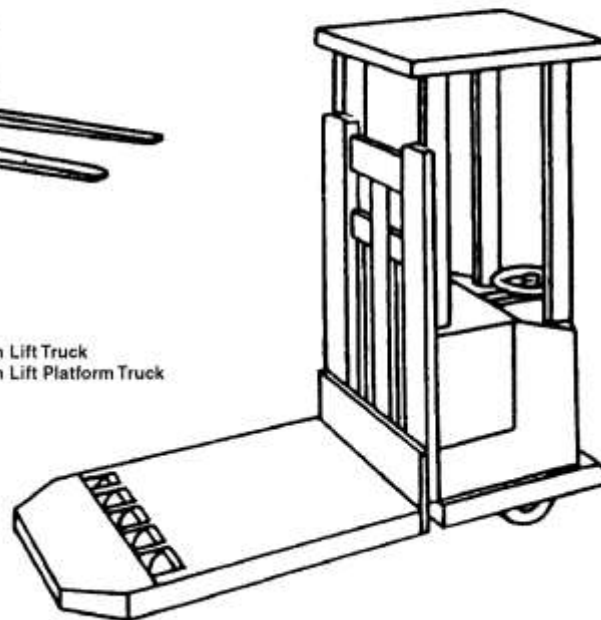
Types of Trucks (sheet 2 of 6)



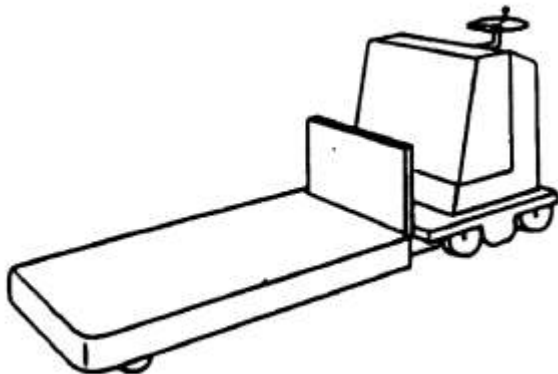
Types of Trucks (sheet 3 of 6)



- High Lift Truck
- Counterbalanced Truck
- Cantilever Truck
- Rider Truck
- Fork Lift Truck

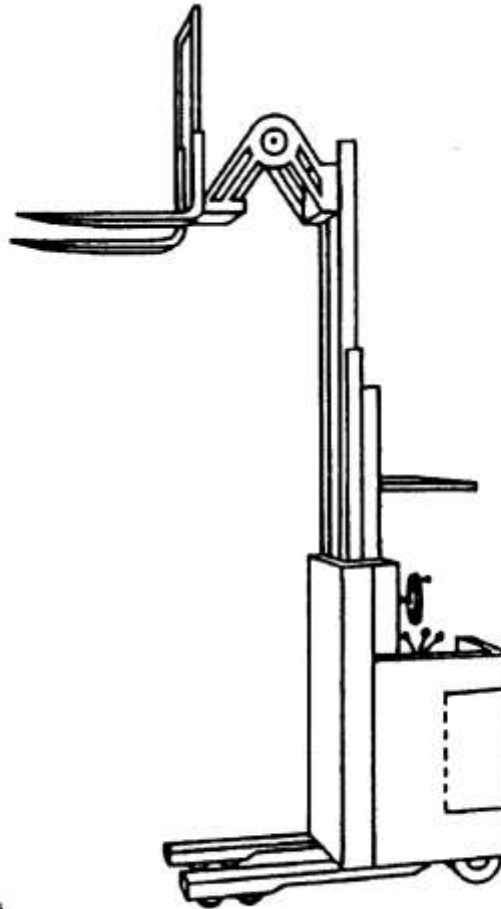


- High Lift Truck
- High Lift Platform Truck

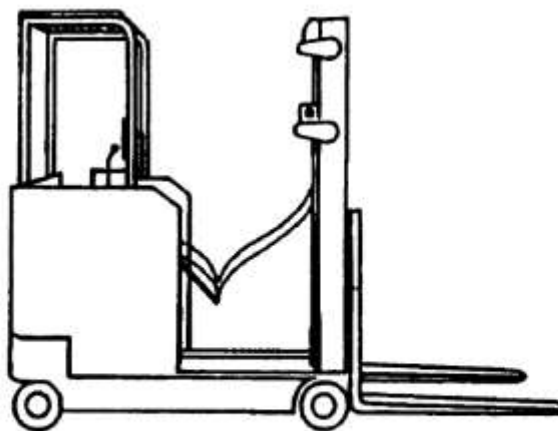


- Low Lift Truck
- Low Lift Platform Truck

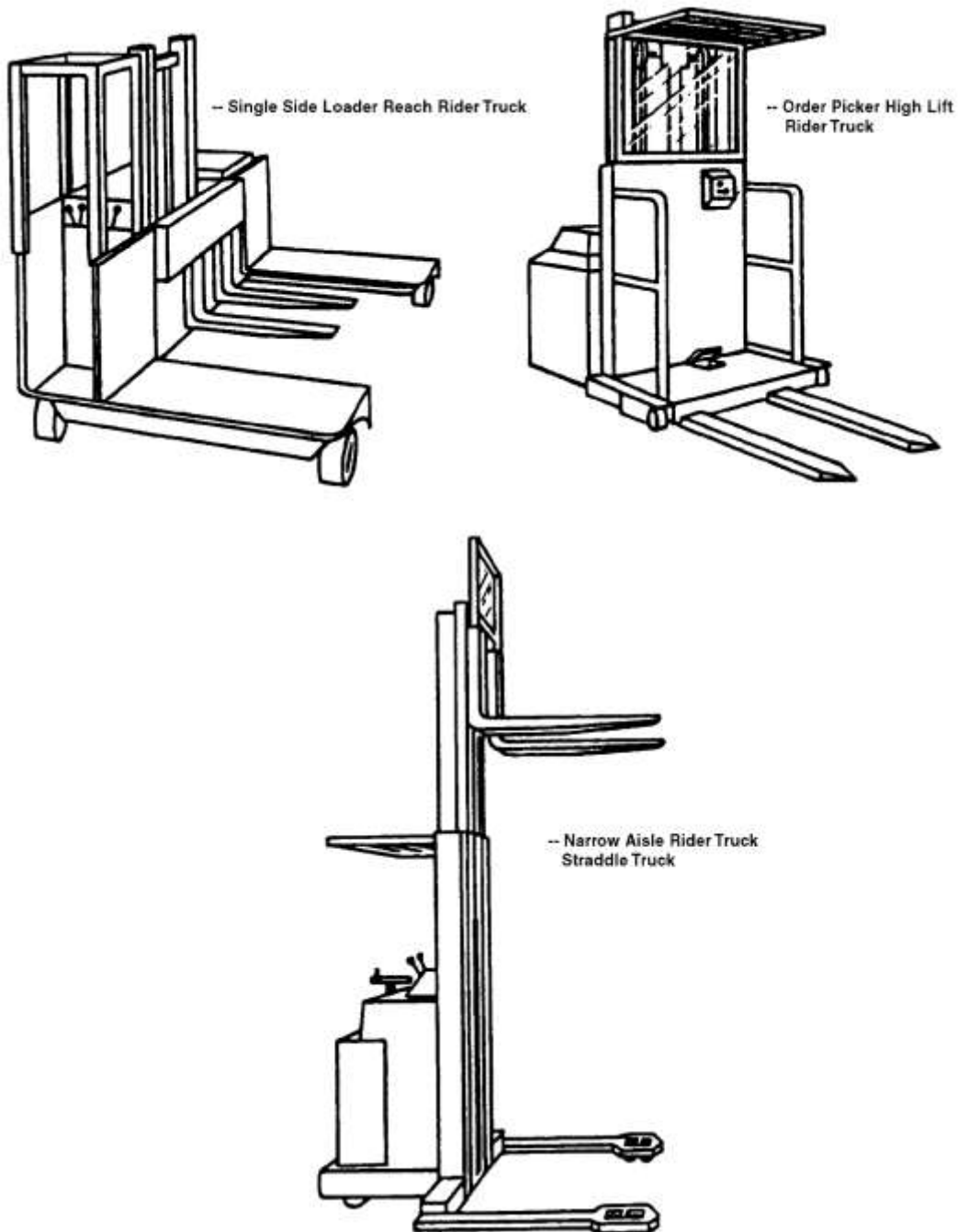
Types of Trucks. (sheet 4 of 6)



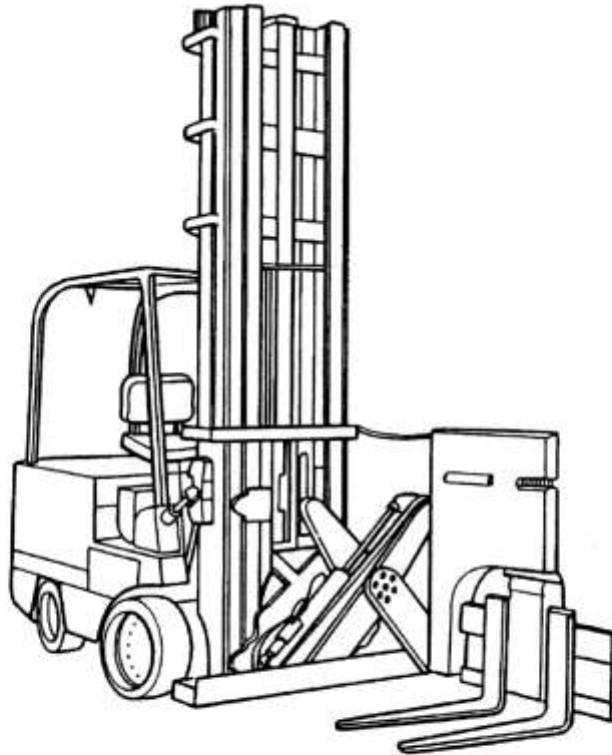
-- Reach Rider Trucks



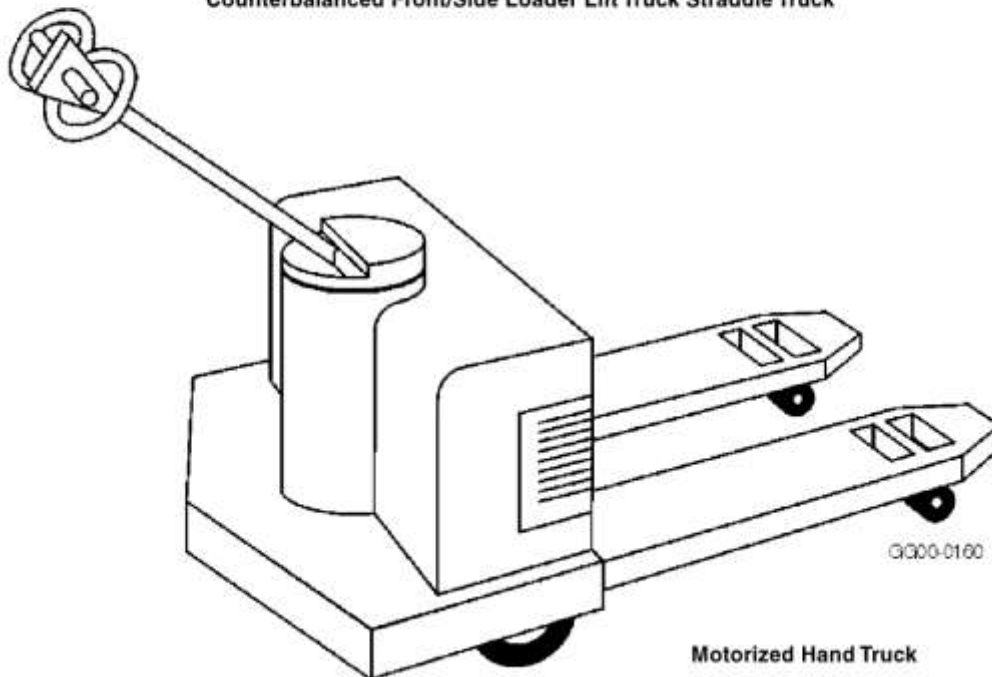
Types of Trucks. (sheet 5 of 6)



Types of Trucks (sheet 6 of 6)

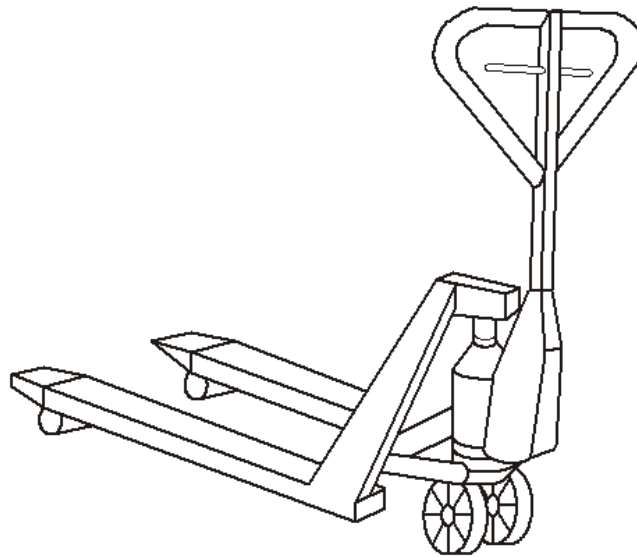


Counterbalanced Front/Side Loader Lift Truck Straddle Truck

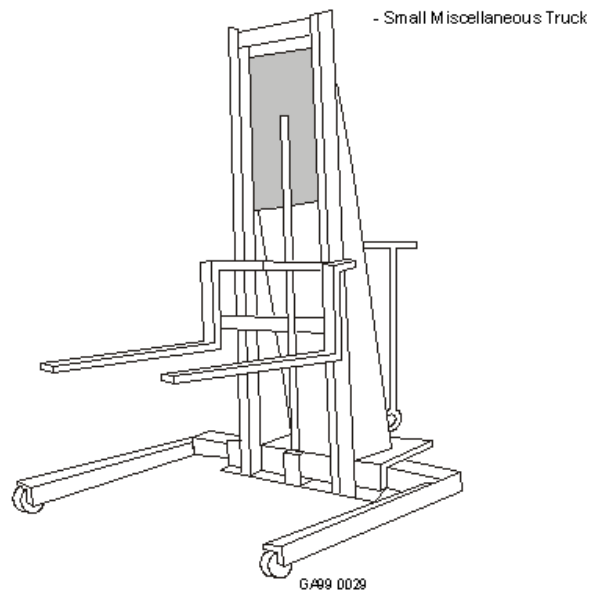


Motorized Hand Truck

Exhibit 10.2 Manually Operated Pallet Trucks



GA99 0028



GA99 0029

Exhibit 10.3 Typical Pre-use Inspection Procedures (Sample Form, Sheet 1 of 2)**OPERATORS PRE-SHIFT INSPECTION (ELECTRIC FORKLIFT)**

Date: _____ Vehicle No.: _____ Shift: _____

Type and Model _____ Hour Meter _____

OK	NA	VISUAL CHECKS	Maintenance Needed – Reported to:
		Leaks – Hydraulic Oil, Battery	
		Tires – Condition and pressure	
		Forks, Top Clip retaining pin and heel – Condition	
		Load Backrest Extension – solid attachment	
		Hydraulic hoses, Mast chains & Stops	
		Finger guards – attached	
		Safety warnings – attached and legible	
		Operators manual – Located on truck and legible	
		Capacity Plate – attached; information matches Model & Serial Nos. and attachments	
		Seat Belt – Buckle and retractor working smoothly	
OPERATONAL CHECKS – Unusual Noises Must be Reported Immediately			
		Accelerator Linkage	
		Parking Brake/Dead man	
		Steering	
		Drive Control – Forward and Reverse	
		Tilt Control – Forward and Back	
		Hoist & Lowering Control	
		Attachment Control	
		Horn	
		Lights	
		Back-Up Alarm	
		Hour Meter	
		Battery Discharge Gauge	

Inspected by: _____ Asset Owner: _____

Exhibit 10.3 Typical Pre-use Inspection Procedures (Sample Form, Sheet 2 of 2)**OPERATORS PRE-SHIFT INSPECTION (GAS, LP, or DIESEL FORKLIFT)**

Date: _____ Vehicle No.: _____ Shift: _____

Type and Model: _____ Hour Meter: _____

OK	NA	VISUAL CHECKS	Maintenance Needed – Reported to:
		Fluid Levels – Oil, Radiator, Hydraulic	
		Leaks – Hydraulic Oil, Battery, Fuel	
		Tires – Condition and pressure	
		Forks, Top Clip retaining pin and heel – Condition	
		Load Backrest Extension – solid attachment	
		Hydraulic hoses, Mast chains & Stops	
		Finger guards – attached	
		Safety warnings – attached and legible	
		Operators manual – Located on truck and legible	
		Capacity Plate – attached; information matches Model & Serial Nos. and attachments	
		Seat Belt – Buckle and retractor working smoothly	
OPERATONAL CHECKS – Unusual Noises Must be Reported Immediately			
		Accelerator Linkage	
		Parking Brake	
		Steering	
		Drive Control – Forward and Reverse	
		Tilt Control – Forward and Back	
		Hoist & Lowering Control	
		Attachment Control	
		Horn	
		Lights	
		Back-Up Alarm	
		Hour Meter	

Inspected by: _____ Asset Owner: _____

Exhibit 10.4 Forklift Load Test(Sample Form, Page 1 of 2)

INSPECTED BY: _____ EQUIPMENT NUMBER: _____

LOCATION: _____ DATE: _____

INSPECTION: Forklifts shall be inspected when assigned to service and at least every 12 months thereafter.

- Prior to initial use, all new, modified, or extensively repaired forklifts shall be inspected.
- Craftsmen shall initial all tests, work, and inspections completed below.
- Qualified inspector shall verify inspections have been complete prior to load test.

CRAFTSMAN
INITIAL

- | | |
|-------|--|
| _____ | 1. Ensure capacity, operation, and maintenance-instruction plates, tags, or decals are legible. |
| _____ | 2. Check all hydraulic systems including tilt cylinders, valves, and other similar parts to ensure “drift” has not developed. |
| _____ | 3. Check fuel system for leaks and condition of parts. Special consideration shall be given in the case of a leak in the fuel system. Immediate action shall be taken to take the forklift out of service until the leak is corrected. |
| _____ | 4. Check all parts of lift and tilt mechanisms and frame members to ensure safe operating conditions, such as, but not limited to, hoist chain for damage and excessive wear. |
| _____ | 5. Check for proper tire inflation (where applicable). Check that tires are secured properly and are level with each other. |
| _____ | 6. Check batteries, motors, controllers, limit switches, protective devices, electrical conductors and connections, with special attention paid to the condition of electrical insulation. |
| _____ | 7. Check brakes, steering mechanisms, warning devices, lights, governors, lift overload devices, guards, and safety devices. |

Qualified inspector shall use the criteria for Items 8, 9, and 10 to perform visual examination; or as required by the manufacturer, liquid penetrant examination, or magnetic particle examination.
Acceptance: No cracks, linear indications, laps, or seams.

- | | |
|-------|--|
| _____ | 8. Check for forks being secured properly and level with each other. |
| _____ | 9. Performs nondestructive test (NDT) on the right angle joint of the fork once every 12 months. |
| _____ | 10. Performs NDT on the load or stress-bearing welds that attach the tines to the forklift once every 12 months. |

Exhibit 10.4 Forklift Load Test (Sample Form, Page 2 of 2)**FORKLIFT LOAD TEST CON'T****LOAD TEST**

- NOTES:
1. Read all steps below prior to load test.
 2. Forklifts in which load-sustaining parts have been altered, replaced, or repaired shall be load tested prior to initial use.
 3. Load test all forklifts at 100% rated capacity.

QUALIFIED INSPECTOR: Shall verify all steps below.

EQUIPMENT NUMBER _____ EQUIPMENT OPERATOR _____

Qualified Inspector Verify (Load Test) _____ Date _____

Weight _____

1. Set forklift on solid, level ground.
2. Perform load test using the required weight (see Note 3).
3. Static Test: Forklift trucks shall demonstrate ability to withstand the appropriate test load for a period of at least 10 min without permanent deformation or apparent damage. Load slippage for this equipment shall not be greater than a maximum of 3 in. vertically and 1 in. horizontally at the cylinder.
4. Check system for leaks while undergoing test.

11.0 CHAPTER 11 WIRE ROPE AND SLINGS

This chapter provides requirements for the fabrication and use of wire rope and slings used in hoisting and rigging.

11.1 GENERAL

11.1.1 The information in this section provides guidance for safely handling lifted loads. Diagrams are used to illustrate hoisting and rigging principles and good and bad rigging practices. This is not a rigging textbook; the information should be applied only by qualified riggers.

11.1.2 Wire rope and slings that have been irreversibly damaged or removed from service shall be made useless for hoisting and rigging operations before being discarded.

11.1.3 Load tables are representative only and are not exact for all materials or all manufacturers.

11.4.4 Determine the weight of the load:

11.1.4.1 From markings on the load.

11.1.4.2 By weighing, if the load is still on a truck or railroad car.

11.1.4.3 From drawings or other documentation.

11.1.4.4 By calculation, using the load dimensions and the weights of common materials in Table 11-1.

11.1.5 Determine the center of gravity of the load as accurately as possible:

11.1.5.1 From drawings or other documentation.

11.5.1.2 From markings on the load.

11.5.1.3 By calculation.

11.1.6 Determine the best method to attach the load and select the appropriate lifting devices (e.g., wire-rope, steel-chain, metal-mesh, or synthetic-web slings).

11.1.7 Bending a wire rope over a fixed object such as a pin or a shackle has an effect on the capacity of the rope: The outside wires and strands of a bend have to stretch farther and therefore take a greater percentage of the load.

11.1.8 There is a convenient method for estimating the efficiency of the rope as it passes over the bend. This method uses the ratio (R) of the diameter (D) of the object (sheave, pin, corner) about which the wire rope is being bent to the diameter (d) of the rope. The efficiency of the bend can then be

Name of Metal	Weight lb/ft ³	Name of Material	Weight lb/ft ³
Aluminum	166	Bluestone	160
Antimony	418	Brick, pressed	50
Bismuth	613	Brick, common	125
Brass, cast	504	Cement, Portland (packed)	100-120
Brass, rolled	523	Cement, Portland (loose)	70-90
Copper, cast	550	Cement, slag (packed)	80-100
Copper, rolled	555	Cement, slag (loose)	55-75
Gold, 24-carat	1,204	Chalk	156
Iron, cast	450	Charcoal	15-34
Iron, wrought	480	Cinder concrete	110
Lead, commercial	712	Clay, ordinary	120-150
Mercury, 60°F	846	Coal, hard, solid	93.5
Silver	655	Coal, hard, broken	54
Steel	490	Coal, soft, solid	84
Tin, cast	458	Coal, soft, broken	54
Uranium	1,163	Coke, loose	23-32
Zinc	437	Concrete or stone	140-155
Name of Wood	Weight lb/ft ³	Earth, rammed	90-100
Ash	35	Granite	165-170
Beech	37	Gravel	117-125
Birch	40	Lime, quick (ground loose)	53
Cedar	22	Limestone	170
Cherry	30	Marble	164
Chestnut	26	Plaster of Paris (cast)	80
Cork	15	Sand	90-106
Cypress	27	Sandstone	151
Ebony	71	Shale	162
Elm	30	Slate	160-180
Fir, Balsam	22	Terra-cotta	110
Hemlock	31	Traprock	170
Maple, Oak	62	Water	65
Pine, Poplar	30		

Table 11-1. Weights of common materials

estimated using the formula shown in Figure 11-1. Note that the efficiency decreases quickly as the ratio of the diameters decreases.

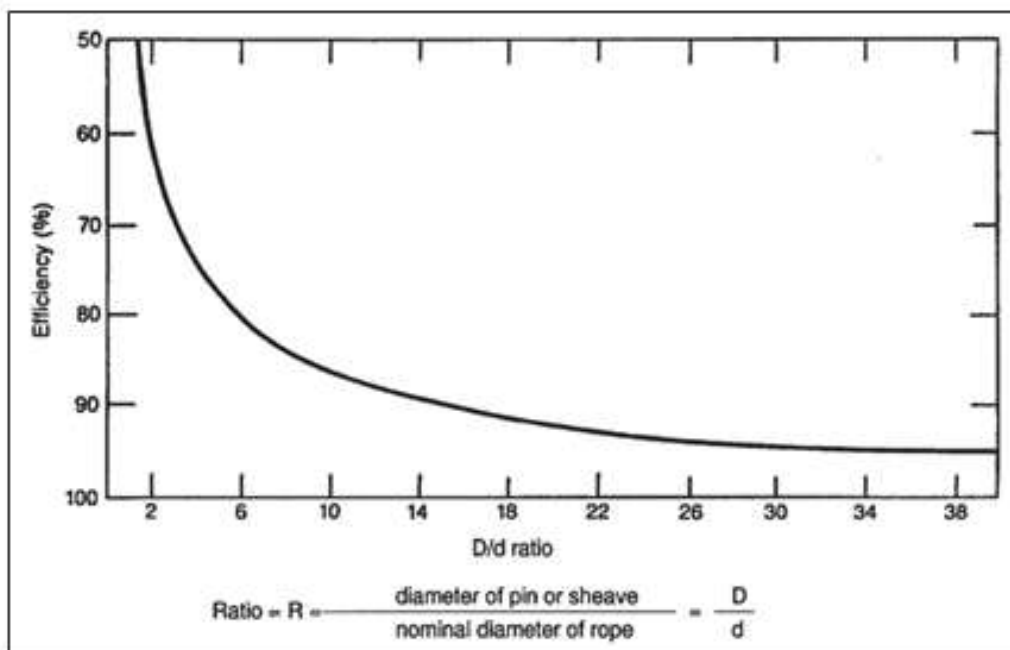


Figure 11-1. Efficiency of wire rope when bent and statically loaded to destruction over sheaves and pins of various diameters.

11.1.9 Aside from efficiency, there are other reasons to avoid sharp bends in wire rope, including physical damage to the rope, reduction of service life, and damage to the object about which the rope is bent.

11.1.10 When the ratio of the diameter of the bend to the nominal rope diameter (D/d ratio) is small, the strength efficiency factor is lower than when the D/d ratio is relatively large. Load tables do not take into account such factors as abnormal temperatures, excessive corrosion, and vibration.

11.1.11 Determine the appropriate ratings of the device to be used, allowing for:

11.1.11.1 **The number of sling legs** – Note that a sling leg completely doubled back on itself constitutes two sling legs.

11.1.11.2 **The angle between the horizontal surface of the load and the sling leg** – The smaller the angle, the smaller the lifting capacity of the equipment.

11.1.11.3 **Wear** – The reduction in strength of the equipment due to normal wear.

11.2 WIRE ROPE

11.2.1 Wire Rope Lays

11.2.1.1 In a right-lay rope, the strands twist to the right around the core like a conventional screw thread; in a left-lay rope, the strands twist to the left.

11.2.1.2 A rope has a lang lay when the strands and the individual wires have the same lay direction. When the strands and the wires have an opposite lay direction, the rope has a regular lay.

11.2.1.3 A standard wire rope, unless otherwise stated, is understood to be right regular lay. With few exceptions, all wire rope is made right lay. Left-lay rope is a special-purpose rope.

11.2.1.4 Figure 11-2 shows ropes with right and left lays combined with regular and lang lays.

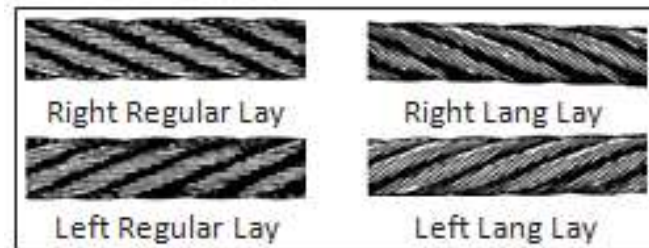


Figure 11-2. Wire-Rope Lays

11.2.1.5 Lay length is the lengthwise distance measured along a wire rope in which a strand makes one complete revolution about the rope's axis.

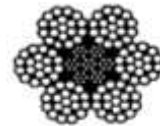
11.2.2 Wire Rope Cores

Wire rope consists of multistrand metal wires wrapped around a suitable core material. Wire-rope cores are carefully designed and must be precisely manufactured to close tolerances to ensure a perfect fit in the rope. The most common types of cores include the following:

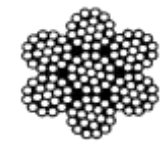
11.2.2.1 Fiber Core (FC) or Sisal Core – Sisalanna is the most common fiber that is used in the manufacture of wire-rope cores. In smaller ropes, cotton and jute are sometimes used for the core. (See illustration at right.)



11.2.2.2 Independent Wire-Rope Core (IWRC) – The primary function of the core is to provide adequate support for the strands. As the name implies, an IWRC is a separate small-diameter wire rope that is used as the core for a larger wire rope. When severe crushing or flattening of the rope is encountered, an IWRC is usually specified. (See illustration at right.)



11.2.2.3 Strand Core – This type of core has a single strand used as the core. This type is generally confined to the smaller ropes as a substitute for IWRC. The strand core may or may not have the same cross section as the surrounding strands. (See illustration at right.)



11.2.3 Wire Rope for General Purposes

11.2.3.1 - 6 x 9 Classification

Most applications can use a rope from this classification; it is the most versatile of all ropes made. There are four varieties of 6 x 19 wire ropes with FCs and IWRCs as shown below:

6 x 19F – The most popular and versatile of all wire ropes and the most flexible is the 6 x 19F classification. This rope is considered the perfect compromise between maximum abrasion resistance and maximum flexibility. (See illustration at right.)



6 x 16F – Slightly more abrasion resistant than the 6 x 19F, the 6 x 16F makes an excellent rope for small draglines and similar uses. The resistance to wear is gained by a slight sacrifice in flexibility. (See illustration at right.)



6 x 19 Seale – The 6 x 19 Seale is a rugged wire rope for applications involving heavy wear. Car pullers often use this rope, and it is widely used for slushers and drag scrapers. (See illustration at right.)



6 x 19 Warrington – The alternating large and small outer wires make this rope an all-around performer. The 6 x 19 Warrington is used for general-purpose hoisting, churn drills, and miscellaneous slings. (See illustration at right.)



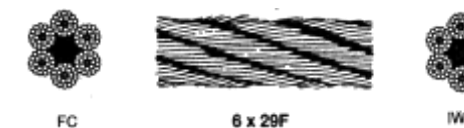
11.2.3.2 - 6 x 37 Classification

When sheaves and drums are fairly small and abrasive conditions are not severe, the ropes in this classification will show better performance than the coarser 6 x 19 construction. Under conditions of repeated bending, they will outlast a 6 x 19 rope; when abrasion is severe, the small outer wires quickly show the effect. There are three varieties of 6 x 37 wire rope with FC and IWRC cores. The principal types of ropes in this classification include the following:

6 x 37 2-operation – A 6 x 37 2-operation strand has 18 outer wires. This construction is used on industrial equipment, for flexible slings, and in miscellaneous hoisting (See illustration at right.)



6 x 29F – A 6 x 29F is used for applications requiring a flexible rope slightly more resistant to wear than the 6 x 37 2-operation rope. (See illustration at right.)



6 x 41 – A 6 x 41 rope is used widely for ropes over 1-in. diameter in the 6 x 37 classification. (See illustration at right.)



Table 11-2 provides breaking strengths for 6 x 19 and 6 x 37 wire ropes with FC and IWRC cores.

Table 11-2 Nominal strengths and weights for standard 6 x 19 and 6 x 37 classification ropes

SIZE	FIBER CORE			IWRC			
Diameter (in.)	Approx. wt./ft. (lbs.)	Nominal Strength (tons of 2000 lbs.) IPS XIP		Approx. wt./ft. (lbs.)	Nominal Strength (tons of 2000 lbs.) IPS XIP XXIP		
3/16	0.059	1.55	1.71	--	--	--	--
1/4	0.105	2.74	3.02	0.116	2.94	3.40	--
5/16	0.164	4.26	4.69	0.18	4.58	5.27	--
3/8	0.236	6.10	6.72	0.26	6.56	7.55	8.30
7/16	0.32	8.27	9.10	0.35	8.89	10.2	11.2
1/2	0.42	10.7	11.8	0.46	11.5	13.3	14.6
9/16	0.53	13.5	14.9	0.59	14.5	16.8	18.5
5/8	0.66	16.7	18.3	0.72	17.9	20.6	22.7
3/4	0.95	23.8	26.2	1.04	25.6	29.4	32.4
7/8	1.29	32.2	35.4	1.42	34.6	39.8	43.8
1	1.68	41.8	46.0	1.85	44.9	51.7	56.9
1 1/8	2.13	52.6	57.8	2.34	56.5	65.0	71.5
1 1/4	2.63	64.6	71.1	2.89	69.4	79.9	87.9
1 3/8	3.18	77.7	85.5	3.50	83.5	96.0	106
1 1/2	3.78	92.0	101	4.16	98.9	114	125
1 5/8	4.44	107	118	4.88	115	132	146
1 3/4	5.15	124	137	5.67	133	153	169
1 7/8	5.91	141	156	6.50	152	174	192
2	6.72	160	176	7.39	172	198	217
2 1/8	7.59	179	197	8.35	192	221	244

11.3 SLINGS

11.3.1 General

11.3.1.1 Overview

11.3.1.1.1 Slings shall have a minimum design factor appropriate to the type of material as specified in the appropriate section. Features that affect the rated capacity of the sling and that shall be considered in calculating the design factor are:

- Nominal breaking strength of material from which it is constructed.
- Splicing or end-attachment.
- Number of parts in the sling.
- Type of hitch (e.g., straight pull, choker hitch, or basket hitch).
- Angle of loading and load center of gravity.
- Diameter of curvature around which the sling is bent.

11.3.1.1.2 The center of gravity of an object is a point around which the entire weight may be concentrated. To make a level lift, the crane hook or point of suspension must be directly above this point. While slight variations are usually permissible, if the crane hook is too far to one side of the center of gravity, dangerous tilting will result and should be corrected at once. For this reason, when the center of gravity is closer to one point of the sling attachment than to the other, the slings must be of unequal length. Sling stresses and sling angles will also be unequal (see Figure 11-3).

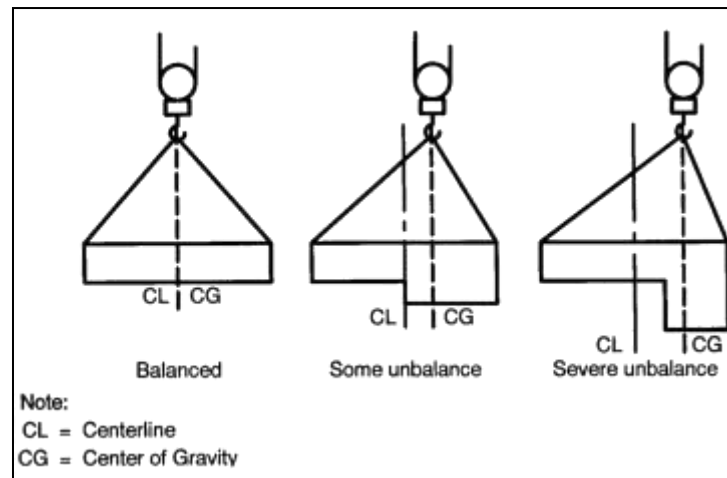


Figure 11.3. Balancing Loads

11.3.1.1.3 Rigging shall be configured such that slings do not reeve or slip through the hook. To attach the load, locate the center of gravity, position the crane hook directly above the center of gravity, and then rig the load so that it will lift level and true.

11.3.1.1.4 If a wire rope, nylon or chain sling is known to have been shock loaded; the component is to be removed from service and destroyed (rendered useless).

11.3.1.2 Load Angle Factor

11.3.1.2.1 Figure 11-4 provides an example of selecting a sling using the load angle factor.

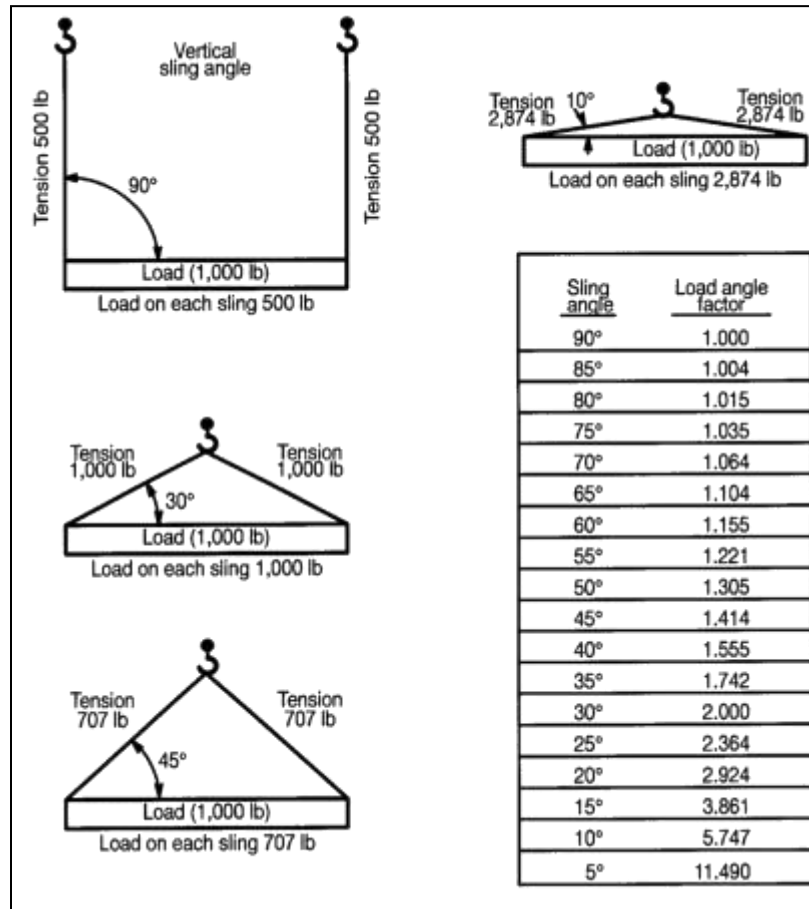


Figure 11-4. Relationship of load angle and lifting

What is the tension on each leg if: Load = 1,000 lbs.

Sling = 2-legged bridle (symmetrical)

Angle with horizontal = 45°

Step 1: Using the Load angle factor (LAF) from Fig. 11-4 we find the LAF for 45° = **1.414**

Step 2: Multiply the vertical load on one sling by the LAF. 500 lbs. X 1.414 = **707 lbs.** on each leg

Explanation: Each of the two legs would lift 500 lb if a vertical lift were made. However, there is a 45° sling angle involved. Therefore, the 500-lb load would be multiplied by the load-angle factor in the chart, giving a total of 707 lb (500 lb x 1.414) tension in each sling leg. Each sling leg, therefore, must have a rated capacity of at least 707 lb.

11.3.1.3 Safe Load

11.3.1.3.1 The rated capacity or working load limit (WLL) of a sling varies depending on the type of hitch. The rated capacity tables in this section show the applications for which the various safe loads apply when the slings are new. All ratings are in pounds (lbs).

11.3.1.3.2 Figures 11-5 and 11-6 provide information for determining the total rated capacity of 3-leg slings so as not to introduce a working load in direct tension in any leg greater than that permitted. Two legs should be considered to carry the load because in normal lifting practice, the load will not be uniformly distributed on all legs. If rigging techniques, verified by a qualified rigger, ensure that the load is evenly distributed then full use of three legs is allowed. Special rigging techniques verified by a member of a qualified engineering organization shall be required to prove that a load is evenly distributed over four or more sling legs.

When legs are not of equal length, use smallest H/L ratio.

NOTE: Load may be supported on only two legs while third leg balances it. Therefore, the required SWL is determined by the following:

Total Rated Capacity = WLL
(of single vertical hitch) x H/L x 2

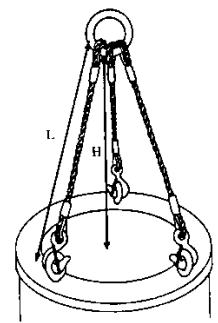


Figure 11-5. Determination of capacity – 3-leg bridle sling

When legs are not of equal length, use smallest H/L ratio.

NOTE: Load may be supported on only two legs while other two legs balance it. Therefore, the required SWL is determined by the following:

Total Rated Capacity = WLL
(of single vertical hitch) x H/L x 2

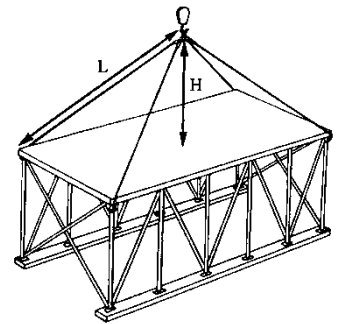


Figure 11-6. Determination of capacity – 4-leg bridle sling

11.3.1.4 Design Factor

In general, a design factor of 5:1 is maintained throughout this section. However, certain sling fittings, such as hooks (which will deform beyond usefulness before breaking) cannot be assigned a definite numerical design factor. In such cases, suitable safe loads are listed, based on wide experience and sound engineering practice.

11.3.1.5 Sling Care

Proper care and usage are essential for maximum service and safety. Wire-rope slings shall be protected from sharp bends and cutting edges by means of corner saddles, burlap padding, or wood blocking. Overloading shall be avoided, as shall sudden dynamic loading that can build up a momentary overload sufficient to break the sling.

11.3.1.6 Sling Storage

Personnel using slings shall ensure that they are stored properly as follows:

11.3.1.6.1 Slings should be stored in racks (preferably vertical) and in designated locations when not in use. Do not store slings in a location (such as a job box) where they will be subjected to mechanical damage, corrosive action, moisture, extreme heat, or kinking. Slings may require segregated storage as determined on a case-by-case basis.

11.3.1.6.2 Before storage and periodically during storage, wipe slings clean to remove as much dirt and abrasive grit as possible and relubricate wire rope and chain slings to extend their useful life. Chains should not be lubricated when in use.

11.3.1.6.3 Do not store metal-mesh slings in areas where the temperature exceeds 550° F (288° C) or 200° F (93° C) if elastomer covered.

11.3.1.6.4 Do not store synthetic-web slings where the temperature exceeds 200° F (93° C).

11.3.2 Wire Rope Slings

11.3.2.1 General

11.3.2.1.1 In general, wire-rope slings are made up of 6 x 19 or 6 x 37 classification wire rope. Rotation-resistant wire rope shall not be used for wire-rope slings. Different kinds of slings have been developed for specific purposes. These are divided into different groups or types as follows:

- Endless-loop slings (grommet construction) and single-part slings with single-rope legs, double-rope legs, or multiple-part rope legs.
- Two-leg bridle slings with single-rope legs, equalizing double-rope legs, or multiple-part rope legs.
- Three-leg bridle slings.
- Four-leg bridle slings.
- Special slings and combinations.

11.3.2.1.2 The total load that can be safely lifted with slings depends on the rating of the slings and the manner in which they are attached to the load. Consult (load) Tables 11-3 through 11-11 and Figure 11-7.





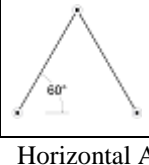
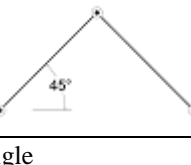
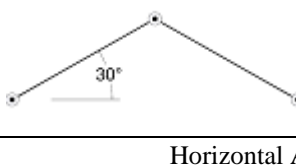

11.3.2.1.3 Braided slings are made by braiding ordinary wire ropes together, thus making them more flexible than wire-rope slings. The size of a braided sling is determined by the diameter of one wire rope and the number of ropes in the cross section of the slings.

11.3.2.1.4 The design factor for wire-rope slings shall be a minimum of 5:1 based upon breaking strength.

11.3.2.1.5 When a wire rope sling is used in a choker hitch, the normal angle formed in the rope body as it passes through the choking eye is 120° or greater [do not confuse the choke angle with the angle of inclination of the load (see Figure 11-7)]. Rated load in load capacity Tables 11-4 through 11-9 are for angles of 120° or greater. For smaller angles, reduce the rated load to the % given in Figure 11-7.

Table11-3. Rated Load for Single- and Two-Leg Slings 6×19 or 6×36 Classification.

Extra Improved Plow Steel (EIPS) Grade Fiber Core (FC) Wire Rope. Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

Hitch Type	Single-Leg							Two-Leg Bridle										Choker	
																			
								Horizontal Angle							Horizontal Angle				
	Vertical			Choker		Vertical Basket		Vertical			60°		45°		30°		60°		
Rope Diameter, in.	HT	MS	S	HT&MS	HT	MS	S	HT	MS	S	HT	MS	HT	MS	HT	MS	HT&MS	HT&MS	
¼	0.54	0.56	0.60	0.42	1.1	1.1	1.1	1.1	1.1	1.1	0.94	0.97	0.77	0.79	0.54	0.56	0.73	0.42	
5/16	0.83	0.87	0.94	0.66	1.7	1.7	1.7	1.7	1.7	1.7	1.4	1.5	1.2	1.2	0.83	0.87	1.1	0.66	
3/8	1.2	1.2	1.3	0.94	2.4	2.5	2.5	2.4	2.5	2.5	2.0	2.2	1.7	1.8	1.2	1.2	1.6	0.94	
7/16	1.6	1.7	1.8	1.3	3.2	3.4	3.4	3.2	3.4	3.4	2.7	2.9	2.2	2.4	1.6	1.7	2.2	1.3	
½	2.0	2.2	2.4	1.6	4.0	4.4	4.4	4.0	4.4	4.4	3.5	3.8	2.9	3.1	2.0	2.2	2.9	1.6	
9/16	2.5	2.7	3.0	2.1	5.0	5.5	5.5	5.0	5.5	5.5	4.4	4.8	3.6	3.9	2.5	2.7	3.6	2.1	
5/8	3.1	3.4	3.7	2.6	6.2	6.8	6.8	6.2	6.8	6.8	5.3	5.9	4.4	4.8	3.1	3.4	4.5	2.6	
¾	4.3	4.8	5.2	3.7	8.6	9.7	9.7	8.6	9.7	9.7	7.4	8.4	6.1	6.8	4.3	4.8	6.3	3.7	
7/8	5.7	6.6	7.1	5.0	11	13	13	11	13	13	9.8	11	8.0	9.3	5.7	6.6	8.6	5.0	
1	7.4	8.3	9.2	6.4	15	17	17	15	17	17	13	14	10	12	7.4	8.3	11	6.4	
1 1/8	9.3	10	12	8.1	19	21	21	19	21	21	16	18	13	15	9.3	10	14	8.1	
1 1/4	11	13	14	9.9	23	26	26	23	26	26	20	22	16	18	11	13	17	9.9	

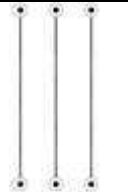


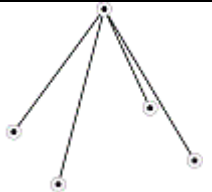
GENERAL NOTES:HT = hand-tucked splice. MS = mechanical splice. S = swaged or poured socket. Rated loads based on minimum D/d ratio of 25/1.

(e) Rated load based on pin diameter no larger than natural eye width or less than the nominal sling diameter.

(f) For choker hitch, the angle of choke is 120 deg or greater.

Table 11-4 Rated Load for Three- and Four-Leg Slings 6x19 or 6x36 Classification

Extra Improved Plow Steel (EIPS) Grade Fiber Core (FC) Wire Rope Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

Hitch Type	Three-Leg								Four-Leg							
																
	Horizontal Angle								Horizontal Angle							
	Vertical		60 deg		45 deg		30 deg		Vertical		60 deg		45 deg		30 deg	
Rope Diameter, in.	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS
¼	1.6	1.7	1.4	1.4	1.2	1.2	0.81	0.84	2.2	2.2	1.9	1.9	1.5	1.6	1.1	1.1
5/16	2.5	2.6	2.2	2.3	1.8	1.8	1.3	1.3	3.3	3.5	2.9	3.0	2.4	2.5	1.7	1.7
3/8	3.5	3.7	3.1	3.2	2.5	2.6	1.8	1.9	4.7	5.0	4.1	4.3	3.3	3.5	2.4	2.5
7/16	4.7	5.0	4.1	4.4	3.4	3.6	2.4	2.5	6.3	6.7	5.5	5.8	4.5	4.8	3.2	3.4
½	6.1	6.5	5.3	5.7	4.3	4.6	3.0	3.3	8.1	8.7	7.0	7.5	5.7	6.2	4.0	4.4
9/16	7.6	8.2	6.6	7.1	5.4	5.8	3.8	4.1	10	11	8.7	9.5	7.1	7.8	5.0	5.5
5/8	9.8	10	8.0	8.8	6.5	7.2	4.6	5.1	12	14	11	12	8.7	9.6	6.2	6.8
¾	13	15	11	13	9.1	10	6.4	7.3	17	19	15	17	12	14	8.5	9.7
7/8	17	20	15	17	12	14	8.5	9.8	23	26	20	23	16	19	11	13
1	22	25	19	22	16	18	11	12	29	33	25	29	21	23	15	17
1 ⅛	28	31	24	27	20	22	14	16	37	42	32	36	26	29	19	21
1 ¼	34	38	30	33	24	27	17	19	45	51	39	44	32	36	23	26

GENERAL NOTES:

HT = hand-tucked splice.







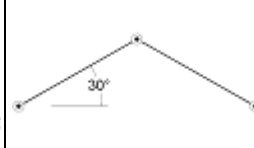

MS = mechanical splice.

Rated loads based on minimum D/d ratio of 25/1.

Rated load based on pin diameter no larger than natural eye width or less than the nominal sling diameter.

Table 11-5 - Rated Load for Single-and Two-Leg Slings 6×19 or 6×36 Classification.

Extra Improved Plow Steel (EIPS) Grade Independent Wire Rope Core (IWRC) Wire Rope. Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

Hitch Type	Single-Leg									Two-Leg Bridle or Basket								Choker				
																						
	Vertical			Choker			Vertical Basket			Horizontal Angle								Horizontal Angle				
										Vertical			60°		45°		30°		60°		30°	
Rope Diameter, in.	HT	MS	S	HT	MS	HT	MS	S	HT	MS	S	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	
¼	0.54	0.65	0.68	0.42	0.48	1.1	1.3	1.3	1.1	1.3	1.3	0.94	1.1	0.77	0.91	0.54	0.65	0.73	0.82	0.42	0.48	
5⁄16	0.83	1.0	1.1	0.66	0.74	1.7	2.0	1.9	1.7	2.0	1.9	1.4	1.7	1.2	1.4	0.83	1.0	1.1	1.3	0.66	0.74	
3⁄8	1.2	1.4	1.5	0.94	1.1	2.4	2.9	2.8	2.4	2.9	2.8	2.0	2.5	1.7	2.0	1.2	1.4	1.6	1.8	0.94	1.1	
7⁄16	1.6	1.9	2.0	1.3	1.4	3.2	3.9	3.8	3.2	3.9	3.8	2.7	3.4	2.2	2.7	1.6	1.9	2.2	2.5	1.3	1.4	
½	2.0	2.5	2.7	1.6	1.9	4.0	5.1	4.9	4.0	5.1	4.98	3.5	4.4	2.9	3.6	2.0	2.5	2.9	3.2	1.6	1.9	
9⁄16	2.5	3.2	3.4	2.1	2.4	5.0	6.4	6.2	5.0	6.4	6.2	4.4	5.5	3.6	4.5	2.5	3.2	3.6	4.1	2.1	2.4	
5⁄8	3.1	3.9	4.1	2.6	2.9	6.2	7.8	7.6	6.2	7.8	7.6	5.3	6.8	4.4	5.5	3.1	3.9	4.5	5.0	2.6	2.9	
¾	4.3	5.6	5.9	3.7	4.1	8.6	11	11	8.6	11	11	7.4	9.7	6.1	7.9	4.3	5.6	6.3	7.1	3.7	4.1	
7⁄8	5.7	7.6	8.0	5.0	5.6	11	15	15	11	15	15	9.8	13	8.0	11	5.7	7.6	8.6	9.7	5.0	5.6	
1	7.4	9.8	10	6.4	7.2	15	20	19	15	20	19	13	17	10	14	7.4	9.8	11	13	6.4	7.2	
1 1⁄8	9.3	12	13	8.1	9.1	19	24	24	19	24	24	16	21	13	17	9.3	12	14	16	8.1	9.1	
1 1⁄4	11	15	16	9.9	11	23	30	30	23	30	30	20	26	16	21	11	15	17	19	9.9	11	
1 3⁄8	14	18	19	12	13	27	36	36	27	36	36	24	31	19	25	14	18	21	23	12	13	
1 ½	16	21	23	14	16	32	42	42	32	42	42	28	37	23	30	16	21	25	28	14	16	
1 5⁄8	19	24	26	16	18	38	49	49	38	49	49	33	42	27	35	19	24	29	32	16	18	
1 ¾	22	28	31	19	21	44	57	57	44	57	57	38	49	31	40	22	28	33	37	19	21	
1 7⁄8	25	32	35	22	24	50	64	64	50	64	64	43	56	35	46	25	32	38	42	22	24	
2	28	37	40	25	28	56	73	73	56	73	73	49	63	40	52	28	37	43	48	25	28	

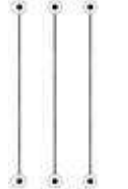



GENERAL NOTES: HT = hand-tucked splice; MS = mechanical splice; S = swaged or poured socket.

Rated loads based on minimum D/d ratio of 25/1.

- (e) Rated load based on pin diameter no larger than natural eye width or less than the nominal sling diameter.
- (f) For choker hitch, the angle of choke is 120 deg or greater.






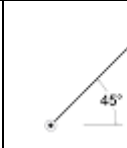
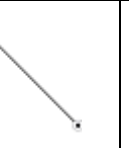

Table 11-6 Rated Load for Three- and Four-Leg Slings 6×19 or 6×36 Classification

Extra Improved Plow Steel (EIPS) Grade Independent Wire Rope Core (IWRC) Wire Rope. Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

	Three-Leg								Four-Leg							
																
	Horizontal Angle								Horizontal Angle							
	Vertical		60 deg		45 deg		30 deg		Vertical		60 deg		45 deg		30 deg	
Rope Diameter, in.	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS
¼	1.6	1.9	1.4	1.7	1.2	1.4	0.81	0.97	2.2	2.6	1.9	2.2	1.5	1.8	1.1	1.3
5/16	2.5	3.0	2.2	2.6	1.8	2.1	1.3	1.5	3.3	4.0	2.9	3.5	2.4	2.8	1.7	2.0
3/8	3.5	4.3	3.1	3.7	2.5	3.0	1.8	2.2	4.7	5.7	4.1	5.0	3.3	4.1	2.4	2.9
7/16	4.7	5.8	4.1	5.0	3.4	4.1	2.4	2.9	6.3	7.8	5.5	6.7	4.5	5.5	3.2	3.9
½	6.1	7.6	5.3	6.6	4.3	5.4	3.0	3.8	8.1	10	7.0	8.8	5.7	7.1	4.0	5.1
9/16	7.6	9.6	6.6	8.3	5.4	6.8	3.8	4.8	10	13	8.7	11	7.1	9.0	5.0	6.4
5/8	9.3	12	8.0	10	6.5	8.3	4.6	5.9	12	16	11	14	8.7	11	6.2	7.8
¾	13	17	11	15	9.1	12	6.4	8.4	17	22	15	19	12	16	8.6	11
7/8	17	23	15	20	12	16	8.5	11	23	30	20	26	16	21	11	15
1	22	29	19	26	16	21	11	15	29	39	25	34	21	28	15	20
1 1/8	28	36	24	31	20	26	14	18	37	48	32	42	26	34	19	24
1 ¼	34	44	30	38	24	31	17	22	45	59	39	51	32	42	23	30
1 3/8	41	53	36	46	29	38	21	27	55	71	47	62	39	50	27	36
1 ½	49	63	42	55	34	45	24	32	65	84	56	73	46	60	32	42
1 5/8	56	73	49	63	40	52	28	37	75	98	65	85	53	69	38	49
1 ¾	65	85	57	74	46	60	33	42	87	113	76	98	62	80	44	57
1 7/8	74	97	64	84	53	68	37	48	99	129	86	112	70	91	50	64
2	84	110	73	95	60	78	42	55	113	147	98	127	80	104	56	73

GENERAL NOTES: HT = hand-ticked splice; MS = mechanical splice. Rated loads based on minimum D/d ratio of 25/1. Rated load based on pin diameter no larger than natural eye width or less than the nominal sling diameter.

Table 11-7 Rated Load for Single- and Two-Leg Slings 6×19 or 6×36 Classification. Extra Extra Improved Plow Steel (EEIPS) Grade Independent Wire Rope Core (IWRC) Wire Rope. Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

Hitch Type	Single-Leg									Two-Leg Bridle								Choker			
																					
	Vertical			Choker		Vertical Basket		Vertical		60°		45°		30°		60°		30°			
Rope Dia- meter, in.	HT	MS	S	HT	MS	HT	MS	S	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	
¼	0.60	0.71	0.74	0.46	0.52	1.2	1.4	1.4	1.2	1.4	1.0	1.2	0.84	1.0	0.60	0.71	0.80	0.90	0.46	0.52	
5⁄16	0.92	1.1	1.2	0.72	0.81	1.8	2.2	2.1	1.8	2.2	1.6	1.9	1.3	1.6	0.92	1.1	1.2	1.4	0.72	0.81	
3⁄8	1.3	1.6	1.7	1.0	1.2	2.6	3.2	3.1	2.6	3.2	2.3	2.7	1.8	2.2	1.3	1.6	1.8	2.0	1.0	1.2	
7⁄16	1.7	2.1	2.2	1.4	1.6	3.5	4.3	4.1	3.5	4.3	3.0	3.7	2.5	3.0	1.7	2.1	2.4	2.7	1.4	1.6	
½	2.2	2.8	2.9	1.8	2.0	4.5	5.5	5.4	4.5	5.5	3.9	4.8	3.1	3.9	2.2	2.8	3.1	3.5	1.8	2.0	
9⁄16	2.8	3.5	3.7	2.3	2.6	5.6	7.0	6.8	5.6	7.0	4.8	6.1	3.9	5.0	2.8	3.5	4.0	4.5	2.3	2.6	
5⁄8	3.4	4.3	4.5	2.8	3.2	6.8	8.6	8.4	6.8	8.6	5.9	7.5	4.8	6.1	3.4	4.3	4.9	5.5	2.8	3.2	
¾	4.7	6.2	6.5	4.0	4.5	9.4	12	12	9.4	12	8.2	11	6.7	8.7	4.7	6.2	7.0	7.9	4.0	4.5	
7⁄8	6.2	8.3	8.8	5.5	6.1	12	17	16	12	17	11	14	8.8	12	6.2	8.3	9.4	11	5.5	6.1	
1	8.1	11	11	7.1	8.0	16	22	21	16	22	14	19	11	15	8.1	11	12	14	7.1	8.0	
1 1⁄8	10	...	14	8.9	...	20	...	26	26	...	18	...	14	...	10	...	15	...	8.9	...	
1 ¼	13	...	18	11	...	25	...	33	25	...	22	...	18	...	13	...	19	...	11	...	
1 3⁄8	15	...	21	13	...	30	...	39	30	...	26	...	21	...	15	...	23	...	13	...	
1 ½	18	...	25	16	...	36	...	46	36	...	31	...	25	...	18	...	27	...	16	...	
1 5⁄8	21	...	29	18	...	41	...	54	41	...	36	...	29	...	21	...	31	...	18	...	
1 ¾	24	...	34	21	...	48	...	63	48	...	42	...	34	...	24	...	36	...	21	...	
1 7⁄8	27	...	38	24	...	55	...	71	55	...	47	...	39	...	27	...	41	...	24	...	
2	31	...	43	27	...	62	...	80	62	...	54	...	44	...	31	...	47	...	27	...	





GENERAL NOTES: HT = hand-tucked splice; MS = mechanical splice; S = swaged or poured socket.

Rated loads based on minimum D/d ratio of 25/1.

(e) Rated load based on pin diameter no larger than natural eye width or less than the nominal sling diameter.

(f) For choker hitch, the angle of choke is 120 deg or greater.

Table 11-8 Rated Load for Three- and Four-Leg Slings 6×19 or 6×36 Classification. Extra Extra Improved Plow Steel (EEIPS) Grade Independent Wire Rope Core (IWRC) Wire Rope. Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)







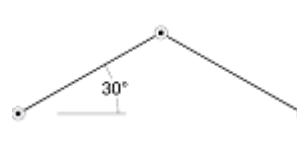

Rope Diameter, in.	Three-Leg							Four-Leg								
																
	Horizontal Angle							Horizontal Angle								
	Vertical		60 deg		45 deg		30 deg	Vertical		60 deg		45 deg	30 deg			
	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS
¼	1.8	2.1	1.6	1.8	1.3	1.5	0.90	1.1	2.4	2.8	2.1	2.4	1.7	2.0	1.2	1.4
5⁄16	2.8	3.3	2.4	2.9	1.9	2.3	1.4	1.7	3.7	4.4	3.2	3.8	2.6	3.1	1.8	2.2
3⁄8	3.9	4.7	3.4	4.1	2.8	3.3	1.9	2.4	5.2	6.3	4.5	5.5	3.7	4.5	2.6	3.2
7⁄16	5.2	6.4	4.5	5.5	3.7	4.5	2.6	3.2	7.0	8.5	6.0	7.4	4.9	6.0	3.5	4.3
½	6.7	8.3	5.8	7.2	4.7	5.9	3.3	4.2	8.9	11	7.7	9.6	6.3	7.8	4.5	5.5
9⁄16	8.3	11	7.2	9.1	5.9	7.5	4.2	5.3	11	14	9.6	12	7.9	9.9	5.6	7.0
5⁄8	10	13	8.8	11	7.2	9.1	5.1	6.5	14	17	12	15	9.6	12	6.8	8.6
¾	14	18	12	16	10	13	7.1	9.2	19	25	16	21	13	17	9.4	12
7⁄8	19	25	16	22	13	18	9.4	12	25	33	22	29	18	24	12	17
1	24	32	21	28	17	23	12	16	32	43	28	37	23	31	16	22
1 1⁄8	31	...	26	...	22	...	15	...	41	...	35	...	29	...	20	...
1 ¼	38	...	32	...	27	...	19	...	50	...	43	...	35	...	25	...
1 3⁄8	45	...	39	...	32	...	23	...	60	...	52	...	43	...	30	...
1 ½	53	...	46	...	38	...	27	...	71	...	62	...	50	...	36	...
1 5⁄8	62	...	54	...	44	...	31	...	83	...	72	...	59	...	41	...
1 ¾	72	...	62	...	51	...	36	...	96	...	83	...	68	...	48	...
1 7⁄8	82	...	71	...	58	...	41	...	109	...	95	...	77	...	55	...
2	93	...	80	...	66	...	46	...	124	...	107	...	88	...	62	...

GENERAL NOTES:

HT = hand-tucked splice. MS = mechanical splice. Rated loads based on minimum D/d ratio of 25/1.





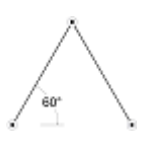

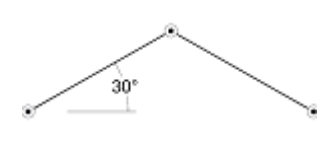

Rated load based on pin diameter no larger than natural eye width or less than the nominal sling diameter.

Table 11-9 Rated Load for Cable-Laid Wire Rope Single- and Two-Leg Slings. Mechanical Splice Only. Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

Rope Diameter, in.	Single-Leg			Two-Leg Bridle				Two-Leg Choker	
									
	Hitch Type			Horizontal Angle				Horizontal Angle-	
	Vertical	Choker	Vertical Basket	Vertical	60°	45°	30°	60°	30°
7X7X7 Construction									
¼	0.50	0.35	1.0	1.0	0.87	0.71	0.50	0.61	0.35
3/8	1.1	0.8	2.2	2.2	1.9	1.5	1.1	1.3	0.76
½	1.9	1.3	3.7	3.7	3.2	2.6	1.9	2.2	1.3
5/8	2.8	1.9	5.5	5.5	4.8	3.9	2.8	3.4	1.9
¾	3.8	2.7	7.6	7.6	6.6	5.4	3.8	4.6	2.7
7/8	5.0	3.5	10	10	8.7	7.1	5.0	6.1	3.5
1	6.4	4.5	13	13	11	9.1	6.4	7.8	4.5
7X7X19 Construction									
½	1.9	1.3	3.8	3.8	3.3	2.7	1.9	2.3	1.3
5/8	2.9	2.0	5.8	5.8	5.0	4.1	2.9	3.5	2.0
¾	4.1	2.8	8.1	8.1	7.0	5.8	4.1	4.9	2.8
7/8	5.4	3.8	11	11	9.3	7.6	5.4	6.5	3.8
1	6.0	4.8	14	14	12	9.7	6.9	8.3	4.8
1 1/8	8.3	5.8	17	17	14	12	8.3	10	5.8
1 ¼	9.9	6.9	20	20	17	14	9.9	12	6.9
7X6X19 or 7X6X36 IWRC Classification									
¾	3.8	2.7	7.6	7.6	6.6	5.4	3.8	4.6	2.7
7/8	5.0	3.5	10	10	8.7	7.1	5.0	6.1	3.5
1	6.4	4.5	13	13	11	9.1	6.4	7.8	4.5
1 1/8	7.7	5.4	15	15	13	11	7.7	9.3	5.4
1 ¼	9.3	6.5	19	19	16	13	9.3	11	6.5
1 3/8	11	7.6	22	22	19	15	11	13	7.6
1 ½	13	9.0	26	26	22	18	13	16	9.0
1 5/8	15	10	30	30	26	21	15	18	10

GENERAL NOTES: (a) 7X7X7 = galvanized specialty cable. (b) 7X7X19 = galvanized specialty cable. (c) Rated loads based on minimum D/d ratio, of 10/1. (d) Rated loads based on pin diameter no larger than natural eye width or less than the nominal sling diameter. (e) For choker hitch, the angle of choke is 120 deg or greater.





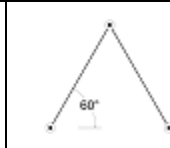
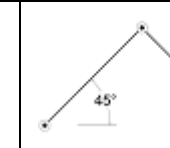
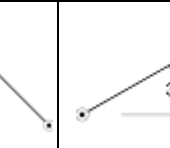
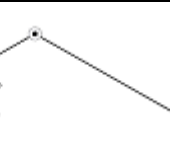

Table 11-10 Rated Load for Six-Part Braided Single- and Two-leg Slings 6x19 or 6x36. Classification Extra Improved Plow Steel (EIPS) Independent Wire Rope Core (IWRC) Wire Rope. Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

	Single-Leg			Two-Leg Bridle				Two-Leg Choker	
									
	Hitch Type			Horizontal Angle				Horizontal Angle	
	Vertical	Choker	Vertical Basket	Vertical	60°	45°	30°	60°	30°
Rope Diameter, in.	HT&MS	HT&MS	HT&MS	HT&MS	HT&MS	HT&MS	HT&MS	HT&MS	HT&MS
3/16	1.6	1.4	3.2	3.2	2.8	2.3	1.6	2.4	1.4
¼	2.9	2.5	5.7	5.7	4.9	4.0	2.9	4.3	2.5
5/16	4.4	3.9	8.9	8.9	7.7	6.3	4.4	6.7	3.9
3/8	6.3	5.5	13	13	11	9.0	6.3	9.6	5.5
7/16	8.6	7.5	17	17	15	12	8.6	13	7.5
½	11	9.8	22	22	19	16	11	17	9.8
9/16	14	12	28	28	24	20	14	21	12
5/8	17	15	35	35	30	24	17	26	15
¾	25	22	49	49	43	35	25	37	22
7/8	33	29	67	67	58	47	33	51	29
1	43	38	87	87	75	61	43	66	38
1 1/8	55	48	109	109	95	77	55	83	48
1 ¼	67	59	134	134	116	95	67	102	59
1 3/8	87	71	161	161	140	114	81	122	71
1 ½	96	84	192	192	166	135	96	145	84
1 5/8	111	97	222	222	192	157	111	168	97
1 ¾	129	112	257	257	223	182	129	195	112
1 7/8	146	128	292	292	253	207	146	222	128
2	166	146	333	333	288	235	166	252	146

GENERAL NOTES:

- (a) HT = hand-tucked splice.
- (b) MT = mechanical splice.
- (c) Rated loads based on minimum D/d ratio of 25 times the component rope diameter.
- (d) Rated loads based on pin diameter no larger than natural eye width or less than the nominal sling diameter.
- (e) For choker hitch, the angle of choke is 120 deg or greater.

Table 11-11 Rated Load for Eight-Part Braided Single- and Two-leg Slings 6x19 or 6x36. Classification Extra Improved Plow Steel (EIPS) Independent Wire Rope Core (IWRC) Wire Rope. Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

	Single-Leg			Two-Leg Bridle				Two-Leg Choker	
									
	Hitch Type			Horizontal Angle				Horizontal Angle	
	Vertical	Choker	Vertical Basket	Vertical	60°	45°	30°	60°	30°
Rope Diameter, in.	HT&MS	HT&MS	HT&MS	HT&MS	HT&MS	HT&MS	HT&MS	HT&MS	HT&MS
3/16	2.2	1.9	4.3	4.3	3.7	3.0	2.2	3.3	1.9
¼	3.8	3.3	7.6	7.6	6.6	5.4	3.8	5.8	3.3
5/16	5.9	5.2	12	12	10	8.3	5.9	8.9	5.2
3/8	8.5	7.4	17	17	15	12	8.5	13	7.4
7/16	11	10	23	23	20	16	11	17	10
½	15	13	30	30	26	21	15	23	13
9/16	19	16	38	38	33	27	19	29	16
5/8	23	20	46	46	40	33	23	35	20
¾	33	29	66	66	57	47	33	50	29
7/8	45	39	89	89	77	63	45	68	39
1	58	51	116	116	100	82	58	88	51
1 1/8	73	64	146	146	126	103	73	110	64
1 ¼	89	78	179	179	155	127	89	136	78
1 3/8	108	94	215	215	186	152	108	163	94
1 ½	128	112	255	255	221	181	128	194	112
1 5/8	148	129	296	296	256	209	148	224	129
1 ¾	171	150	343	343	297	242	171	260	150
1 7/8	195	171	390	390	338	276	195	295	171
2	222	194	444	444	384	314	222	336	194

GENERAL NOTES:

- (a) HT = hand-tucked splice.
- (b) MT = mechanical splice.
- (c) Rated loads based on minimum D/d ratio of 25 times the component rope diameter.
- (d) Rated loads based on pin diameter no larger than natural eye width or less than the nominal sling diameter.
- (e) For choker hitch, the angle of choke is 120 deg or greater.

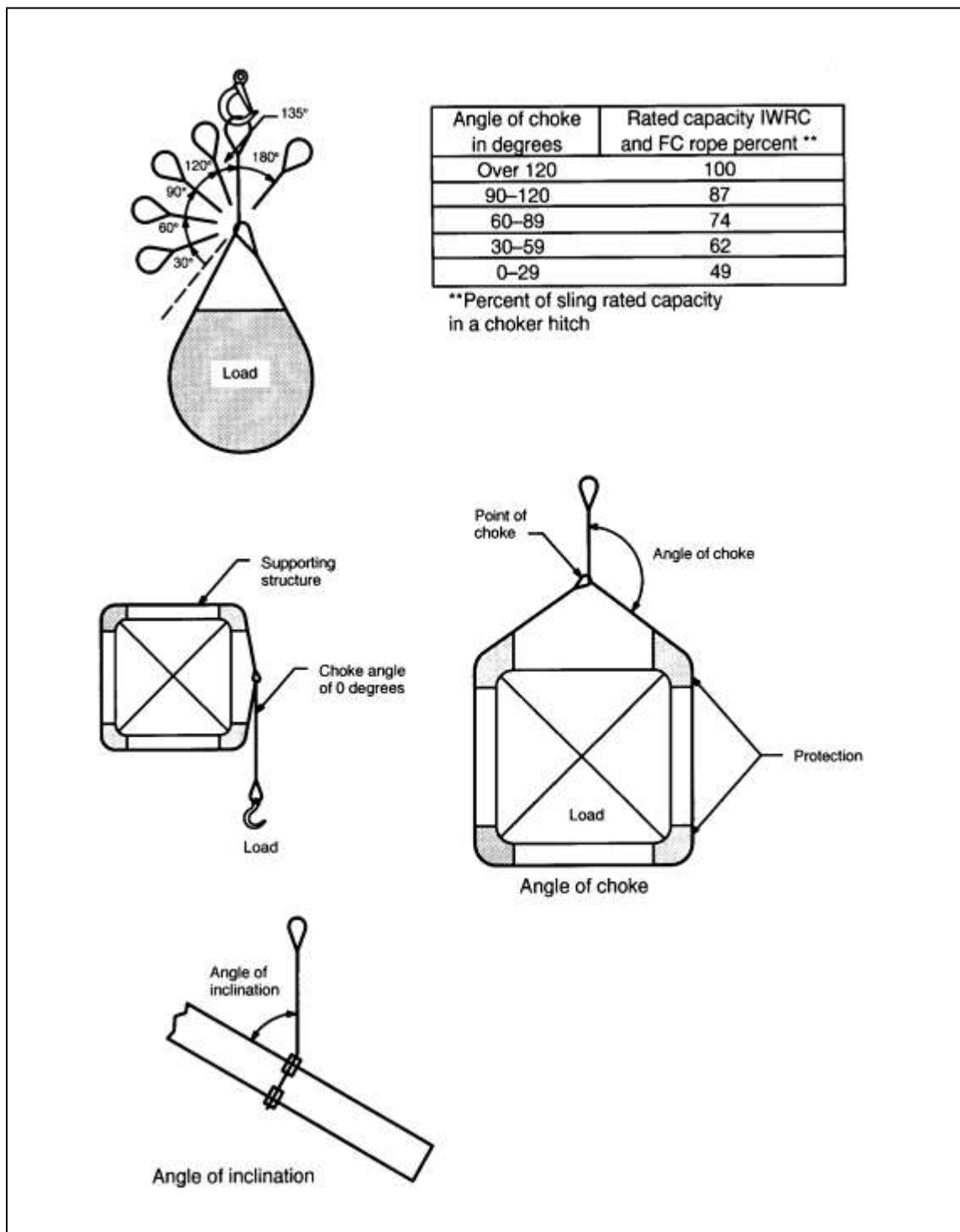


Figure 11-7. Choker hitch rated capacity adjustment.

11.3.2.2. Inspections

11.3.2.2.1 Wire-rope sling users shall visually inspect all slings each day they are used or prior to use if the sling has not been in regular service (records are not required). In addition, a periodic inspection (with records) shall be made at least annually by a qualified inspector. More frequent intervals should be established if necessary as determined by a qualified person based on:

- Frequency of sling use.
- Severity of service conditions.
- Nature of lifts being made.
- Experience gained on the service life of slings used in similar circumstances.

11.3.2.2.2 Users shall carefully note any deterioration that could result in an appreciable loss of original strength and determine whether further use of the sling would constitute a safety hazard.

11.3.2.2.3 A sample annual inspection form is included as Exhibit 11.1 at the end of this section. This form is intended to be a sample only and is not intended to be mandatory.

11.3.2.2.4 Annual and initial inspections shall be documented by entering inspection data into a computer generated data base and color coding the sling.

11.3.2.2.5 Slings shall be immediately removed from service if any of the following conditions are present:

- Ten randomly distributed broken wires in one rope lay or five broken wires in one strand in one rope lay.
- Wear or scraping of one-third the original diameter of the outside individual wire.
- Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.
- Evidence of heat damage.
- End attachments that are cracked, deformed, or worn.
- Corrosion of the rope or end attachments.
- Missing or illegible sling identification.

Note: Use only slings with permanently affixed identification markings that show the maximum load capacity for each sling.

11.3.2.2.6 Hooks shall be inspected according to Chapter 12, “Rigging Accessories.”

11.3.2.3 Proof-Testing

11.3.2.3.1 All swaged socket and poured socket sling assemblies shall be proof-tested to the wire rope or fitting manufacturer’s recommendations but in no case greater than 50% of the component wire ropes’ or structural strands’ nominal strength. All other sling assemblies shall be proof-tested when specified by the purchaser.

11.3.2.3.2 As a minimum, the proof load shall be equal to the rated capacity but shall not exceed:

- 125% of the vertical rated capacity for single-let, hand-tucked slings.
- 200% of the vertical rated capacity for mechanical-splice single-leg slings and endless slings.

11.3.2.3.3 The proof-load for multiple-leg bridle slings assemblies shall be applied to the individual leg and shall be in accordance with paragraph 11.3.2.3.4 and 11.3.2.3.5 as applicable.

11.3.2.3.4 Master links to which multiple-leg slings are connected shall be proof-loaded to 200% times the force applied by the combined legs.

11.3.2.3.5 Welded end attachments shall not be used unless proof-tested at 2 times rated capacity prior to initial use.

11.3.2.3.6 Test loads described above shall be accurate to within –5%, +0% of stipulated values. A written letter of certification by the manufacturer or a pull test witnessed and certified in writing by a qualified person is acceptable.

11.3.2.4 Operation

The following shall apply to all personnel who use wire-rope slings:

11.3.2.4.1 Start and stop slowly; sudden starts and stops dramatically increase the stresses in hoist ropes and slings. Lift slowly until the load is suspended to minimize swinging.

11.3.2.4.2 Loads shall be set on blocks. Do not pull a sling from under a load that is resting on the sling.

11.3.2.4.3 Ensure that wire-rope slings are protected against weather, chemicals, solvents, and high temperatures.

11.3.2.4.4 Permanently remove from service fiber-core rope slings that have been exposed to temperatures in excess of 180° F (82° C).

11.3.2.4.5 When wire rope slings of any grade are to be used at temperatures above 400° F (204° C) or below -60° F (-51° C), the sling manufacturer should be consulted.

11.3.2.4.6 Extremely low temperatures (less than 0° F) may cause brittle fractures. Under these conditions, sudden loading should be avoided and the rope should be carefully observed while the load is being applied.

11.3.2.4.7 Do not use knotted slings.

11.3.2.4.8 Do not use single-leg wire-rope slings unless proper precautions are taken to prevent suspended loads from rotating.

11.3.2.4.9 Rigging shall be configured such that slings do not reeve or slip through the hook.

11.3.2.4.10 Do not make a complete turn of wire rope around the crane hook.

11.3.2.4.11 Use protector pads or blocking at sharp corners.

11.3.2.4.12 Keep hands and fingers out of the area between the sling and the load.

11.3.2.4.13 Ensure that the weight of the load is within the rated capacity of the sling.

11.3.2.4.14 Do not use damaged slings.

11.3.2.4.15 Ensure that all personnel stand clear of the suspended load.

11.3.2.4.16 Avoid shock loading.

11.3.2.4.17 In a basket hitch, ensure that the load is balanced to prevent slippage.

11.3.2.4.18 Avoid handling hot material with wire-rope slings. See paragraph 11.3.2.4.5.

11.3.2.4.19 Store slings on racks away from moisture and acids when not in use.

11.3.2.4.20 Ensure that damaged wire-rope slings are removed from service and returned to the competent person, for destruction (rendered useless) and removal from inspection data base.

11.3.2.4.21 Before use and before storage, check wire-rope slings for:

- Broken or cut wires or strands.
- Rust or corrosion.
- Kinks.
- Broken seizing wire.
- Damage to swaged fittings.
- Other signs of damage or abuse.

11.3.2.4.22 The capacity of wire-rope slings is derated by the manufacturer by applying the efficiency factors such as those given in Figure 11-8.

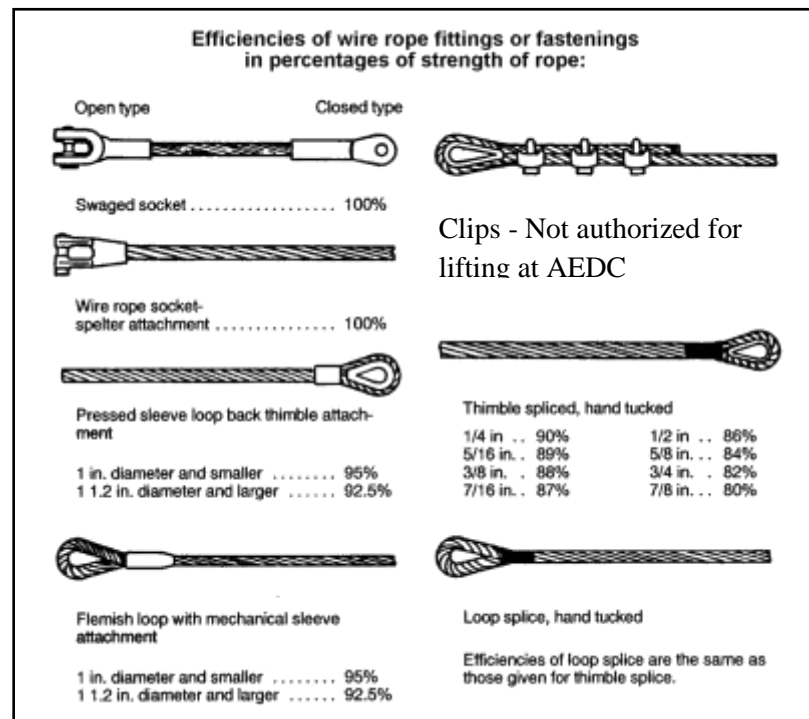


Figure 11-8. Efficiencies of Wire Rope Fittings or Fastenings

11.3.2.4.23 As a minimum, wire-rope slings shall be marked with the following information:

- Name of trademark of manufacturer
- Rated capacity for the type of hitch(s)
- Diameter or size
- Number of legs if more than one
- Evidence of periodic inspection date

NOTE: Marking requirements specified in paragraphs 11.3.2.4.24.1, 11.3.2.4.24.2, and 11.3.2.4.24.3 are ASME B30.9 requirements effective January 2001. In addition, use only slings with permanently affixed identification markings that show the maximum load capacity for each sling. Sling identification should be maintained by the user so as to be legible during the life of the sling. (Stenciling or stamping on the swages of a sling is not recommended.)

11.3.2.4.24 Slings made of rope with 6 x 19 and 6 x 36 construction and cable-laid slings shall have a minimum clear length of rope 10 times the rope diameter between splices, sleeves, or end fittings.

11.3.2.4.25 Braided slings shall have a minimum clear length of rope 40 times the component (individual) rope diameter between the loops or end fittings.

11.3.2.4.26 Grommets and endless slings shall have a minimum circumferential length of 96 times the body diameter of the grommet or endless sling.

11.3.2.5 Cautions and Prohibitions

The sling's intended use shall determine by the type of rope and termination. The following cautions and restrictions apply to this determination:

11.3.2.5.1 Rotation-resistant wire rope shall not be used for slings.

11.3.2.5.2 Wire rope wedge sockets shall not be used to fabricate wire rope slings.

11.3.2.5.3 Wire rope slings larger than 1/4 inch, with eyes formed by folding back the rope (not a Flemish eye loop) and secured with one or more metal sleeves pressed (not forging) over the wire rope junction are prohibited for lifting service.

11.3.2.5.4 Wire rope clamps (clips) shall not be used to fabricate wire rope slings larger than 1/4 inch. (See Figures 11-9 through 11-11.)

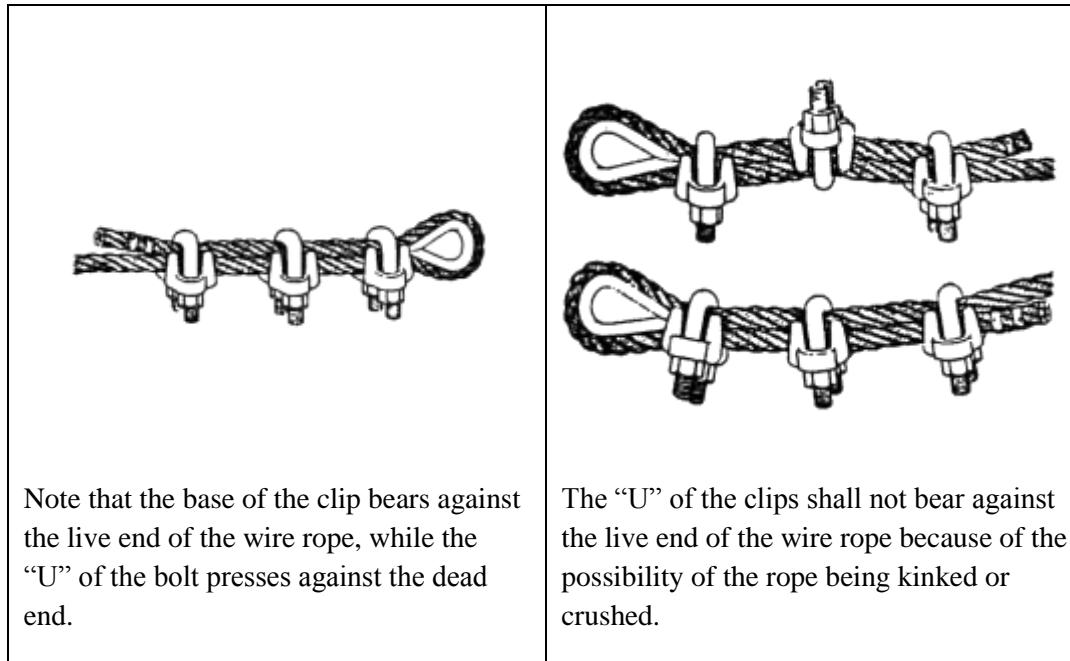


Figure 11-9. Wire-rope clips – correct.

Figure 11-10. Wire-rope clips – wrong.

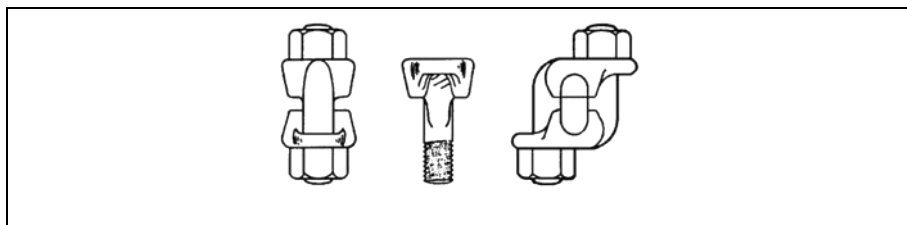


Figure 11-11. Double-saddle clips (drop-forged steel, galvanized).

11.3.2.6 Onsite Sling Fabrication - Slings for lifting service may be fabricated onsite by knowledgeable craftsmen using one of the following methods:

11.3.2.6.1 Hand tucked--The terminal efficiency is reduced (see Figure 12). This sling type is usually more expensive than most commercially made slings.

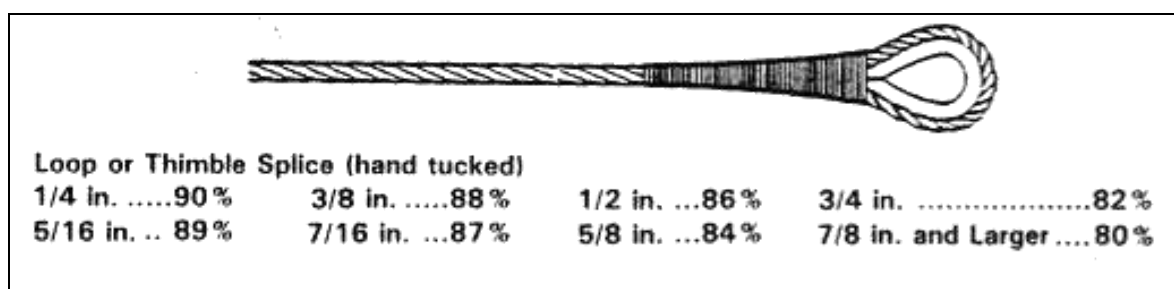


Figure 12. Hand-tucked splice – Nominal End Attachment Efficiency

11.3.2.6.2 Flemish eye with swaged socket--This is the best selection for general purposes and shall be used except when use is impractical.

11.3.2.6.3 Slings shall be made only from new wire rope. When swaged fittings are used, they shall be used as recommended by the fitting manufacturer and the swaging machine manufacturer. Thimbles should be used unless their use makes the sling impractical.

11.3.2.6.4 Identification of fabricated slings shall be as described in paragraph 11.3.2.4.23.

11.3.2.7 Critical Lifts

See Chapter 2 for critical lift requirements.

11.3.2.7.1 All provisions of paragraph 11.3.2.4 also shall apply to critical lifts.

11.3.2.7.2 Wire-rope slings used for critical lift service should have an initial proof test, performed and documented by OEM. If proof test cannot be verified, the wire rope sling shall be load tested before used to make a critical lift. As a minimum the load test shall be equal to the expected load seen by the sling, but shall not exceed the slings' rated capacity.

- Test weights shall be accurate to within –5%, +0% of stipulated values.

11.3.2.7.3 Wire-rope sling eyes with thimbles shall be made with a thimble having a ratio of thimble diameter (D) to rope diameter (d) of 3 or more (D/d greater than or equal 3).

11.3.2.7.4 Do not use wedge sockets or wire-rope clips on slings used for critical lifts.

11.3.2.7.5 Ensure that working loads of wire-rope slings do not exceed their rated capacities.

11.3.2.7.6 Do not splice slings together.

11.3.2.7.7 Use thimble eyes for slings to be joined end-to-end.

11.3.2.7.8 Locate sling eyes so that:

- Adequate clearance is maintained between the attached slings and other parts or surfaces of the component or equipment.
- there is no interference with the functioning of hoisting, rigging, or handling equipment.
- Maximum accessibility to the eye is maintained.
- Attached slings can converge over the center of gravity of the lift.
- Proper stability can be maintained during lifting and positioning of the item at the installation site.
- The plane of the slinging eye is coincident with the plane of the sling under loaded conditions within $\pm 5^\circ$.
- Sling angles are not less than 45° with the horizontal.

11.3.2.7.9 In addition to marking requirements listed for ordinary lifts, other items may need to be marked as determined on a case-by-case basis, such as the reach, type, weight of the sling assembly, and rated capacity.

11.3.3 Alloy Steel Chain Slings

NOTE: It is strongly recommended by the AEDC Crane Committee that chain slings not be used at AEDC; however, it is understood at some time chain slings may be necessary under certain conditions. If chain slings are to be used, then the following procedures shall be complied with.

11.3.3.1 General

11.3.3.1.1 Chain for alloy steel chain slings shall conform to the requirements of ASTM A906/A 906M, *Standard Specification for Grade 80 and Grade 100 Alloy Steel Chain Slings for Overhead Lifting*. If chain other than this is used, it shall be used in accordance with the recommendations of the chain manufacturer.

11.3.3.1.2 Alloy Steel-chain slings differ from wire-rope slings in that components using wire are replaced by link chain. Other sling components are similar. Chain slings are more rugged and flexible, but less shock resistant than wire-rope or braided slings. This size is measured by the link stock.

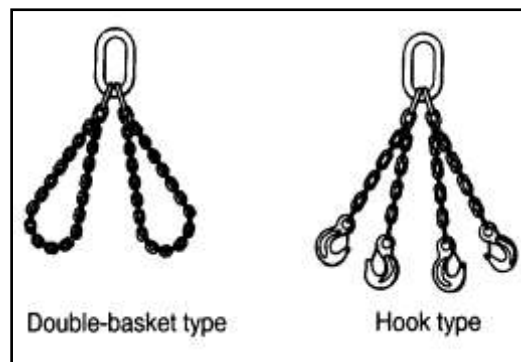


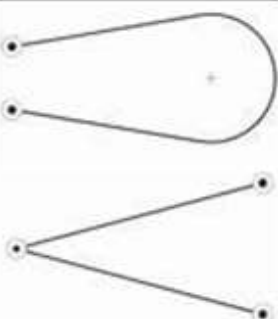

Figure 11-13 Wire rope fastenings

- 11.3.3.1.3 Two basic types with many variations are used: basket type and hook type. An example of each is shown in Figure 11-13.
- 11.3.3.1.4 Alloy-steel-chain slings shall not be heated above 1,000° F (537° C) after being received from the manufacturer.
- 11.3.3.1.5 When exposed to service temperatures in excess of 600° F (315° C), reduce working load limits in accordance with the chain manufacturer's recommendations. (See Table 11-12)
- 11.3.3.1.6 Extremely low temperatures (less than 0° F) may cause brittle fractures. Under these conditions, sudden loading should be avoided and the load should be lifted a very short distance while the chains are carefully inspected.
- 11.3.3.1.7 The design factor for steel-chain slings shall be a minimum of 4:1 based upon breaking strength.
- 11.3.3.1.8 Chains should be stored in racks or in designated locations when not in use. Chains should never be stored in damp or dirty places, nor in places exposed to the weather. For long-term storage, they should receive a coating of oil. The ends of all empty chains should be hooked onto the hoist hook or bull ring.
- 11.3.3.1.9 Chains should not be lubricated when in use because this might make them dangerous to handle. Chains should be cleaned periodically to remove abrasive grit and to facilitate inspection.
- 11.3.3.1.10 The total load that can be lifted safely with steel-chain slings depends on the manner by which the slings are attached to the load. If all legs of a steel-chain sling are hooked back into the master link, the safe-load capacity of the whole sling may be increased by 100% if the capacity of the master link is not exceeded.
- 11.3.3.1.11 The safe-load level of any chain sling is a function of three basic factors: size and number of legs, condition of chain and other components, and sling angle between legs and horizontal. Tables 11-13 thru 11-16 show safe loads in pounds per leg which can be carried by various chain-sling arrangements. Note the effect of very low hook height and wide leg spreads.
- 11.3.3.1.12 Attachments: Hooks, rings, oblong links, pear shaped links, welded or mechanical coupling links and other attachments shall have a rated capacity at least equal to that of the alloy steel chain with which they are used or the sling shall not be used in excess of the rated capacity of the weakest component.

Table 11-12
Effect of Elevated Temperature on
Rated Load of Alloy Steel Chain

Temperature		Grade of Chain			
		Grade 80		Grade 100	
(°F)	(°C)	Temporary Reduction of Rated Load WHILE AT Temperature	Permanent Reduction of Rated Load AFTER EXPOSURE to Temperature	Temporary Reduction of Rated Load WHILE AT Temperature	Permanent Reduction of Rated Load AFTER EXPOSURE to Temperature
Below 400	Below 204	NONE	NONE	NONE	NONE
400	204	10%	None	15%	None
500	260	15%	None	25%	5%
600	316	20%	5%	30%	15%
700	371	30%	10%	40%	20%
800	427	40%	15%	50%	25%
900	482	50%	20%	60%	30%
1000	538	60%	25%	70%	35%
Over 1000	Over 538	REMOVE FROM SERVICE			

TABLE 11-13
RATED LOAD FOR GRADE 80 ALLOY STEEL CHAIN SLINGS
VERTICAL AND BRIDLE HITCHES

		Double Leg Bridle Slings Single Basket Slings				Triple and Quadruple Leg Bridle Slings Double Basket Slings						
Nominal Chain Size	Single Leg Slings											
					Horizontal Angle [Note 1]							
	90°	60°	45°	30°	60°	45°	30°	lb	lb	lb	lb	
7/32	5.5	2,100	3,600	3,000	2,100	5,500	4,400	3,200				
9/32	7	3,500	6,100	4,900	3,500	9,100	7,400	5,200				
5/16	8	4,500	7,800	6,400	4,500	11,700	9,500	6,800				
3/8	10	7,100	12,300	10,000	7,100	18,400	15,100	10,600				
1/2	13	12,000	20,800	17,000	12,000	31,200	25,500	18,000				
5/8	16	18,100	31,300	25,600	18,100	47,000	38,400	27,100				
3/4	20	28,300	49,000	40,000	28,300	73,500	60,000	42,400				
7/8	22	34,200	59,200	48,400	34,200	88,900	72,500	51,300				
1	26	47,700	82,600	67,400	47,700	123,900	101,200	71,500				
1-1/4	32	72,300	125,200	102,200	72,300	187,800	153,400	108,400				

NOTES:

(1) The horizontal angle is the angle formed between the inclined leg and the horizontal plane [see figure 1(d)].

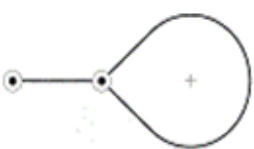
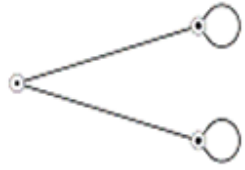
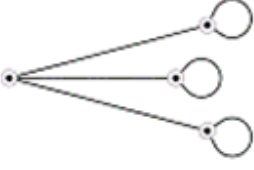
TABLE 11-14
RATED LOAD FOR GRADE 100 ALLOY STEEL CHAIN SLINGS
VERTICAL AND BRIDLE HITCHES

Nominal Chain Size	Single Leg Slings				Double Leg Bridle Slings Single Basket Slings				Triple and Quadruple Leg Bridle Slings Double Basket Slings			
	In	mm	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
7/32	5.5	2,700	4,700	3,800	2,700	4,300	2,700	4,300	7,000	11,200	5,700	9,100
9/32	7	4,300	7,400	6,100	4,300	7,400	4,300	7,400	11,200	14,800	12,100	18,700
5/16	8	5,700	9,900	8,100	5,700	9,900	5,700	9,900	14,800	22,900	18,700	31,800
3/8	10	8,800	15,200	12,400	8,800	15,200	8,800	15,200	22,900	39,000	31,800	47,900
1/2	13	15,000	26,000	21,200	15,000	26,000	15,000	26,000	39,000	58,700	47,900	74,900
5/8	16	22,600	39,100	32,000	22,600	39,100	22,600	39,100	58,700	91,700	74,900	110,900
3/4	20	35,300	61,100	49,900	35,300	61,100	35,300	61,100	91,700	110,900	90,600	130,000
7/8	22	42,700	74,000	60,400	42,700	74,000	42,700	74,000	110,900	130,000	110,900	150,000

NOTES:

(1) The horizontal angle is the angle formed between the inclined leg and the horizontal plane [see figure 1(d)].

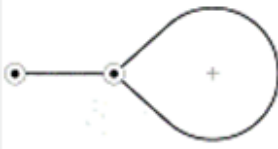
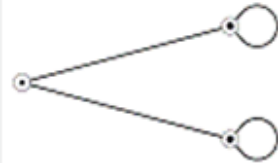
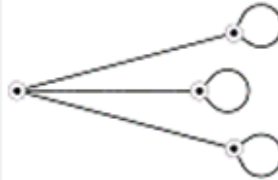
TABLE 11-15
RATED LOAD FOR GRADE 80 ALLOY STEEL CHAIN SLINGS
CHOKER HITCHES [Note 2]

Nominal Chain Size	Single Leg Slings		Double Leg Bridle Slings Single Basket Slings		Triple and Quadruple Leg Bridle Slings Double Basket Slings	
						
	Horizontal Angle [Note 1]		Horizontal Angle [Note 1]		Horizontal Angle [Note 1]	
	90°	30°	45°	60°	45°	30°
in	lb	lb	lb	lb	lb	lb
7/32	1,700	2,900	2,400	4,400	3,500	2,600
9/32	2,800	5,000	3,900	7,300	5,900	4,200
5/16	3,600	6,200	5,100	9,300	7,600	5,400
3/8	5,700	9,800	8,000	14,700	12,100	8,500
1/2	9,600	16,600	13,600	25,000	20,400	14,400
5/8	14,500	25,000	20,500	37,600	30,700	21,700
3/4	22,600	39,200	32,000	58,800	48,000	33,900
7/8	27,400	47,400	38,700	71,100	58,000	41,000
1	38,200	66,100	53,900	99,100	81,000	57,200
1-1/4	57,800	100,200	81,800	150,200	122,700	86,700

NOTES:

- (1) The horizontal angle is the angle formed between the inclined leg and the horizontal plane [see figure 1(d)].
 (2) Rated loads are for angles of choke greater than 120°.

TABLE 11-16
RATED LOAD FOR GRADE 100 ALLOY STEEL CHAIN SLINGS
CHOKER HITCHES [Note2]

Nominal Chain Size	Single Leg Slings			Double Leg Bridle Slings Single Basket Slings			Triple and Quadruple Leg Bridle Slings Double Basket Slings		
									
	90°			Horizontal Angle [Note 1]			Horizontal Angle [Note 1]		
		lb		60°	45°	30°	60°	45°	30°
	in	mm		lb	lb	lb	lb	lb	lb
	7/32	5.5	2,100	3,600	3,000	2,100	5,500	4,400	3,200
	9/32	7	3,500	6,100	4,900	3,500	9,100	7,400	5,200
	5/16	8	4,500	7,800	6,400	4,500	11,700	9,500	6,800
	3/8	10	7,100	12,300	10,000	7,100	18,400	15,100	10,600
	1/2	13	12,000	20,800	17,000	12,000	31,200	25,500	18,000
5/8	16	18,100	31,300	25,600	18,100	47,000	38,400	27,100	
3/4	20	28,300	49,000	40,000	28,300	73,500	60,000	42,400	
7/8	22	34,200	59,200	48,400	34,200	88,900	72,500	51,300	

NOTES:

- (1) The horizontal angle is the angle formed between the inclined leg and the horizontal plane [see figure 1(d)].
 (2) Rated loads are for angles of choke greater than 120°.

11.3.3.2 Pre-Use Inspections

Steel-chain sling users shall visually inspect all slings before they are used as follows:

- 11.3.3.2.1 Conduct a link-by-link inspection for the following defects: bent links, stretched links, cracks in any section of link, scores, abrasions, heat damage, or markings tending to weaken the links. Reject if discovered.
- 11.3.3.2.2 Check rings and hooks for distortion, cracks in weld areas, corrosion, and scores, heat damage, or markings tending to weaken the links. Reject if discovered.
- 11.3.3.2.3 Perform inspection on an individual-link basis. If any link does not hinge freely with the adjoining link, remove the assembly from service.
- 11.3.3.2.4 Remove from service assemblies with deformed master links or coupling links.
- 11.3.3.2.5 Remove from service assemblies if hooks show any distortion causing an increase in throat opening of 5%, not to exceed 1/4 in. (or as recommended by the manufacturer), or any visibly apparent bend or twist from the plane of the unbent hook.
- 11.3.3.2.6 Do not straighten deformed hooks or other attachments on the job. Assemblies with such defects shall be reconditioned by the manufacturer or discarded.
- 11.3.3.2.7 Remove from service assemblies with cracked hooks or other end attachments; assemblies with such defects shall be reconditioned or repaired prior to return to service.

11.3.3.3 Annual Inspections

- 11.3.3.3.1 A sample annual inspection form is included as Exhibit 11.2 at the end of this section. This form is intended to be a sample only and is not intended to be mandatory.
- 11.3.3.3.2 Annual inspections shall be conducted by a qualified inspector. In addition to criteria for daily inspections, the qualified inspector shall do the following for annual inspections:
 - Hang chain in a vertical position, if practicable, for preliminary inspection. Chain should hang reasonable straight if links are not distorted.
 - Accurately measure the reach (inside of crane ring to inside of hook) under no load when new and at each inspection, and keep a record of increase in length; an increase in length may be due to stretch (sign of overload or wear).
 - Check for localized stretch and wear. Lift each link from its seat and visually inspect for grooving. If grooving is noticed, verify stock diameter of link to be within the minimum safe dimensions in the table below. Reject chain if it does not meet the requirements in the table.
 - Remove the assembly from service if wear at any point of any chain link exceeds that shown in Table 11-11.
 - Round out sharp transverse nicks by grinding. If the minimum dimensions are reduced below those values specified in Table 11-17, remove the assembly from service.
 - Check for evidence of heat damage.

Table 11-17. Minimum allowable thickness at any point on link.

Chain size or Coupling Link size (in.)	Minimum allowable thickness at any point (in.)
7/32	0.189
9/32	0.239
5/16	0.273
3/8	0.342
1/2	0.443
5/8	0.546
3/4	0.687
7/8	0.750
1	0.887
1-1/4	1.091
For other sizes, consult chain or sling manufacturer.	

11.3.3.3.3 After annual inspection each chain sling will be color coded, using a colored nylon wire tie attached to the sling, to show when next inspection is due as follows, with colors continuing in sequence thereafter:

- The color GREEN will be used for FY 2014
- The color RED will be used for FY 2015
- The color WHITE will be used for FY 2016
- The color BLUE will be used for FY 2017
- The color GREEN will be used for FY 2018

Colors will continue in sequence thereafter.

11.3.3.4 Proof Testing

11.3.3.4.1 Single-leg and endless alloy-steel chain slings shall be certified as having been proof-tested to 200% of the rated capacity prior to initial use.

11.3.3.4.2 The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200% of the vertical rated capacity of a single-leg sling.

11.3.3.4.3 Master links to which multiple-leg slings are connected shall be proof-loaded to 200% multiplied by the force applied by the combined legs.

11.3.3.4.4 Test loads shall be accurate to within –5%, +0% of stipulated values. Either certification by the manufacturer or a pull test certified by a qualified person is acceptable.

11.3.3.5 Operation

The following shall apply to all personnel who use steel-chain slings:

11.3.3.5.1 Do not set a load on a sling or pull a sling from under a load. Place wooden blocks or other supports under the load to provide sufficient clearance for the chain.

11.3.3.5.2 Shorten chain slings by hooking back into the chain, into the master link, or with grab hooks. Do not shorten by knotting, twisting, bolting, or inserting the tip of the hook into a link.

11.3.3.5.3 Do not hammer a chain to force it into position.

11.3.3.5.4 Protect chain slings from sharp corners that might bend the links. Use a suitable pad to prevent gouging or bending of the chain links, as well as possible scarring of the load.

11.3.3.5.5 When making choker hitches with chain slings, always face the hook opening out and away from the pull of the sling so that the hooks will not slip out when slack is taken out of the sling.

11.3.3.5.6 Check steel-chain slings for:

- Nicks, cracks, gouges, and wear.
- Bending, stretching, or shearing of links.
- Bends or distortions in hooks.
- Rust and corrosion.
- Uneven lengths when sling legs are hanging free.
- Evidence of heat damage.

11.3.3.5.7 Do not weld or perform local repairs on chain slings. All defective chain slings should be returned, through a formal procedure, to the manufacturer for examination, repair, and recertification.

11.3.3.5.8 Avoid sudden loading of chain slings.

11.3.3.5.9 Maintain latches on hooks in good condition.

11.3.3.5.10 If a chain sling does not look safe, do not use it. Do not assume that a chain sling is safe because it looks new; look for stretched links. If in doubt, check with the **AEDC Crane System Engineer**.

11.3.3.5.11 Do not carry loads on the point or tip of a hook.

11.3.3.5.12 Avoid unbalanced loads.

11.3.3.5.13 Do not use homemade links, makeshift fasteners formed from bolts, rods, and the like, or other nonstandard attachments.

11.3.3.5.14 Do not use makeshift or field-fabricated hooks on steel-chain slings.

11.3.3.5.15 Hook the ends of all empty chain onto the hoist hook or bull ring.

11.3.3.5.16 Ensure the steel-chain slings used in AEDC-controlled areas are marked, at a minimum, with the following:

- Chain size.
- Manufacturer's grade (Only ASTM A 906 is allowed for lifting purposes (ASTM A906/A 906M, Standard Specification for Grade 80 and Grade 100 Alloy Steel Chain Slings for Overhead Lifting.)).
- Rated load and angle on which the rating is based.
- Reach.
- Number of legs.
- Sling manufacturer.

11.3.3.5.17 This information may be stenciled or stamped on a metal tag or tags affixed to the sling.

11.3.3.5.18 Where slings have more than one leg, ensure that the tag is affixed to the master link.

11.3.3.5.19 Ensure that the working load does not exceed the rated capacity of the sling.

11.3.3.6 Critical Lifts

See Chapter 2, “Critical Lifts,” for critical lift requirements.

11.3.3.6.1 Single-leg and endless alloy-steel chain slings used for critical-lift service should have an initial proof test, performed and documented by OEM. If proof test cannot be verified, the alloy-steel chain sling shall be load tested before used to make a critical lift. As a minimum the load test shall be equal to the expected load seen by the sling, but shall not exceed the slings' rated capacity.

11.3.4 Metal-Mesh Slings

11.3.4.1 General

11.3.4.1.1 Metal-mesh slings (Figure 11-14) shall be classified with the designations shown in Table 11-18, based on types of duty and material classification.

11.3.4.1.2 The carbon steel used in metal-mesh slings shall be processed to produce the required mechanical properties.

11.3.4.1.3 The material used for stainless-steel metal-mesh slings shall conform, at least, to the American Iron and Steel Institute standards for Type-302 or Type-304 stainless steel. Other materials may be used. When metal-mesh slings are produced from such materials, however, the sling manufacturer should be consulted for specific data.

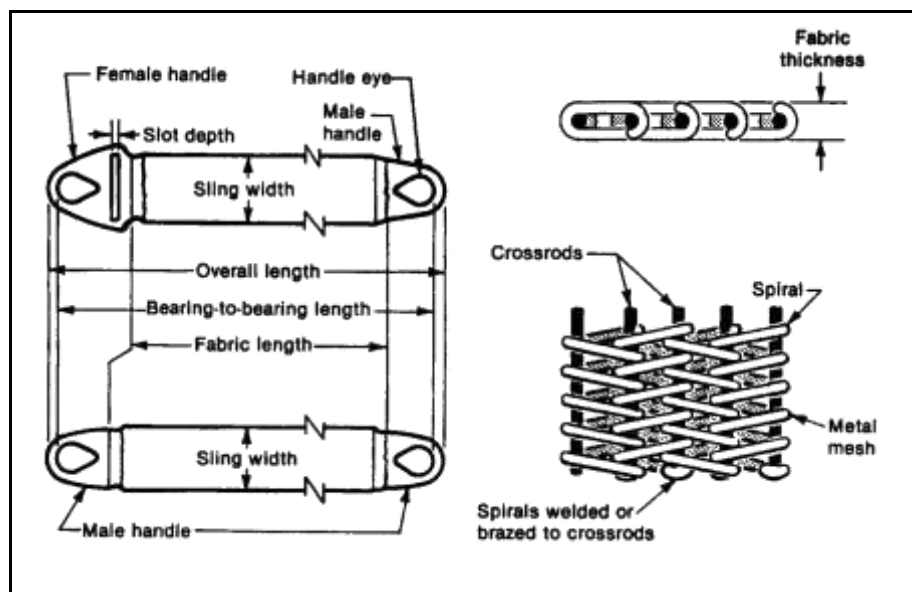


Figure 11-14. Typical metal-mesh sling.

11.3.4.1.4 The handle shall be designed to ensure:

- At least the same rated capacity as the fabric.

- No visible permanent deformation after proof-testing.

11.3.4.1.5 The fabric and handles shall be so joined that:

- The rated capacity of the sling is not reduced.
- The load is evenly distributed across the width of the fabric.
- Sharp edges do not damage the fabric.

11.3.4.1.6 Metal-mesh slings may be painted, plated, impregnated with elastomers such as neoprene or polyvinyl chloride (PVC), or otherwise suitably coated. The coating shall not diminish the rated capacity of a sling.

11.3.4.1.7 The design factor for metal-mesh slings shall be a minimum of 5:1 based upon breaking strength.

11.3.4.1.8 Metal-mesh slings shall not be used to lift loads greater than the rated capacity, properly derated for other than straight-pull configurations (Table 11-19).

11.3.4.1.9 Except for elastomer-impregnated slings, all metal-mesh slings covered by this section may be used without derating in a temperature range from -20°F (-29°C) to 550°F (288°C).






11.3.4.1.10 All metal-mesh slings covered by this section and impregnated with PVC or neoprene shall be used only in a temperature range from 0°F (-18°C) to 200°F (93°C).

11.3.4.1.11 For operation at temperatures outside these ranges or for other impregnations, consult the manufacturer for specific data

Table 11-18
Fabric Construction (Metal Mesh Slings) Type Designation

	Heavy Duty	Medium Duty	Light Duty
Nominal spiral turns per foot mesh width	35	43	59
Approx. spiral wire size	10 gage	12 gage	14 gage
Equivalent decimal size	0.135 in.	0.105 in.	0.080 in.
Nominal cross rods per foot of fabric length	21	30	38
Approx. size of cross rods	8 gage	10 gage	14 gage
Equivalent decimal size	0.162 in.	0.135 in.	0.080 in.
Nominal fabric thickness	1/2 in.	3/8 in.	5/16 in.

Table 11-19
Rated Load for Metal Mesh Slings
Based on Design Factor = 5

			Effect of Angle on Rated Capacities in Basket Hitch		
					
Hitch Type	Vertical or Choker	Vertical Basket	60°	45°	30°
Width, in.					
Heavy Duty - 10 gage [Rated Loads in Pounds (lb)]					
2	1,600	3,200	2,770	2,260	1,600
3	3,000	6,000	5,200	4,240	3,000
4	4,400	8,800	7,620	6,220	4,400
6	6,600	13,200	11,430	9,330	6,600
8	8,800	17,600	15,240	12,440	8,800
10	11,000	22,000	19,050	15,550	11,000
12	13,200	26,400	22,860	18,660	13,200
14	15,400	30,800	26,670	21,770	15,400
16	17,600	35,200	30,480	24,880	17,600
18	19,800	39,600	34,290	28,000	19,800
20	22,000	44,000	38,100	31,100	22,000
Medium Duty - 12 gage [Rated Loads in Pounds (lb)]					
2	1,450	2,900	2,510	2,050	1,450
3	2,170	4,350	3,770	3,070	2,170
4	2,900	5,800	5,020	4,100	2,900
6	4,800	9,600	8,310	6,780	4,800
8	6,400	12,800	11,080	9,050	6,400
10	8,000	16,000	13,850	11,310	8,000
12	9,600	19,200	16,620	13,570	9,600
14	11,200	22,400	19,400	15,830	11,200
16	12,800	25,600	22,170	18,100	12,800
18	13,500	27,000	23,380	19,090	13,500
20	15,000	30,000	25,980	21,210	15,000
Light Duty - 14 gage [Rated Loads in Pounds (lb)]					
2	900	1,800	1,560	1,270	900
3	1,400	2,800	2,420	1,980	1,400
4	2,000	4,800	4,150	3,390	2,000
6	3,000	6,000	5,190	4,240	3,000
8	4,000	8,000	6,920	5,650	4,000
10	5,000	10,000	8,660	7,070	5,000
12	6,000	12,000	10,390	8,480	6,000
14	7,000	14,000	12,120	9,890	7,000
16	8,000	16,000	13,850	11,310	8,000
18	9,000	18,000	15,580	12,720	9,000
20	10,000	20,000	17,320	14,140	10,000

GENERAL NOTE: For choker hitch, the angle of choke is 120 deg or greater.

11.3.4.2 Inspections

11.3.4.2.1 Users of metal-mesh sling shall visually inspect all metal-mesh slings before each use.

Annual inspections shall be made by a qualified inspector, and inspections shall be documented by entering inspection data into a computer generated data base and color coding, using a color nylon wire tie attached to the sling.

11.3.4.2.2 Metal-mesh slings shall be removed from service if any of the following defects are present:

11.3.4.2.3 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 female handle so the depth of the slot is increased by more than 10%.
- Distortion of either end fitting so the width of the eye opening is decreased by more than 10%.
- A 15% reduction of the original cross-sectional area of metal at any point around a handle eye.
- Any distortion or twisting of either end fitting out of its plane.
- Cracked end fitting.
- Evidence of heat damage.

11.3.4.2.4 After annual inspection each metal mesh sling will be color coded to show when next inspection is due as follows:

- The color GREEN will be used for FY 2014
- The color RED will be used for FY 2015
- The color WHITE will be used for FY 2016
- The color BLUE will be used for FY 2017
- The color GREEN will be used for FY 2018

11.3.4.2.5 Colors will continue in sequence thereafter.

11.3.4.3 Proof Testing

11.3.4.3.1 Metal-mesh slings shall be certified as having been proof-tested to 200% of their rated capacity prior to initial use.

11.3.4.3.2 Coated slings shall be proof-tested prior to being coated.

11.3.4.3.3 Test loads shall be accurate to within -5%, +0% of stipulated values. Either certification by the manufacturer or a pull test certified by a qualified person is acceptable.

11.3.4.4 Operation

11.3.4.4.1 The following shall apply to all personnel who use metal-mesh slings:

- Ensure that the weight of the load is within the rated capacity of the sling.
- Ensure that metal-mesh slings have suitable characteristics and rated capacity for the load and environment.

11.3.4.4.2 Metal-mesh slings should be long enough to provide the maximum practical angle between the sling leg and the horizontal (minimum practical angle at the crane hook if vertical angles are used).

11.3.4.4.3 Do not shorten metal-mesh slings with knots, bolts, or other unapproved methods.

11.3.4.4.4 Do not use damaged slings.

11.3.4.4.5 Securely hitch metal-mesh slings to the load.

11.3.4.4.6 Ensure that sharp corners are padded.

11.3.4.4.7 Keep hands and fingers out of the area between the sling and the load.

11.3.4.4.8 Ensure that all personnel stand clear of the suspended load.

11.3.4.4.9 Avoid shock loading.

11.3.4.4.10 Do not pull metal-mesh slings from under a load when the load is resting on the sling.

11.3.4.4.11 Do not store metal-mesh slings in an area where they will be subjected to mechanical damage or corrosive action.

11.3.4.4.12 Avoid twisting and kinking of the legs.

11.3.4.4.13 In a choker hitch, ensure that metal-mesh slings are long enough so that the female handle chokes freely on the mesh, never on the handle.

11.3.4.4.14 In a choker hitch, ensure that the load is balanced. When this cannot be done, consult the manufacturer for a derating factor or for other means of handling this type of load.

11.3.4.4.15 In a basket hitch, ensure that the load is balanced to prevent slippage.

11.3.4.4.16 Do not use metal-mesh slings in which the spirals are locked or are without free articulation.

11.3.4.4.17 Never hammer a sling to straighten a spiral or cross rod or to force a spiral into position.

11.3.4.4.18 Metal-mesh slings used in pairs should be attached to a spreader beam.

11.3.4.4.19 Ensure that all metal-mesh slings have a permanently affixed metal identification tag or tags containing the following information:

- Manufacturer's name or trademark.
- Rated load in vertical, basket, and choker hitches.
- Inspection due date.

11.3.4.5 Critical Lifts

See Chapter 2, "Critical Lifts," for critical lift requirements.

11.3.4.5.1 Metal mesh slings used for critical lift service should have an initial proof test, performed and documented by OEM. If proof test cannot be verified, the metal mesh sling shall be load tested before used to make a critical lift. As a minimum the load test shall be equal to the expected load seen by the sling, but shall not exceed the slings' rated capacity.

11.3.5 Synthetic Web Slings

11.3.5.1 General

11.3.5.1.1 Synthetic web shall possess the following qualities:

- Be of sufficient strength to meet the sling manufacturer's requirements.
- Have uniform thickness and width.
- Have edges which prevent raveling.

11.3.5.1.2 The thread used in the manufacture of a synthetic-web sling shall be of the same type of material as the web.

11.3.5.1.3 Fitting shall be:

- Of sufficient strength to sustain twice the rated capacity without permanent deformation.
- Of a minimum breaking strength equal to that of the sling.

- Free of all sharp edges that would in any way damage the mesh.

11.3.4.4.4 The stitching in all load-bearing splices shall be of sufficient strength to maintain the sling design factor.

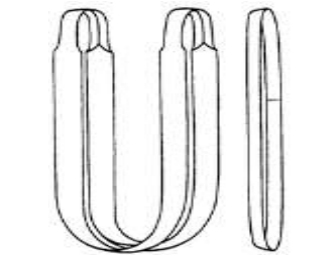
11.3.4.4.5 Synthetic-web slings may be coated with elastomers or other suitable material that will provide characteristics such as abrasion resistance, sealing of pores, and increased coefficient of friction.

11.3.4.4.6 The design factor for synthetic-web slings shall be a minimum of 5:1 based upon breaking strength.

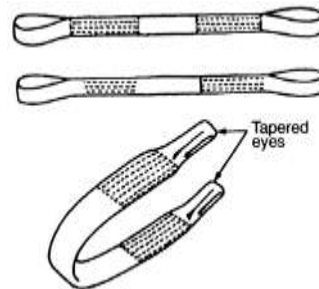
11.3.4.4.7 Rated capacities are affected by the type of hitch used and by the angle from the vertical when used as multilegged slings or in basket hitches. The sling manufacturer shall supply data on these effects.

11.3.4.4.8 Synthetic-web slings are available in a number of configurations as described below:

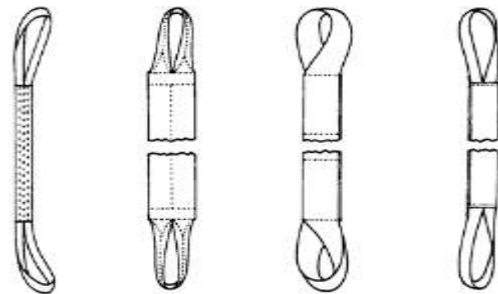
Endless or Grommet Sling – Both ends of one piece of webbing are lapped and sewn to form a continuous piece. They can be used as vertical hitches, bridle hitches, in choker arrangements, or as basket slings. Because load contact points can be shifted with every lift, wear is evenly distributed and sling life is extended. (See right)



Standard Eye and Eye – Webbing is assembled and sewn to form a flat-body sling with an eye at each end and the eye openings in the same plane as the sling body. The eyes may either be full web width or may be tapered by being folded and sewn to a width narrower than the webbing width. (See right)



Twisted Eye – An eye-and-eye type of sling that has twisted terminations at both ends. The eye openings are at 90° to the plane of the sling body. This configuration is also available with either full-width or tapered eyes. (See right)



11.3.4.4.9 In place of the sewn eyes, synthetic-web slings are also available with metal end fittings (see Figure 11-15). The most common are triangle and choker hardware. Combination hardware consists of a triangle for one end of the sling and a triangle/rectangle choker attachment for the other end. With this arrangement, both choker and basket hitches, as well as straight hitches, may be rigged. They help reduce wear in the sling eyes and thus lengthen sling life.

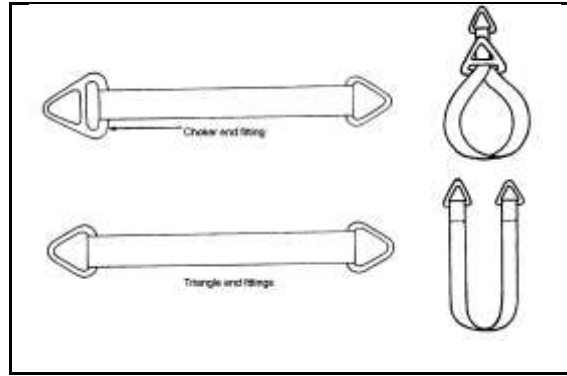


Figure 11-15. Metal end fittings

11.3.5.1.10 Despite their inherent toughness, synthetic-web slings can be cut by repeated use around sharp-cornered objects. They eventually show signs of abrasion when they are repeatedly used to hoist rough-surfaced products. There are, however, protective devices offered by most sling manufacturers that minimize these effects (see Figure 11-16). Other protective devices include:

- Buffer strips of leather, nylon, or other materials that are sewn on the body of a sling protect against wear. Leather pads are the most resistant to wear and cutting, but are subject to weathering and gradual deterioration. They are not recommended in lengths over 6 ft due to the different stretching characteristics of the leather and webbing. On the other hand, nylon-web wear pads are more resistant to weathering, oils, grease, and most alkalis; and they stretch in the same ratio as the sling body.
- Edge guards consist of strips of webbing or leather sewn around each edge of the sling. This is necessary for certain applications where the sling edges are subject to damage.
- Sleeve- or sliding-tube-type wear pads are available for slings used to handle material having sharp edges. They can be positioned on the sling where required, do not move when the sling stretches, adjust to the load, and cover both sides of the sling.
- Reinforcing strips that double or triple the eye's thickness and greatly increase its life and safety can be sewn into the sling eyes.
- Coatings can be applied to provide added resistance to abrasion and chemical damage. These treatments also increase the coefficient of friction, affording a better grip when loads with slippery surfaces are to be handled. These coatings can be brightly colored for safety or load-rating purposes.
- Cotton-faced nylon webbing can be used for hoisting rough-surfaced material.

11.3.5.1.11 The synthetic-web sling capacities listed in Tables 11-20 and 11-24 are approximate only and are based on nylon webbing having breaking strengths between 6,000 and 9,000 lb/in. of webbing width. The capacities are also based on a 5:1 design factor and assume that the end fittings are of adequate strength.

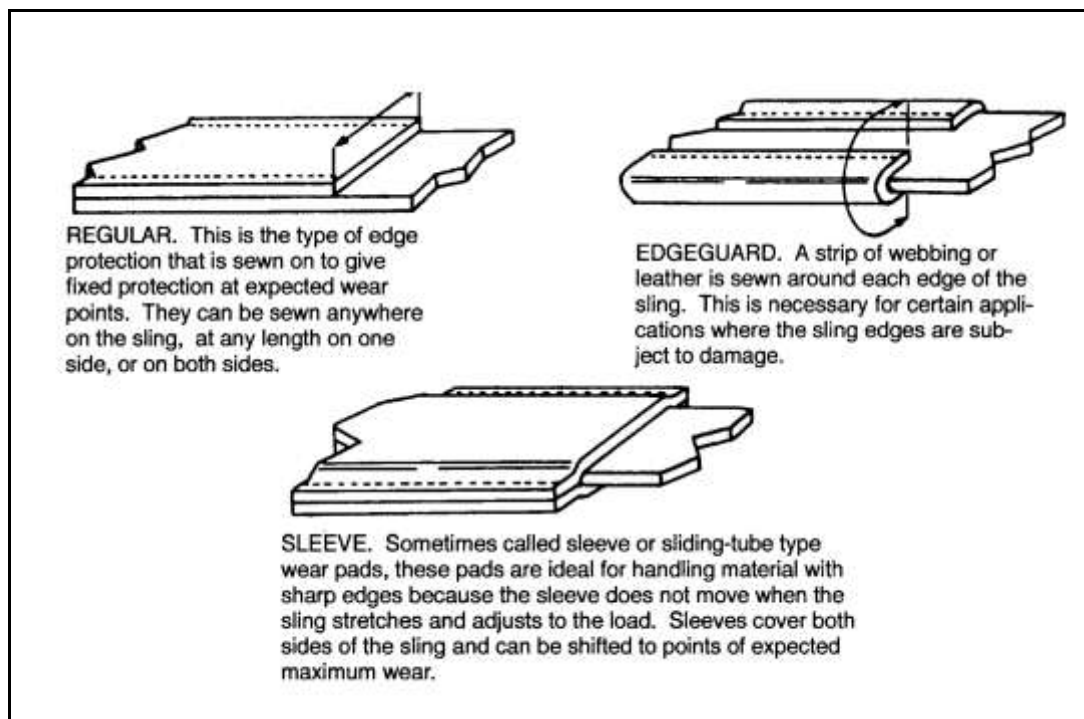


Figure 11-16. Web and edge protectors




Table 11-20
 Rated Load for One-ply, Class 5 Synthetic Webbing Slings
 Expressed in Pounds

Types I, II, III, and IV								Type V
	Single-Leg - Hitch Type			Two Leg - Horizontal Angles				
	Vertical	Choker	Vertical Basket	Vertical	60°	45°	30°	Endless Vertical
Width, in.								
1	1,100	880	2,200	2,200	1,900	1,600	1,100	2,200
1 ½	1,600	1,280	3,200	3,200	2,800	2,300	1,600	3,200
1 ¾	1,900	1,520	3,800	3,800	3,300	2,700	1,900	3,800
2	2,200	1,760	4,400	4,400	3,800	3,100	2,200	4,400
3	3,300	2,640	6,600	6,600	5,700	4,700	3,300	6,600
4	4,400	3,520	8,800	8,800	7,600	6,200	4,400	8,800
5	5,500	4,400	11,000	11,000	9,500	7,800	5,500	11,000
6	6,600	5,280	13,200	13,200	11,400	9,300	6,600	13,200

GENERAL NOTES:

- (a) The rated loads are based on stuffer weave construction webbing with a minimum certified tensile strength of 6,800 pounds per inch of width of the webbing.
- (b) Rated loads for Types III and IV slings apply to both tapered and nontapered eye constructions. Rated loads for Type V slings are based on nontapered webbing.
- (c) For Type VI slings, consult the manufacturer for rated loads.
- (d) For choker hitch, the angle of choke is 120 deg or greater.




Table 11-21
Rated Load for Two-Ply, Class 5 Synthetic Webbing Slings
Expressed in Pounds

Types I, II, III, and IV								Type V
								
Single-Leg - Hitch Type			Two Leg - Horizontal Angles					
Vertical	Choker	Vertical Basket	Vertical	60°	45°	30°	Endless Vertical	
Width, in.								
1	2,200	1,760	4,400	4,400	3,800	3,100	2,200	4,400
1 ½	3,300	2,640	6,600	6,600	5,700	4,700	3,300	6,600
1 ¾	3,800	3,040	7,600	7,600	6,600	5,400	3,800	7,600
2	4,400	3,520	8,800	8,800	7,600	6,200	4,400	8,800
3	6,600	5,280	13,200	13,200	11,400	9,300	6,600	13,200
4	8,200	6,560	16,400	16,400	14,200	11,600	8,200	16,400
5	10,200	8,160	20,400	20,400	17,700	14,400	10,200	20,400
6	12,300	9,840	24,600	24,600	21,300	17,400	12,300	24,600

GENERAL NOTES:

- (a) The rated loads are based on stuffer weave construction webbing with a minimum certified tensile strength of 6,800 pounds per inch of width of the webbing.
- (b) Rated loads for Types III and IV slings apply to both tapered and nontapered eye constructions. Rated loads for Type V slings are based on nontapered webbing.
- (c) For Type VI slings, consult the manufacturer for rated loads.
- (d) For choker hitch, the angle of choke is 120 deg or greater.

Table 11-22
Rated Load for One-Ply, Class 7
Synthetic Webbing Slings
Expressed in Pounds

Types I, II, III, and IV								Type V
								
Single-Leg - Hitch Types			Two Leg - Horizontal Angles					
Sling Width, in.	Vertical	Choker	Vertical Basket	Vertical	60°	45°	30°	Endless Vertical
1	1,600	1,280	3,200	3,200	2,800	2,300	1,600	3,200
1 ½	2,300	1,840	4,600	4,600	4,000	3,300	2,300	4,600
1 ¾	2,700	2,160	5,400	5,400	4,700	3,800	2,700	5,400
2	3,100	2,480	6,200	6,200	5,400	4,400	3,100	6,200
3	4,700	3,760	9,400	9,400	8,100	6,600	4,700	9,400
4	6,200	4,960	12,400	12,400	10,700	8,800	6,200	12,400
5	7,800	6,240	15,600	15,600	13,500	11,000	7,800	15,600
6	9,300	7,440	18,600	18,600	16,100	13,200	9,300	18,600
8	11,750	9,440	21,150	23,600	18,300	15,000	11,750	21,150
10	14,700	11,760	26,450	29,400	22,900	18,700	14,700	26,450
12	17,650	14,120	31,750	35,200	31,750	22,400	17,650	31,750

GENERAL NOTES:

- (a) The rated loads are based on stuffer weave construction webbing with a minimum certified tensile strength of 9,800 pounds per inch of width of the webbing.
- (b) Rated loads for Types III and IV slings apply to both tapered and nontapered eye constructions. Rated loads for Type V slings are based on nontapered webbing.
- (c) For Type VI slings, consult the manufacturer for rated loads.
- (d) For choker hitch, the angle of choke is 120 deg or greater.

Table 11-23
Rated Loads for Two-Ply, Class 7
Synthetic Webbing Slings
Expressed in Pounds

Types I, II, III, and IV								Type V
Single-Leg - Hitch Types				Two Leg - Horizontal Angles				
Sling Width, in.	Vertical	Choker	Vertical Basket	Vertical Basket	60°	45°	30°	Endless Vertical
1	3,100	2,480	6,200	6,200	5,400	4,400	3,100	6,200
1 ½	4,700	3,760	9,400	9,400	8,100	6,600	4,700	9,400
1 ¾	5,400	4,320	10,800	10,800	9,400	7,600	5,400	10,800
2	6,200	4,960	12,400	12,400	10,700	8,800	6,200	12,400
3	8,800	7,040	17,600	17,600	15,200	12,400	8,800	17,600
4	11,000	8,800	22,000	22,000	19,100	15,600	11,000	22,000
5	13,700	10,960	27,400	27,400	23,700	19,400	13,700	27,400
6	16,500	13,200	33,000	33,000	28,600	23,000	16,500	33,000
8	22,750	18,200	42,350	45,400	36,700	29,900	22,750	42,350
10	28,400	22,720	52,900	56,800	45,800	37,400	28,400	52,900
12	34,100	27,280	63,500	68,200	55,000	44,900	34,100	63,500

GENERAL NOTES:

- The rated loads are based on stuffer weave construction webbing with a minimum certified tensile strength of 9,800 pounds per inch of width of the webbing.
- Rated loads for Types III and IV slings apply to both tapered and nontapered eye constructions. Rated loads for Type V slings are based on nontapered webbing.
- For Type VI slings, consult the manufacturer for rated loads.
- For choker hitch, the angle of choke is 120 deg or greater.

Table 11-24
Rated Load for Four-Ply, Class 7
Synthetic Webbing Slings
Expressed in Pounds

Types I, II, III, and IV							
Single-Leg - Hitch Types				Two Leg - Horizontal Angles			
Sling Width, in.	Vertical	Choker	Vertical Basket	Vertical Basket	60°	45°	30°
1	5,500	4,400	11,000	11,000	9,500	7,800	5,500
2	11,000	8,800	22,000	22,000	19,000	15,600	11,000
3	16,450	13,160	32,900	32,800	28,500	23,300	16,450
4	20,400	16,320	40,800	40,800	35,300	28,800	20,400
5	25,500	20,400	51,000	51,000	44,200	36,100	25,500
6	30,600	24,480	61,200	61,200	53,000	43,300	30,600

GENERAL NOTES:

- The rated loads are based on stuffer weave construction webbing with a minimum certified tensile strength of 9,800 pounds per inch of width of the webbing.
- Rated loads for Types III and IV slings apply to both tapered and nontapered eye constructions. Rated loads for Type V slings are based on nontapered webbing.
- For Type VI slings, consult the manufacturer for rated loads.
- For choker hitch, the angle of choke is 120 deg or greater.

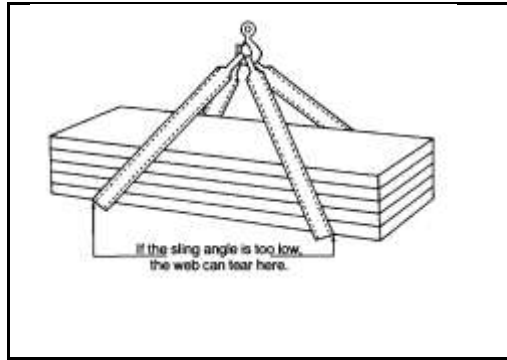


Figure 11-17. Effect of low sling angle

11.3.5.1.12 Although safe working loads for bridle hitches in the choker or double-basket configuration are provided, they should be used only with extreme caution because, as the sling angle decreases, one edge of the web will take all the load, producing a risk of tearing (see Figure 11-17).

11.3.5.1.13 Synthetic-web slings, other than those described in this section [i.e., polyester round and kevlar fiber (yarn) slings], shall be used in accordance with the sling manufacturer's recommendation.

11.3.5.1.14 Conventional three-strand natural or synthetic fiber rope slings are **NOT** recommended for lifting service, and should be used only if conventional sling types are not suitable for a unique application. The requirements of ASME B 30.9 ("Slings"), paragraph 9-4, and 29 CFR 1910.184(h) shall be followed.

CAUTION: Tiedown and/or ratchet strap shall not be used as synthetic-web slings. Only synthetic-web slings constructed from webbing approved for sling construction by the manufacturer or other qualified person shall be used at AEDC.

11.3.5.2 Inspections

11.3.5.2.1 Users of synthetic-web sling shall visually inspect all slings before each use.

11.3.5.2.2 Annual inspection shall be made by a qualified inspector, and shall be documented by entering inspection data into a computer generated data base and color coding, by attaching a colored nylon wire tie to the sling. After annual inspection each synthetic sling will be color coded to show when next inspection is due as follows:

- The color GREEN will be used for FY 2014
- The color RED will be used for FY 2015
- The color WHITE will be used for FY 2016
- The color BLUE will be used for FY 2017
- The color GREEN will be used for FY 2018

Colors will continue in sequence thereafter.

11.3.5.2.3 Slings shall be removed from service if any of the following defects are visible:

- Acid or caustic burns.
- Melting or charring of any part of the surface.
- Snags, punctures, tears, or cuts.

- Broken or worn stitches.
- Wear or elongation exceeding the amount recommended by the manufacturer.
- Distortion of fittings.
- Knots in any part.
- Missing or illegible sling identification.

11.3.5.2.4 A sample periodic inspection form is included as Exhibit 11.3 at the end of this section. This form is intended to be a sample only and is not intended to be mandatory.

11.3.5.3 Proof Testing

11.3.5.3.1 When specified by the purchaser, web slings of all types shall be certified as having been proof-tested prior to initial use.

- The proof load for single-leg slings and endless slings shall be 200% of the vertical rated capacity.
- The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200% of the vertical rated capacity of a single-leg sling. Master links to which multiple-leg slings are connected shall be proof-loaded to 200% times the force applied by the combined legs.

11.3.5.3.2 Test loads shall be accurate to within -5%, +0% of stipulated values. Either certification by the manufacturer or a pull test certified by a qualified person is acceptable.

11.3.5.4 Operation - The following shall apply to all personnel who use synthetic-web slings:

11.3.5.4.1 Determine the weight of the load.

11.3.5.4.2 Select a sling having suitable characteristics for the type of load, hitch, and environment.

11.3.5.4.3 Ensure that slings with end fittings that are used in a choker hitch have sufficient length to that the choking action is on the body of the sling.

11.3.5.4.4 In slings used in a basket hitch, balance the load to prevent slippage.

11.3.5.4.5 Do not drag slings across the floor or over any abrasive surface.

11.3.5.4.6 Do not twist or tie slings into knots.

11.3.5.4.7 Protect slings from being cut by sharp corners, sharp edges, and highly abrasive surfaces.

11.3.5.4.8 Do not pull slings from under loads when a load is resting on a sling.

11.3.5.4.9 Do not use synthetic-web slings to lift loads in excess of the rated capacity, properly derated for other than straight-pull configuration.

11.3.5.4.10 Store synthetic-web slings to prevent mechanical or chemical damage.

11.3.5.4.11 Do not use nylon slings where acid conditions exist.

11.3.5.4.12 Do not use polyester and polypropylene slings where caustic conditions exist.

11.3.5.4.13 Nylon and polyester slings shall not be used on contact with objects or at temperatures in excess of 194° F (90° C), or below -40° F (-40° C). Polypropylene slings shall not be used in contact with objects or at temperatures in excess of 150° F (66° C), or below -40° F (-40° C). The sling manufacturer should be consulted for the temperature range of slings made from other synthetic yarns.

11.3.5.4.14 Do not use aluminum fittings where acid or caustic fumes, vapors, sprays, mists or liquids are present.

11.3.5.4.15 Ensure that each sling is permanently marked to show:

- Name or trademark of manufacturer.
- Manufacturer's code or stock number.
- Rated capacity for types of hitches used.
- Type of synthetic-web material.
- Number of legs, if more than one.

NOTE: Slings may be marked with serial number or other identifying number that can be used to determine capacity in situations where it becomes impossible to mark the sling as described above due to security classification of the load or other valid reason approved by the **person in charge**.

11.3.5.4.13 Ensure that synthetic-web slings are marked with the inspection due date.

11.3.5.4.17 Synthetic slings (e.g., Kevlar, K-Spec, nylon, polyester) may be used in radiation areas only when a qualified person ensures that the absorbed dose does not exceed 100,000 rad during the life of the sling.

11.3.5.5 Critical Lifts

See Chapter 2 for critical lift requirements.

11.3.5.5.1 Synthetic web slings used for critical lift service should have an initial proof test, performed and documented by OEM. If proof test cannot be verified, the **synthetic web** sling shall be load tested before used to make a critical lift. As a minimum the load test shall be equal to the expected load seen by the sling, but shall not exceed the slings' rated capacity.

11.3.6 Synthetic Roundslings

11.3.6.1 General

11.3.6.1.1 Synthetic roundslings shall possess the following qualities:

- Core yarn shall be of a synthetic fiber wound together on a plurality of turns for even distribution of the load.
- In chemically active environments the cover shall be the same type yarn as the load-bearing core.
- The thread used in the manufacture of a synthetic roundsling shall be of the same type of material as the core.
- Finishes and coatings shall be compatible with material of the core, cover, and thread and not impair the performance of the roundsling.

11.3.6.1.2 Fittings shall be:

- Of sufficient strength to sustain twice the rated capacity without permanent deformation.
- Of a minimum breaking strength equal to that of the roundsling.
- Free of all sharp edges that would in any way damage the roundsling.
- Compatible with the mechanical and environmental requirements imposed on the roundsling.

- 11.3.6.1.3 The roundsling manufacturer should be consulted before using roundslings in chemically active environments.
- 11.3.6.1.4 Nylon and polyester slings shall not be used on contact with objects or at temperatures in excess of 194° F (90° C), or below -40° F (-40° C). Polypropylene slings shall not be used in contact with objects or at temperatures in excess of 150° F (66° C), or below -40° F (-40° C). The sling manufacturer should be consulted for the temperature range of slings made from other synthetic yarns.
- 11.3.6.1.5 The design factor for synthetic roundslings shall be a minimum of 5:1 based on breaking strength.
- 11.3.6.1.6 Rated capacities are affected by the type of hitch used and by the angle from the vertical when used as multi-legged slings or in basket hitches. The sling manufacturer shall supply data on these effects.
- 11.3.6.1.7 Despite their inherent toughness, synthetic roundslings can be cut by repeated use around sharp-cornered objects. They eventually show signs of abrasion when they are repeatedly used to hoist rough-surfaced products. There are, however, protective devices offered by most sling manufacturers that minimize these effects.
- 11.3.6.1.8 Synthetic roundslings are available in a number of configurations (see Figure 11-18). Roundsling capacities are listed in Table 11-25; these capacities are approximate only. The capacities are also based on a 5:1 design factor, and assume that the end fittings are of adequate strength.

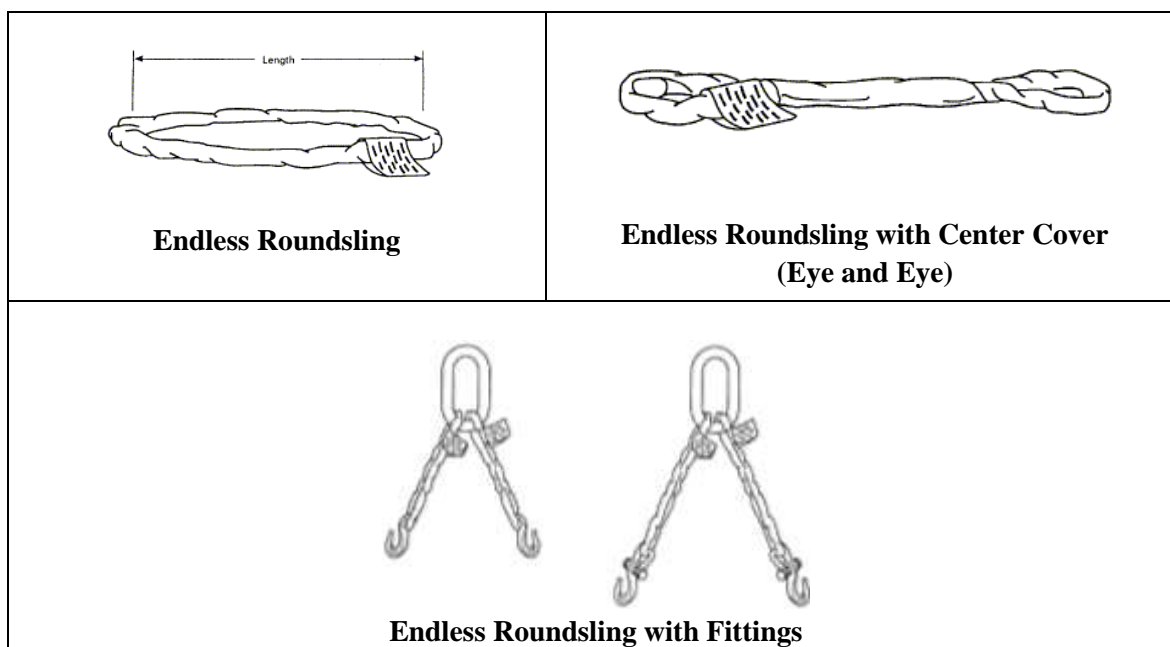








Figure 11-18. Synthetic Roundsling Configurations

Table 11-25
Rated Load for Single-Leg Polyester Roundslings:
Endless and Eye-and Eye Type Expressed in
Pounds

Size	Hitch Type			Horizontal Angle, deg		
						
	Vertical	Choker	Vertical Basket	60°	45°	30°
1	2,600	2,100	5,200	4,500	3,700	2,600
2	5,300	4,200	10,600	9,200	7,500	5,300
3	8,400	6,700	16,800	14,500	11,900	8,400
4	10,600	8,500	21,200	18,400	15,000	10,600
5	13,200	10,600	26,400	22,900	18,700	13,200
6	16,800	13,400	33,600	29,100	23,800	16,800
7	21,200	17,000	42,400	36,700	30,000	21,200
8	25,000	20,000	50,000	43,300	35,400	25,000
9	31,000	24,800	62,000	53,700	43,800	31,000
10	40,000	32,000	80,000	69,300	56,600	40,000
11	53,000	42,400	106,000	91,800	74,900	53,000
12	66,000	52,800	132,000	114,300	93,300	66,000
13	90,000	72,000	180,000	155,900	127,300	90,000

GENERAL NOTES:

(a) Roundslings are identified by the vertical rated load shown on the sling identification. The size numbers in the first column have been adopted by the Web Sling & Tie Down Association to describe certain polyester roundslings. They are included for references only. Other polyester roundslings may have different vertical rated loads.

(b)) Color guidelines for polyester roundsling covers are widely used to indicate the vertical rated load of roundslings; however, this is not followed by some manufacturers. Always select and use roundslings by the rated load as shown on the sling identification; never by color.

(c) For choker hitch, the angle of choke is 120 deg or greater.

11.3.6.2 Inspections

11.3.6.2.1 Users of synthetic roundslings shall visually inspect all slings before each use.

11.3.6.2.3 Annual inspection shall be made by a qualified inspector, and shall be documented by entering inspection data into a computer generated data base and color coding, using a colored nylon wire tie attached to the sling. After annual inspection each roundsling will be color coded to show when next inspection is due as follows with colors continuing in sequence thereafter:

- The color GREEN will be used for FY 2014.
- The color RED will be used for FY 2015.
- The color WHITE will be used for FY 2016.
- The color BLUE will be used for FY 2017.
- The color GREEN will be used for FY 2018.

Colors will continue in sequence thereafter.

11.3.6.2.3 When it is necessary to use a polyester or nylon roundsling in a radiation area, the supervisor or manager in charge of the operation shall ensure that radiation exposure does not exceed 100,000 rad during the life of the sling.

11.3.6.2.4 Slings shall be removed from service if any of the following defects are visible:

- Acid or caustic burns.

- Melting or charring of any part of the surface.
- Snags, punctures, tears, cuts, or abrasive wear that expose the core yarns.
- Broken or worn stitches in the cover which exposes the core yarns.
- Wear or elongation exceeding the amount recommended by the manufacturer.
- Stretched, cracked, worn, pitted or distortion of fittings.
- Knots in any part.
- Missing or illegible sling identification.

A sample periodic inspection form is included as Exhibit 11.3 at the end of this section. This form is intended to be a sample only, and is not intended to be mandatory.

11.3.6.3 Proof Testing

11.3.6.3.1 When specified by the purchaser synthetic round slings of all types shall be certified as having been proof-tested prior to initial use.

- The proof load for roundslings shall be 200% of the vertical rated capacity.
- The proof load for multiple-leg roundslings shall be applied to the individual legs and shall be 200% of the vertical rated capacity of the roundslings. Master links to which multiple-leg roundslings are connected shall be proof-loaded to 200% times the force applied by the combined legs.

11.3.6.3.2 Test loads shall be accurate to within –5%, +0% of stipulated values. Either certification by the manufacturer or a pull test certified by a qualified person is acceptable.

11.3.6.4 Operation

The following shall apply to all personnel who use roundslings:

11.3.6.4.1 Determine the weight of the load.

11.3.6.4.2 Select a sling having suitable characteristics for the type of load, hitch, and environment.

11.3.6.3.3 Ensure that slings with end fittings that are used in a choker hitch have sufficient length so that the choking action is on the body of the sling.

11.3.6.4.4 In slings used in a basket hitch, balance the load to prevent slippage.

11.3.6.4.5 Do not drag slings across the floor or over any abrasive surface.

11.3.6.4.6 Do not twist or tie slings into knots.

11.3.6.4.7 Protect slings from being cut by sharp corners, sharp edges, and highly abrasive surfaces.

11.3.6.4.8 Do not pull slings from under loads when a load is resting on a sling.

11.3.6.4.9 Do not use roundslings to lift loads in excess of the rated capacity, properly derated for other than straight-pull configuration.

11.3.6.4.10 Store roundslings to prevent mechanical or chemical damage.

11.3.6.4.11 Personnel should never stand in line with or next to a roundsling that is under tension.

11.3.6.4.12 if extreme temperatures are involved, ensure the guidance in 11.3.6.d is followed.

11.3.6.4.13 Do not allow the load, hook, or any fitting to constrict, bunch, or pinch roundslings.

11.3.6.4.14 Ensure that roundslings are not used as bridles on suspended personnel platforms.

11.3.6.4.15 For multiple leg roundslings used with non-symmetrical loads, an analysis should be performed by a qualified person to prevent overloading of any leg.

11.3.6.4.16 Ensure that each sling is permanently marked to show:

- Name or trademark of manufacturer.
- Manufacturer's code or stock number.
- Rated capacity for types of hitches used.
- Type of core material and cover material if different from core material.
- Number of legs, if more than one.

NOTE: Slings may be marked with a serial number or other identifying number that can be used to determine capacity in situations where it becomes impossible to mark the sling as described above due to security classification of the loads to be lifted or for other valid reasons approved by the **person in charge**.

11.3.6.4.17 Ensure that roundslings are marked with the inspection due date.

11.3.6.5 Critical Lifts

See Chapter 2 for critical lift requirements.

11.3.6.5.1 Roundslings used for critical lift service should have an initial proof test, performed and documented by OEM. If proof test cannot be verified, the wire rope sling shall be load tested before used to make a critical lift. As a minimum the load test shall be equal to the expected load seen by the sling, but shall not exceed the slings' rated capacity.

NOTE: Exhibits **11.1** through **11.5** are intended to be sample forms only. The equipment manufacturer's inspection/testing criteria supersede any other criteria. In cases where the equipment manufacturer does not include inspection/testing criteria, other forms developed to facilitate required inspection/testing are acceptable.

Exhibit 11.1 Wire-Rope Sling Periodic Inspection (Sample Form)

WIRE-ROPE PERIODIC INSPECTION
(WIRE-ROPE SLINGS)

INSPECTOR _____ INSPECTION DATE _____

Notes:

1. Qualified inspector shall witness and verify all steps below.
2. When required, proof-test to 200% for mechanical-splice and endless slings and 125% for hand-tucked slings of rated capacity to certify new equipment procured without manufacturer's certification. Test loads shall be accurate to within -5%, +0% of the stipulated values.

Wire rope shall be immediately removed from service if any of the following conditions are present:

INSPECTION

1. Ten randomly distributed broken wires in one rope lay or five broken wires in one strand in one rope lay.
2. Wear or scraping of 1/3 the original diameter of the outside individual wire.
3. Kinking, crushing, birdcaging, or any other damage resulting in distortion of the wire-rope structure.
4. Heat damage.
5. Cracked, deformed, or worn end attachments.
6. Hooks that are cracked or opened more than 5% of normal throat opening, not to exceed ¼ inch, measured at the narrowest point or any visibly apparent bend or twist from the plan of the unbent hook.
7. Corrosion of the rope or end attachments.

Size: (Length, Diameter, Etc.) _____ Capacity (SWL) _____

Actual Load Test _____ lb

REMARKS _____

A qualified inspector shall inspect hook by visual examination, liquid penetrant examination or magnetic particle examination.

Acceptance: No cracks, linear indications, laps, or seams.

NDT INSPECTION OF HOOKS/RINGS, ETC. _____

QUALIFIED INSPECTOR _____ DATE _____

Exhibit 11.2 Wire-Rope Periodic Inspection (Sample Form)WIRE-ROPE PERIODIC INSPECTION

INSPECTOR _____ INSPECTION _____ DATE _____

Wire rope shall be immediately removed from service if any of the following conditions are present:

INSPECTION

- _____ 1. Twelve randomly distributed broken wires in one rope lay or four broken wires in one strand in one rope lay.
- _____ 2. Wear or scraping of 1/3 the original diameter of the outside individual wire.
- _____ 3. Kinking, crushing, birdcaging, or any other damage resulting in distortion of the wire-rope structure.
- _____ 4. Heat damage.
- _____ 5. Cracked, deformed, or worn, or improperly applied end attachments.
- _____ 6. Corrosion of the rope or end connections.
- _____ 7. Rope reduction from nominal diameter more than 5%.

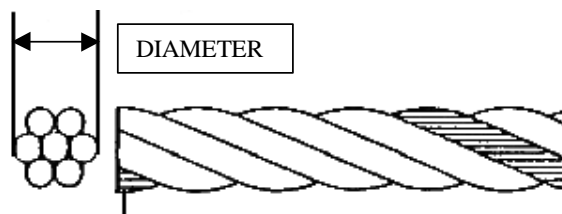
 Size: (Length, Diameter, Etc.) _____ Capacity
 (SWL) _____

REMARKS _____

QUALIFIED INSPECTOR _____ DATE _____

Exhibit 11.3 Wire-Rope Periodic Inspection Report (Historical Record)

(SAMPLE FORM)



	Crane/Sling	Location	Rope Description	Breaking Strength	Application
DATE					
Lay Length					
Measured Diameter					
Rope Damage					
Broken Wires in 1 Strand					
Broken Wires in 1 Lay					
Excess Wear					
Corrosion					
End Attachments Broken Wires					
End Attachments Fitting Condition					
Lubrication					
Pass/Fail					
Signature					

Exhibit **11.4** Rigging Tackle Periodic Inspection –Chain (Sample form page 1 of 2)

Page 1 of 2

RIGGING TACKLE PERIODIC INSPECTION
(CHAIN)

INSPECTOR _____ INSPECTION DATE _____

- Notes: 1. Qualified inspector shall witness and verify all steps below.
2. Proof-test to 200% of rated capacity to certify new equipment procured without manufacturer's certification. Test loads shall be accurate to within -5%, +0% of the stipulated values.

INSPECTION

- _____ 1. Hang chain in a vertical position, if practical, for preliminary inspection. Chain should hang reasonable straight if links are not distorted.
- _____ 2. Accurately measure the reach (inside of crane ring to inside of hook) under no load when new and at each inspection, and keep a record of increase in length.
- _____ 3. Check for localized stretch and wear. Lift each link from its seat and visually inspect for grooving. If grooving is noticed, verify stock diameter of links to be within the minimum safe dimension in the table below.
- _____ 4. Sharp transverse nicks should be rounded out by grinding.
- _____ 5. Check for evidence of heat damage.

Chain slings shall be immediately removed from service if any of the following conditions are present:

- Cracked or deformed master links, coupling links, etc.
- Hooks that are cracked or opened more than 5% of normal throat opening, not to exceed ¼ inch, measured at the narrowest point or any visibly apparent bend or twist from the plane of the unbent hook.
- Wear at any point of any chain link exceeding that shown in the table below.

Nominal Chain or Coupling Link Size		Minimum Allowable Thickness at Any Point on the Link	
in.	mm	in.	mm
7/32	5.5	0.189	4.80
9/32	7	0.239	6.07
5/16	8	0.273	6.93
3/8	10	0.342	8.69
½	13	0.443	11.26
5/8	16	0.546	13.87
¾	20	0.687	17.45
7/8	22	0.750	19.05
1	26	0.887	22.53
1-1/4	32	1.091	27.71

NOTE: For other sizes, consult chain or sling manufacturer.

Rigging Tackle Periodic Inspection –Chain (Sample form page 1 of 2)

Page 2 of 2

RIGGING TACKLE PERIODIC INSPECTION
(CHAIN)

Size and Length _____ Actual Load Test _____ Capacity (SWL) _____

Remarks _____

Qualified inspector shall inspect hook by visual examination, liquid penetrant examination, or magnetic particle examination.

Nondestructive test inspection of hooks/rings, etc. _____

QUALIFIED INSPECTOR _____ DATE _____

Exhibit 11.5 Rigging Tackle Periodic Inspection (Synthetic Web And Round Slings)

RIGGING TACKLE PERIODIC INSPECTION
(SYNTHETIC WEB AND ROUND SLINGS)

INSPECTOR _____ INSPECTION DATE _____

Notes: 1. Proof-test to 200% of rated capacity to certify new equipment procured without manufacturer's certification. Test loads shall be accurate to within -5%, +0% of the stipulated values.

2. Qualified inspector shall witness all steps below.

Synthetic-web slings shall be immediately removed from service if any of the following conditions are present that would give doubt to the integrity of the sling:

_____ a. Acid or caustic burns.

_____ b. Melting or charring of any part of the sling surface.

_____ c. Snags, punctures, tears, or cuts.

_____ d. Broken or worn stitches.

_____ e. Distortion of fittings

_____ f. Wear or elongation exceeding manufacturer's recommendation.

TYPE: Web Sling _____

SIZE: (Length, Diameter, Etc.) _____ Capacity (SWL) _____

REMARKS: _____

QUALIFIED INSPECTOR _____ DATE _____

12.0 CHAPTER 12 - RIGGING ACCESSORIES

This chapter provides/incorporates requirements of ASME B30.26-2004 for rigging accessories used in hoisting and rigging – shackles, eyebolts, rings, wire-rope clips, turnbuckles, rigging hooks, and load-indicating devices.

12.1 GENERAL

12.1.1 Overview

12.1.1.1 The information presented in this chapter provides guidance for safely handling lifted loads. It incorporates requirements of ASME B30.26. Diagrams are used to illustrate hoisting and rigging principles and good and bad rigging practices. This is not a rigging textbook; the information should be applied only by qualified riggers.

12.1.1.2 Rigging accessories that have been damaged or removed from service shall be rendered useless for hoisting and rigging operations before being discarded.

12.1.1.3 Load tables are representative only and are not exact for all materials or all manufacturers.

Table 12-1. Weights of common materials

Article III. Name of Metal	Weight lb/ft ³	Name of Material	Weight lb/ft ³
Aluminum	166	Bluestone	160
Antimony	418	Brick, pressed	50
Bismuth	613	Brick, common	125
Brass, cast	504	Cement, Portland (packed)	100-120
Brass, rolled	523	Cement, Portland (loose)	70-90
Copper, cast	550	Cement, slag (packed)	80-100
Copper, rolled	555	Cement, slag (loose)	55-75
Gold, 24-carat	1,204	Chalk	156
Iron, cast	450	Charcoal	15-34
Iron, wrought	480	Cinder concrete	110
Lead, commercial	712	Clay, ordinary	120-150
Mercury, 60° F	846	Coal, hard, solid	93.5
Silver	655	Coal, hard, broken	54
Steel	490	Coal, soft, solid	84
Tin, cast	458	Coal, soft, broken	54
Uranium	1,163	Coke, loose	23-32
Zinc	437	Concrete or stone	140-155
Name of Wood	Weight lb/ft ³	Earth, rammed	90-100
Ash	35	Granite	165-170
Beech	37	Gravel	117-125
Birch	40	Lime, quick (ground loose)	53
Cedar	22	Limestone	170
Cherry	30	Marble	164
Chestnut	26	Plaster of paris (cast)	80
Cork	15	Sand	90-106
Cypress	27	Sandstone	151
Ebony	71	Shale	162
Elm	30	Slate	160-180
Fir, Balsam	22	Terra-cotta	110
Hemlock	31	Traprock	170
Maple, Oak	62	Water	65
Pine Poplar	30		

12.1.1.4 Determine the weight of the load:

12.1.1.4.1 From markings on the load.

12.1.1.4.2 By weighing, if the load is still on the truck or railroad car.

12.1.1.4.3 From drawings or other documentation.

12.1.1.4.4 By calculation, using load dimensions and weights of common materials in Table 12-1.

12.1.1.4.5 Determine the center of gravity of the load as accurately as possible:

- From drawings or other documentation.
- From markings on the load.
- By calculation.

12.1.1.4.6 Determine the best method to attach the load and select lifting devices (e.g., eyebolts or shackles).

12.1.2 Inspections

12.1.2.1 The operator or other designated person shall visually inspect rigging accessories at the beginning of each work shift or prior to use for the following (records not required):

12.1.2.1.1 Wear.

12.1.2.1.2 Corrosion.

12.1.2.1.3 Cracks.

12.1.2.1.4 Nicks and gouges.

12.1.2.1.5 Distortion such as bending or twisting.

12.1.2.1.6 Evidence of heat damage from any cause.

12.1.2.2 A designated person shall determine whether conditions found during the inspection constitute a hazard and whether a more detailed inspection is required.

12.1.2.3 Rigging accessories having any of the following conditions shall be removed from service:

12.1.2.3.1 Cracks.

12.1.2.3.2 Bent, twisted, distorted, stretched, elongated, cracked, or broken load-bearing components

12.1.2.3.3 Any sign of incipient failure in shear for shackle pins.

12.1.2.3.4 Wear exceeding 10% of original dimensions.

12.1.2.3.5 Excessive corrosion.

12.1.2.3.6 Shackles not marked according to paragraph 12.3, "Shackles."

12.1.2.3.7 Heat damage.

12.1.2.4 A designated person shall perform nondestructive examinations according to applicable ASTM standards.

12.1.2.5 A sample load test and inspection form is included as Exhibit 12.1 at the end of this chapter. This form is a sample only and is not intended to be mandatory.

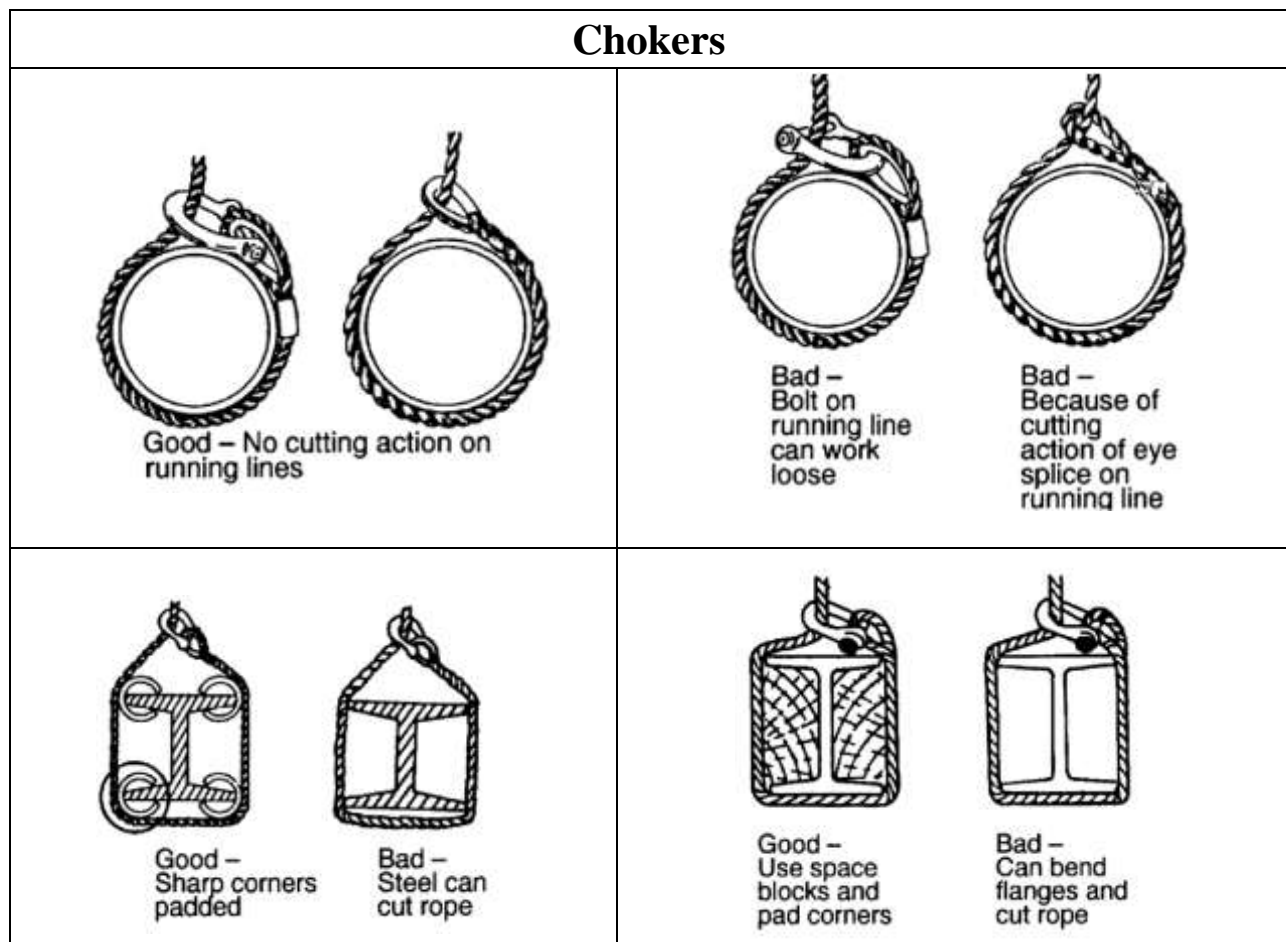
12.1.3 Testing

12.1.3.1 Multileg assemblies shall be proof-tested based on any two legs sharing the entire load. Attach legs not undergoing test in a manner to ensure that load stability is not lost during the test.

12.1.3.2 Dynamometers and load cells shall be calibrated at least once a year and when specified in the critical lift procedure before being used to make a critical lift. This also applies if they have not been used in the previous 6 months. All calibrated devices shall have a tag affixed indicating date of calibration, by whom they were calibrated, and the date that the next calibration is due.

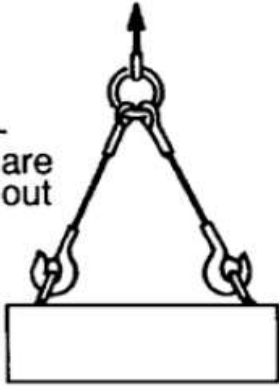
12.1.4 Good and Bad Rigging Practices

Figure 12-1 illustrates some good and bad rigging practices

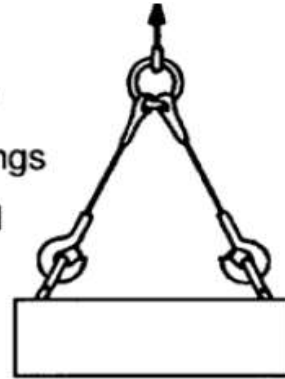


Hook Slings

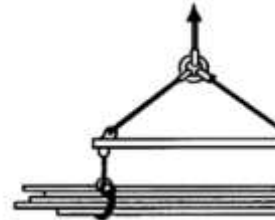
Good –
Hooks are
turned out



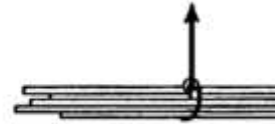
Bad –
Hook
openings
are
turned
in



**Double Slings shall
be used when
hoisting two or
more pieces of
material over 12 feet
long**



Right – Load over 12 ft l



Wrong – Load over 12 ft

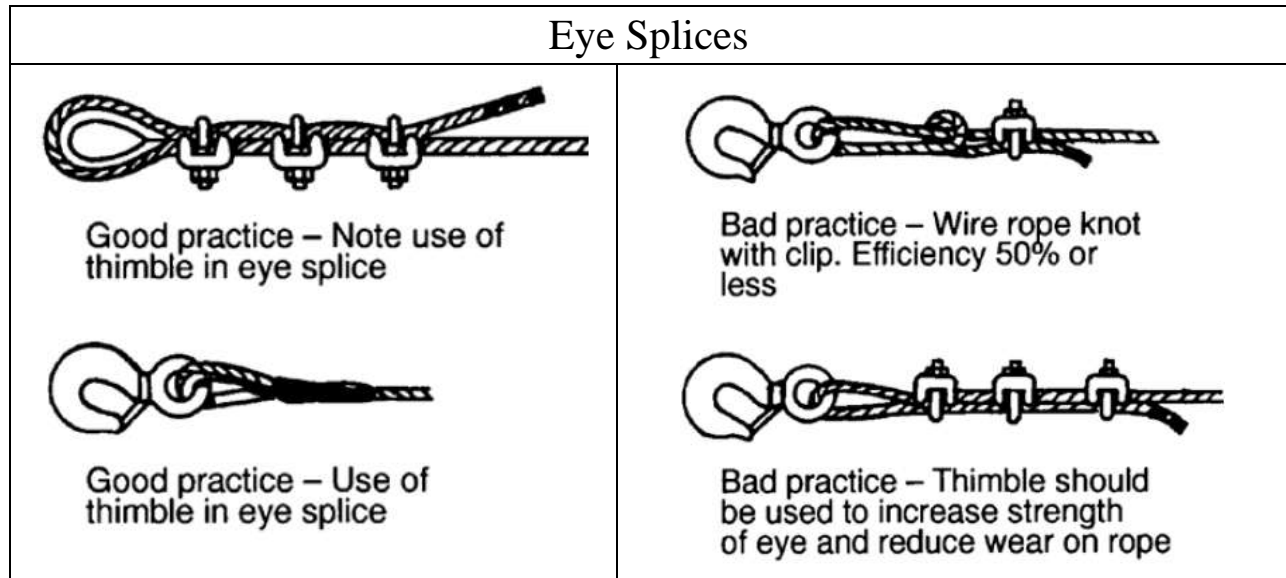
Eyebolts



Good practice—vertical
lift on eyebolt



Bad practice – lifting on eye-
bolts from an angle reduces
safe loads as much as 90%



12.2 RIGGING HOOKS

12.2.1 Design

12.2.1.1 Hook design shall meet generally accepted hook design standards and be compatible with the requirements of ASME B30.10, Chapter 10-2 (see Chapter 13 for equipment load hook requirements.)

12.2.1.2 Latch-equipped hooks shall be used unless the application makes the use of the latch impractical or unnecessary.

12.2.2 Marking

The manufacturer's identification shall be forged, cast, or die-stamped on a low-stress and nonwearing area of the hook.

12.2.3 Construction

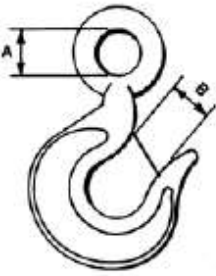
12.2.3.1 The hook material shall have sufficient ductility to permanently deform before failure at the temperature at which the hook will be used.

12.2.3.2 Rated capacities for hooks shall equal or exceed the rated capacity of the chain, wire rope, or other suspension members to which they are attached.

12.2.4 Load Limits

A hook shall not be loaded beyond its rated capacity. See Table 12-2 for hook capacity.

Table 12-2. Strength of standard sling hooks.

	Standard Hook Number	Inside diameter of Eye A (in.)	Throat Opening B (in.)	Rated capacity (tons)
	22	$\frac{3}{4}$	1	0.5
	23	$\frac{7}{8}$	$1 \frac{1}{16}$	0.6
	24	1	$1 \frac{1}{8}$	0.7
	25	$1 \frac{1}{8}$	$1 \frac{1}{4}$	1.2
	26	$1 \frac{1}{4}$	$1 \frac{3}{8}$	1.7
	27	$1 \frac{3}{8}$	$1 \frac{1}{2}$	2.1
	28	$1 \frac{1}{2}$	$1 \frac{3}{4}$	2.5
	29	$1 \frac{5}{8}$	$1 \frac{7}{8}$	3.0
	30	$1 \frac{3}{4}$	$2 \frac{1}{16}$	4.0
	31	2	$2 \frac{1}{4}$	4.7
	32	$2 \frac{3}{8}$	$2 \frac{1}{2}$	5.5
	33	$2 \frac{3}{4}$	3	6.8
	34	$3 \frac{1}{8}$	$3 \frac{3}{8}$	8.0
	34 ^a	$3 \frac{1}{4}$	$3 \frac{5}{8}$	10.0
	35	$3 \frac{1}{2}$	4	11.0
	36	4	$4 \frac{1}{2}$	20.0
	38	$4 \frac{1}{2}$	5	30.0

NOTES:

The above values are for "Vulcan" and similarly designed standard hooks.

(2) The capacity can be found by the diameter of the hole in the eye of the hook. If the throat opening of any hook exceeds the dimension given above the corresponding diameter of the eye, the hook has been over strained and must not be used.

12.2.5 Inspections**12.2.5.1 Initial Inspection**

12.2.5.1.1 A qualified inspector shall inspect all new and repaired hooks prior to initial use to ensure compliance with the applicable provisions of ASME B30.10, paragraph 10-2.2. Dated and signed inspection records shall be kept on file and shall be readily available.

12.2.5.1.2 Inspection procedure and record keeping requirements for hooks in regular service shall be determined by the kind of equipment in which they are used. When such requirements for hooks are stated in standards for the specific equipment, they shall take precedence over requirements of this section.

12.2.5.2 Pre-use Inspection

12.2.5.2.1 The user is to be a designated person (craftsman) and is required to perform a pre-use inspection and determine if hook is in an acceptable condition for use. Inspect for the following (records are not required):

- Distortion, such as bending, twisting, or increased throat opening
- Wear
- Cracks, nicks, or gouges
- Latch engagement (if provided)
- Damage, engagement, or malfunction of latch (if provided).
- Hook attachment and securing means.
- Self-locking hooks for proper operation and locking

12.2.5.2.2 A designated person shall examine deficiencies and determine whether they constitute a safety hazard and whether a more detailed inspection is required.

12.2.5.3 Periodic Inspection

12.2.5.3.1 The operator or other designated person shall visually inspect hooks at designated intervals:

- Normal service – yearly.
- Heavy service – semiannually.
- Severe service – quarterly.

12.2.5.3.2 A qualified inspector shall examine deficiencies and determine whether they constitute a safety hazard.

12.2.5.3.3 The inspection shall include the requirements of paragraph 12.2.52, “Pre-use Inspection”

12.2.5.3.4 Hooks having any of the following conditions shall be removed from service until repaired or replaced:

- Deformation – Any visibly apparent bend or twist from the plane of the unbent hook.
- Throat opening – Any distortion causing an increase in throat opening exceeding 5%, not to exceed ¼ inch (or as recommended by the manufacturer).
- Wear – Any wear exceeding 10% (or as recommended by the manufacturer) of the original section dimension of the hook or its load pin.
- Inability to Lock - Any self-locking hook that does not lock.
- Inoperative Latch – Any latch that does not close the hook’s throat.

12.2.5.3.5 If a latch is provided and it becomes inoperative because of wear or deformation or fails to fully bridge the throat opening, the hook shall be removed from service until the device has been repaired or replaced and the throat opening has been determined not to exceed 5% (or as recommended by the manufacturer).

12.2.5.3.6 Periodic inspections shall be made by a qualified inspector, and inspections shall be documented by entering inspection data into a computer generated database and color coding, using a color nylon wire tie attached to the hook.

12.2.6 Testing

12.2.6.1 Performance testing of hooks shall not be required except where necessary to conform to the requirements for the equipment of which they are part. When tests are specified, documentation shall be uniquely identified to the hook by serial number or other identifier.

12.2.6.2 If detailed inspections are performed (refer to paragraphs 12.2.5.2.2, 12.2.5.3.4, and 12.2.5.4.2), the results shall be evaluated by a qualified person to determine the need for subsequent nondestructive testing (NDT). If NDT is deemed necessary, it shall be performed in accordance with paragraph 13.4.3.

12.2.7 Maintenance

12.2.7.1 A designated person shall repair cracks, nicks, and gouges by grinding longitudinally, following the contour of the hook, provided that no dimension is reduced more than 10% of its original value (or as recommended by the manufacturer).

12.2.7.2 All other repairs shall be performed by the manufacturer.

12.2.8 Operation

The following shall apply to rigging hook users:

12.2.8.1 Determine that the load or force required does not exceed the rated capacity of the hook's assembly, especially when considering special conditions such as choking or grabbing.

12.2.8.2 Avoid shock loading

12.2.8.3 Keep hands, fingers, and body from getting between the hook and the load.

12.3 SHACKLES

12.3.1 General

12.3.1.1 Shackles are made of drop-forged steel bent into shape. They are strong, closed attachments that will not unhook. The shackle shall have sufficient ductility to permanently deform before losing the ability to support the load at the temperatures at which the manufacturer has specified for use. The size is specified by the diameter of the body. Side pulls on shackle body are only permitted if the manufacturer has rated the shackle for that type of lift.

Note: Round pin shackles (restrained by cotter pin only) shall not be used for lifting.

12.3.1.1.1 Body types covered are anchor, chain, and synthetic sling.

12.3.1.1.2 Pin types covered are screw pin and bolt-type.

12.3.1.1.3 Shackles other than those detailed in this chapter shall be used only in accordance with recommendations of the shackle manufacturer or a qualified person.

12.3.1.2 Shackle pins should fit free without binding. Do not substitute a bolt for the shackle pin. Figure 12-3 shows shackles and provides examples of good and bad practices and inspection points.

12.3.1.3 Each shackle body shall be permanently and legible marked by the manufacturer. Raised or stamped letters on the side of the bow shall be used to show:

12.3.1.3.1 Manufacturer's name or identifiable trademark.

12.3.1.3.2 Shackle size.

12.3.1.3.3 Rated capacity (Safe working load SWL/WLL).

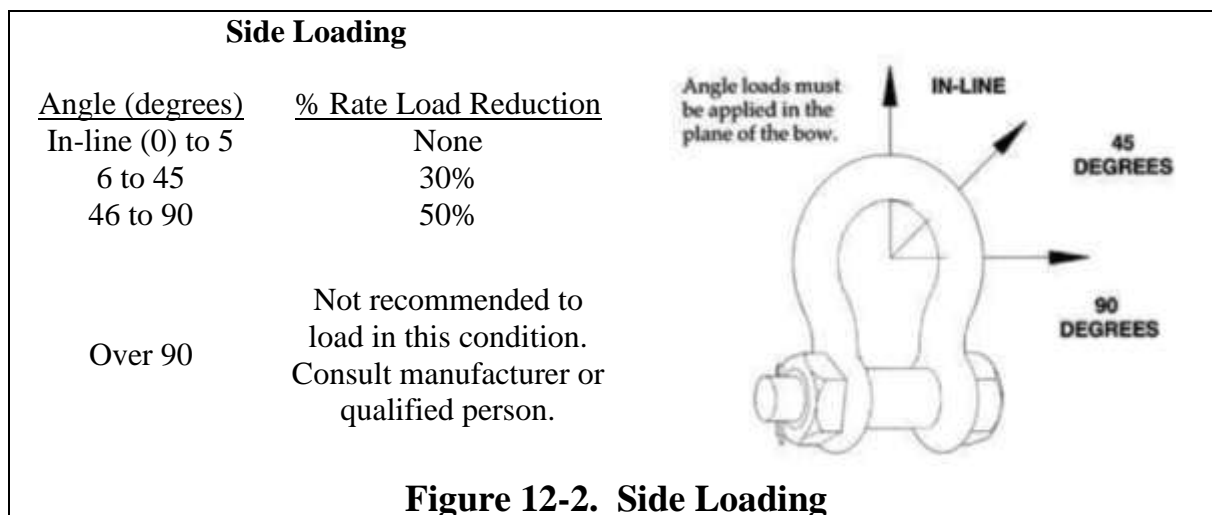
12.3.1.4 Each new shackle pin shall have forged, cast, or die stamped markings by the manufacturer to show:

12.3.1.4.1 Name or trademark of manufacturer

12.3.1.4.2 Grade, material type, or load rating

12.3.1.5 Shackles and/or pins not properly marked shall be permanently removed from rigging service.

12.3.1.6 When shackles are used at load angles other than 90°, the safe-load rating shall be reduced accordingly. (See figure 12-2. Side Loading)



12.3.2 Inspections

12.3.2.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired shackles shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter. Written records are not required.

12.3.2.2 Frequent Inspection

12.3.2.2.1 A visual inspection shall be performed by the user or other designated person each day before the shackle is used. Semi-permanent and inaccessible locations where frequent inspections are not feasible shall have periodic inspections performed.

12.3.2.2.2 Conditions such as those listed in paragraph 12.3.3 or any other condition that may result in a hazard shall cause the shackle to be removed from service. Shackles shall not be returned to service until approved by a qualified person.

12.3.2.2.3 Written records are not required.

12.3.2.3 Periodic Inspection

12.3.2.3.1 A complete inspection of the shackle shall be performed by a designated person. The shackle shall be examined for conditions such as those listed in paragraph 12.3.3 and a determination made as to whether they constitute a hazard.

12.3.2.3.2 Periodic inspection intervals shall not exceed one year. The frequency of periodic inspections should be based on:

- Frequency of shackle use.
- Severity of service conditions.
- Nature of lifts being made.
- Experience gained on the service life of shackles used in similar circumstances.
- Guidelines for the time intervals are:
 - Normal service – yearly
 - Severe service – monthly to quarterly
 - Special service – as recommended by a qualified person

12.3.2.3.3 Written records are not required.

12.3.3 Removal Criteria

12.3.3.1 Shackles shall be removed from service if damage such as the following is visible and shall only be returned to service when approved by a qualified person:

12.3.3.1.1 Missing or illegible manufacturer's name or trademark and/or rated load identification.

12.3.3.1.2 Indications of heat damage including weld spatter or arc strikes.

12.3.3.1.3 Excessive pitting or corrosion.

12.3.3.1.4 Excessive nicks or gouges.

12.3.3.1.5 A 10% reduction of the original or catalog dimension at any point around the body or pin.

12.3.3.1.6 Incomplete pin engagement.

12.3.3.1.7 Excessive thread damage.

12.3.3.1.8 Evidence of unauthorized welding.

12.3.3.1.9 Bent, twisted, distorted, stretched, elongated, or broken load bearing components

12.3.3.1.10 Other conditions that cause doubt as to the continued use of the shackle.

12.3.4 Repairs and Modifications

12.3.4.1 Repairs, alterations, or modifications shall be as specified by the shackle manufacturer or a qualified person.

12.3.4.2 Replacement parts, such as pins, shall meet or exceed the original equipment manufacturer's specifications.

12.3.5 Operating Practices

12.3.5.1 Shackle Selection

12.3.5.1.1 Shackles having suitable characteristics for the type of sling, load, hitch, and environment shall be selected in accordance with the shackle manufacturer's data.

12.3.5.1.2 The rated load of the shackle shall not be exceeded.

12.3.5.1.3 Shackles that appear to be damaged shall not be used until inspected and accepted as usable under paragraph 12.3.2.

NOTE: The angle of loading affects the stress in the shackle. As the horizontal angle decreases, the stress increases in the shackle.

12.3.5.2 Cautions to Personnel

12.3.5.2.1 All portions of the human body shall be kept from between the shackle, the load, and any other rigging during the lift.

12.3.5.2.2 Personnel should stand clear of the suspended load.

12.3.5.2.3 Personnel shall not ride the shackle.

12.3.5.3 Storage and Work Environments

12.3.5.3.1 Shackles should be stored in an area where they will not be subjected to damage, corrosive action, or extreme heat.

12.3.5.3.2 If extreme temperatures or chemically active environments are involved, the guidance provided in paragraph 12.3.6.1 or 12.3.6.2 shall be followed.

12.3.5.4 Rigging Practices

12.3.5.4.1 The screw pin shall be fully engaged, with the shoulder in contact with the shackle body (see Fig. 12-2).

12.3.5.4.2 If a shackle is designed for a cotter pin, it shall be used and maintained in good working condition. Alterations or modifications shall comply with paragraph 12.3.4.

12.3.5.4.3 Contact with sharp edges that could damage the shackle should be avoided.

12.3.5.4.4 Shock loading should be avoided.

12.3.5.4.5 The load applied to the shackle should be centered in the bow of the shackle to prevent side loading of the shackle.

12.3.5.4.6 Multiple sling legs should not be applied to the shackle pin.

12.3.5.4.7 If the shackle is to be side loaded, the rated load shall be reduced according to the recommendations of the manufacturer or a qualified person.

12.3.5.4.8 The screw pin shackle shall not be rigged in a manner that would cause the pin to unscrew.

12.3.5.4.9 For long-term installations, bolt type shackles should be used; if screw pin type shackles are used, the pin shall be secured from rotation or loosening.

12.3.5.4.10 Shackles should not be dragged on an abrasive surface.

12.3.5.4.11 Multiple slings in the body of a shackle shall not exceed 120°° included angle.

12.3.5.4.12 When a shackle is used in a choker hitch, the pin shall be connected to the choking eye of the sling.

12.3.6 Effects of Environment

12.3.6.1 Temperature - When shackles are to be used at temperatures above 400°F (204°C) or below -40°F (-40°C), the shackle manufacturer or a qualified person should be consulted.

12.3.6.2 Chemically Active Environments - The strength of shackles can be affected by chemically active environments such as caustic or acid substances or fumes. The shackle manufacturer or a qualified person should be consulted before shackles are used in chemically active environments.

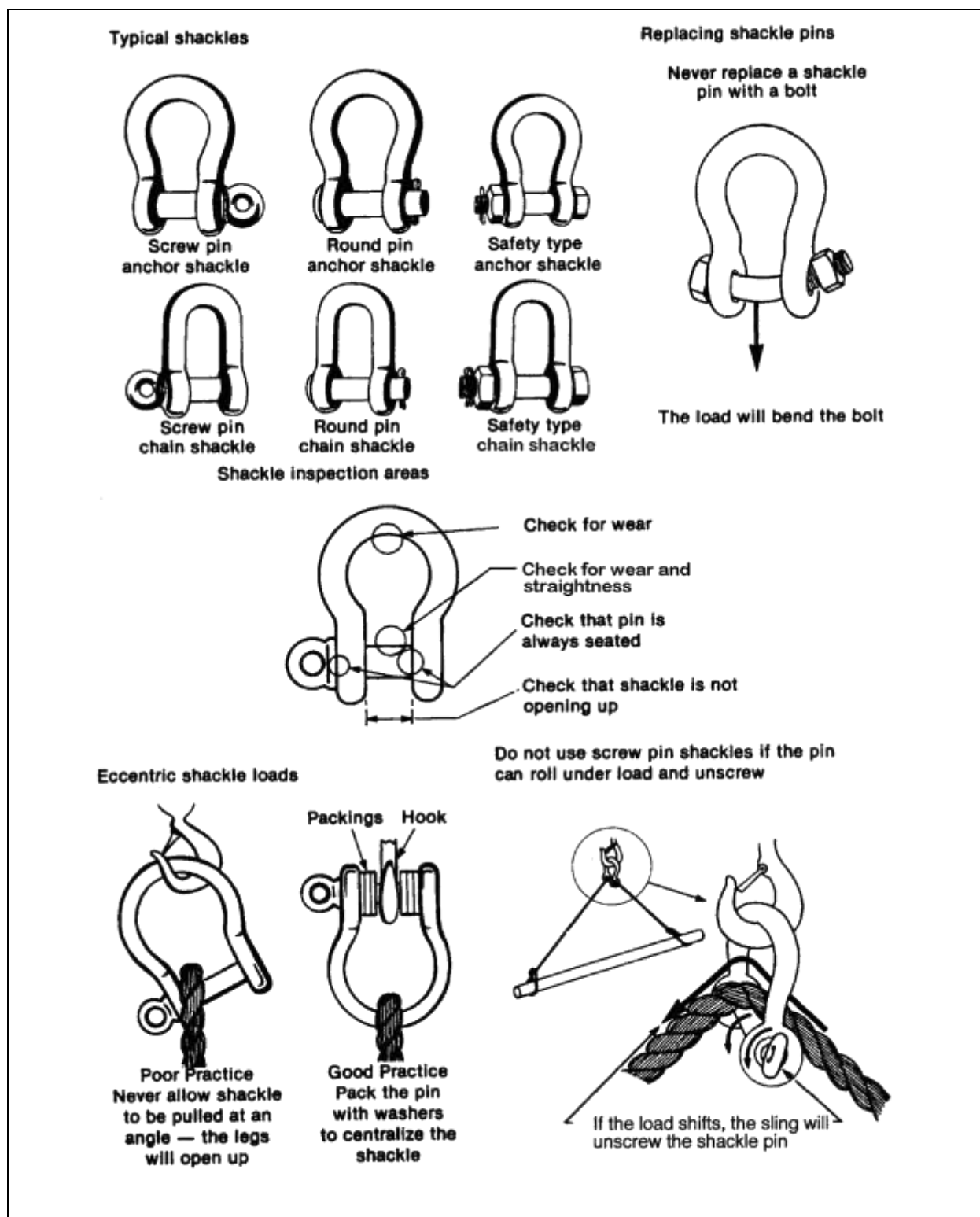


Figure 12-3. Shackles

12.3.7 Design Factor

12.3.7.1 The design factor for shackles up to and including a 150-ton rated load shall be a minimum of 5.

12.3.7.2 The design factor for shackles over 150-ton rated load shall be a minimum of 4.

12.3.8 Rated Loads

Rated load shall be in accordance with the recommendation of the shackle manufacturer. The terms “rated capacity” and “working load limit” are commonly used to describe rated load.

12.3.9 Proof Test

12.3.9.1 Proof Test Requirements

12.3.9.1.1 Shackles are not required to be proof tested unless specified by the purchaser.

12.3.9.1.2 If proof tested, a shackle shall be inspected after the test for the conditions stated in paragraph 12.3.2.

12.3.9.2 Proof Load Requirements

12.3.9.2.1 The proof load for a shackle up to and including a 150-ton rated load shall be a minimum of 2 and a maximum of 2.2 times the rated load unless approved by the manufacturer.

12.3.9.2.2 The proof load for a shackle over a 150-ton rated load shall be a minimum of 1.33 and a maximum of 2 times the rated load unless approved by the manufacturer.

12.3.10 Training

Shackle users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this Chapter.

12.3.11 Critical Lifts

See Chapter 2 for critical lift requirements.

12.3.11.1 Shackles used for critical-lift service shall have an initial proof load test of 200% of the rated capacity. Test weights shall be accurate to within –5%, +0% of stipulated values. If proof testing cannot be verified, the shackle(s) shall be proof tested before being used to make a critical lift.

12.3.11.2 Shackles that have been proof tested for critical service shall have a tag or other marking to indicate clearly to the user that proof testing has been done.

12.4 ADJUSTABLE HARDWARE

12.4.1 General

12.4.1.1 This section applies to adjustable hardware including turnbuckles, eyebolts, eye nuts, and swivel hoist rings that are used as rigging hardware during normal hoisting and rigging activities.

12.4.1.2 Hardware designed for and permanently installed on existing engineered equipment is considered part of the engineered equipment, and they may not meet all requirements specified for rigging hardware. Hardware permanently installed on engineered equipment is acceptable for their intended use so long as they pass normal visual inspection before use. It is important to know how the manufacturer or engineered equipment intends permanently installed hardware to be

used. In some cases the intended use is obvious to an experienced craftsman in other cases engineering review of vendor information may be necessary.

CAUTION: Hardware installed by the manufacturer to lift only parts of the engineered equipment are not suitable for lifting the completed piece of equipment. When questions arise regarding the use of manufactured-installed hardware, the **asset owner, system manager** or AEDC Crane System Engineer shall be consulted.

12.4.2 Types and Materials

12.4.2.1 Types

12.4.2.1.1 Turnbuckles, including open and pipe body types with hook, eye, or jaw end fittings (see Fig. 12.4a and 12.4b).

12.4.2.1.2 Eyebolts including shoulder nut, non-shoulder nut, non-shoulder machinery, and shoulder machinery types (see Fig. 12.5).

12.4.2.1.3 Swivel hoist rings (see Fig. 12.6).

12.4.2.1.4 Adjustable hardware other than those detailed in this chapter shall be used only in accordance with recommendations of the manufacturer or a qualified person.

12.4.2.2 Materials

The hardware, excluding bushings and bearings, shall have sufficient ductility to permanently deform before losing ability to support the load at the temperatures at which the manufacturer has specified for use.

12.4.2.2.1 Eyebolts used for hoisting shall be fabricated from forged carbon alloy or alloy steel.

12.4.2.2.2 Turnbuckles used for hoisting shall be fabricated from forged alloy steel.

12.4.2.2.3 Swivel Hoist Rings shall be fabricated from forged carbon alloy or alloy steel.

12.4.3 Design Factor

The design factor for adjustable hardware shall be a minimum of 5.

12.4.4 Rated Loads

Rated load shall be in accordance with the recommendation of the hardware manufacturer. The terms “rated capacity” and “working load limit” are commonly used to describe rated load.

12.4.5 Proof Test

12.4.5.1 Proof Test Requirements

12.4.5.1.1 New adjustable hardware is not required to be proof tested unless specified by the purchaser.

12.4.5.1.2 All repairs to swivel hoist rings with bushings or bearings should be proof tested.

12.4.5.1.3 If proof tested, adjustable hardware shall be inspected after the test for the conditions stated in paragraph 12.4.9.4.

12.4.5.2 Proof Test Load Requirements

The proof load shall be a minimum of 2 times the rated load.

12.4.6 Hardware Identification/Markings

12.4.6.1 Each turnbuckle, eyebolt, and eye nut shall be marked to show:

12.4.6.1.1 Name or trademark of manufacturer.

12.4.6.1.2 Size or rated load.

12.4.6.1.3 Grade for alloy eyebolts.

12.4.6.2 Each swivel hoist ring shall be marked to show:

12.4.6.2.1 Name or trademark of manufacturer.

12.4.6.2.2 Rated load.

12.4.6.2.3 Torque value.

12.4.6.3 Adjustable hardware identification shall be provided by the manufacturer.

12.4.6.4 Maintenance of Identification

Turnbuckle, eyebolt, eye nut, and swivel hoist ring identification should be maintained by the user to be legible during the life of the hardware.

12.4.7 Effects of Environment

12.4.7.1 Temperature

12.4.7.1.1 When adjustable hardware, excluding swivel hoist rings and carbon steel eyebolts, is to be used at temperatures above 400°F (204°C) or below -40°F (-40°C), the hardware manufacturer or a qualified person should be consulted.

12.4.7.1.2 When swivel hoist rings are to be used at temperatures above 400°F (204°C) or below -20°F (-29°C), the hardware manufacturer or a qualified person should be consulted.

12.4.7.1.3 When carbon steel eyebolts are to be used at temperatures above 275°F (135°C) or below 30°F (-1°C), the hardware manufacturer or a qualified person should be consulted.

12.4.7.2 Chemically Active Environments

The strength of adjustable hardware can be affected by chemically active environments such as caustic or acid substances or fumes. The adjustable hardware manufacturer or a qualified person should be consulted before use in chemically active environments.

12.4.8 Training

Adjustable hardware users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this Chapter.

12.4.9 Inspection, Repair, and Removal

12.4.9.1 Initial Inspection - Prior to use, all new, altered, modified, or repaired adjustable hardware shall be inspected by a designated person to verify compliance with the applicable provisions of this section. Written records are not required.

12.4.9.2 Frequent Inspection

12.4.9.2.1 A visual inspection shall be performed by the user or other designated person each shift before the adjustable hardware is used. Semi-permanent and inaccessible locations where frequent inspections are not feasible shall have periodic inspections performed.

12.4.9.2.2 Conditions such as those listed in paragraph 12.4.9.4 or any other condition that may result in a hazard shall cause the adjustable hardware to be removed from service. Adjustable hardware shall not be returned to service until approved by a qualified person.

12.4.9.2.3 Written records are not required.

12.4.9.3 Periodic Inspection

12.4.9.3.1 A complete inspection of the adjustable hardware shall be performed by a designated person. The adjustable hardware shall be examined for conditions such as those listed in paragraph 12.4.9.4 and a determination made as to whether they constitute a hazard.

12.4.9.3.2 Periodic inspection intervals shall not exceed one year. The frequency of periodic inspections should be based on:

- Frequency of use.
- Severity of service conditions.
- Nature of lifts being made.
- Experience gained on the service life of adjustable hardware used in similar circumstances.
- Guidelines for the time intervals are:
 - Normal service – yearly
 - Severe service – monthly to quarterly
 - Special service – as recommended by a qualified person

12.4.9.3.3 Written records are not required.

12.4.9.4 Removal Criteria - Adjustable hardware shall be removed from service if damage such as the following is present and shall only be returned to service when approved by a qualified person:

12.4.9.4.1 Missing or illegible identification.

12.4.9.4.2 Indications of heat damage including weld spatter or arc strikes.

12.4.9.4.3 Excessive pitting or corrosion.

12.4.9.4.4 Bent, twisted, distorted, stretched, elongated, cracked, or broken load-bearing components.

12.4.9.4.5 Excessive nicks or gouges.

12.4.9.4.6 A 10% reduction of the original or catalog dimension at any point.

12.4.9.4.7 Excessive thread damage or wear.

12.4.9.4.8 Evidence of unauthorized welding or modification

12.4.9.4.9 For swivel hoist rings, lack of the ability to freely rotate or pivot.

12.4.9.4.10 Other conditions, including visible damage, that cause doubt as to continued use.

12.4.9.5 Repairs and Modifications

12.4.9.5.1 Repairs, alterations, or modifications shall be as specified by the adjustable hardware manufacturer or a qualified person.

12.4.9.5.2 Replacement parts, including nuts, pins, and bolts, shall meet or exceed the original equipment manufacturer's specifications.

12.4.10 Operating Practices

12.4.10.1 Adjustable Hardware Selection

12.4.10.1.1 Adjustable hardware having suitable characteristics for the type of load, hitch, angle of loading, and environment shall be selected in accordance with the adjustable hardware manufacturer's data.

12.4.10.1.2 The rated load of the adjustable hardware shall not be exceeded.

12.4.10.1.3 Adjustable hardware that appears to be damaged shall not be used until inspected and accepted as usable per paragraph 12.4.9.

NOTE 1: The angle of loading affects the stress in the hardware. As the horizontal angle decreases, the stress increases (see Table 12.3).

NOTE 2: The integrity of the load where the adjustable hardware attaches is the responsibility of the end user.

12.4.10.2 Cautions to Personnel

12.4.10.2.1 All portions of the human body shall be kept from between the rigging hardware, the load, and any other rigging during the lift.

12.4.10.2.2 Personnel should stand clear of the suspended load.

12.4.10.2.3 Personnel shall not ride rigging hardware.

12.4.10.3 Storage and Work Environments

12.4.10.3.1 Adjustable hardware should be stored in an area where it will not be subjected to damage, corrosive action, or extreme heat.

12.4.10.3.2 If extreme temperatures or chemically active environments are involved, the guidance provided in paragraphs 12.4.7.1 or 12.4.7.2 shall be followed.

12.4.10.4 Rigging Practices

12.4.10.4.1 Turnbuckles

- Before each use, turnbuckles shall be inspected for damage. Damaged threads, jamb nuts, or bent frame members make the unit unsuitable for use.
- Turnbuckles may be used in sling systems that are engineered, designed, and approved as a part of the sling system. Approved turnbuckles shall be marked and identified for use with the sling set for which they were designed and shall be load-tested as part of the sling set.
- Turnbuckle end fitting threads shall be fully engaged in the body threads.
- Components, including pins, bolts, nuts, or cotter pins used with jaw ends, shall be in good working condition prior to use. Alterations or modifications shall comply with paragraph 12.4.9.5.
- Jamb nuts or locking devices must be tightened or locked before making lifts with turnbuckles. See Figure 12-4a for safe working load information and turnbuckle inspection areas.
- Contact with obstructions that could damage or bend the turnbuckle should be avoided.
- Shock loading should be avoided.
- The load applied to the turnbuckle should be in line and in tension.
- Turnbuckles should not be side loaded.

- Turnbuckles used in applications where there is vibration shall be secured to the frame with locks, pins, or wires to prevent turning or loosening
- For long-term installations, turnbuckles shall be secured to prevent unscrewing.
- Turnbuckles should not be dragged on an abrasive surface.
- Turnbuckles should be adjusted with a properly sized wrench, used on the wrench flats of the turnbuckle body.

Turnbuckle Inspection Areas		Turnbuckles		
	Check for cracks and bends Check for thread damage and bent rods	<ul style="list-style-type: none"> • Weldless Construction • Forged Alloy Steel 		
		End fitting, stock diameter (in.)	Safe working load (SWL) of any combination of jaw end fittings, eye end fittings, and stub end fittings (lb)	SWL of any turnbuckle having a hook end fitting (lb)
	Check for cracks and bends Check for thread damage and bent rods	1/4	500	400
		5/16	800	700
	Check for cracks and bends Check for thread damage and bent rods	3/8	1,200	1,000
		1/2	2,200	1,500
	Check for cracks and bends Check for thread damage and bent rods	5/8	3,500	2,250
		3/4	5,200	3,000
	Check for cracks and bends Check for thread damage and bent rods	7/8	7,200	4,000
		1	10,000	5,000
	Check for cracks and bends Check for thread damage and bent rods	1 1/4	15,200	5,000
		1 1/2	21,400	7,500
	Check for cracks and bends Check for thread damage and bent rods	1 3/4	28,000	—
		3	37,000	—
	Check for cracks and bends Check for thread damage and bent rods	2 1/2	60,000	—
		2 3/4	75,000	—

Figure 12-4a. Turnbuckle Inspection Areas

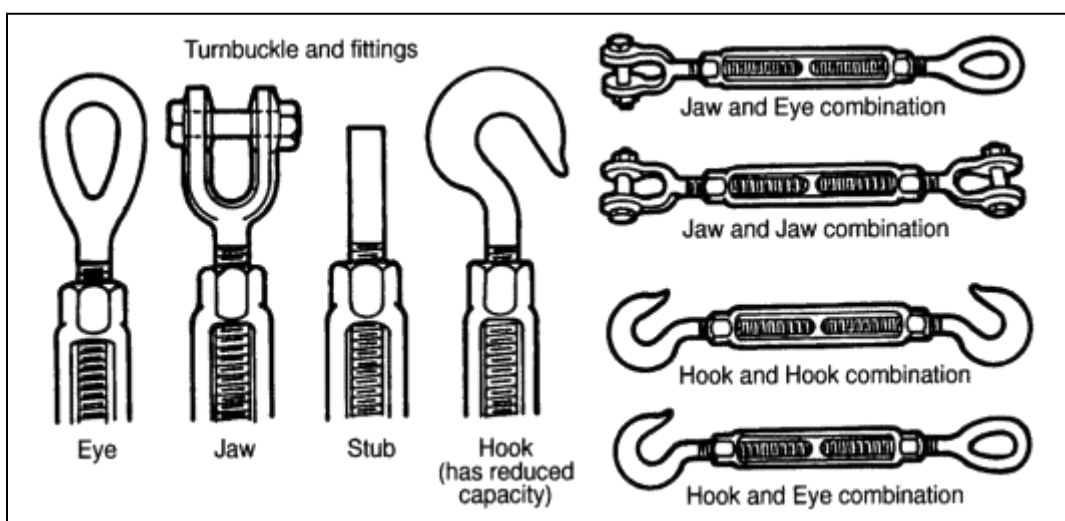


Figure 12-4b. Turnbuckles and Fittings

12.4.10.4.2 Eyebolts

- Do not use wire-type or welded eyebolts in AEDC-lifting operations.
- Carefully inspect each eyebolt before use. Visually inspect the hole to ensure that there has been no deformation. Check the condition of the threads in the hole to ensure that the eyebolt will secure and the shoulder can be brought down snug. Destroy eyebolts that are cracked, bent, or have damaged threads.
- Eyebolts should be tightened or otherwise secured against rotation during the lift.
- Ensure shoulders seat snugly against the surface on which they bear.
- When used in a tapped blind hole, the effective thread length shall be at least 1-1/2 times the diameter of the bolt for engagement in steel (see Figure 12.5). For other thread engagements or engagement in other materials, contact the eyebolt manufacturer or a qualified person prior to use. Alterations or modifications shall comply with paragraph 12.4.9.5.
- When used in a tapped through-hole of less than one diameter thickness, a nut shall be used under the load and shall be fully engaged and tightened securely against the load (see Fig. 12.5).
- When used in an untapped through-hole the nut under the load shall be fully engaged. If the eyebolt is not shouldered to the load, a second nut on top of the load should be used where possible (see Fig. 12.3).
- Eyebolts not shouldered to the load shall only be used for in-line loads (see Fig. 12.5).
- When unshouldered eyebolts are used, do not use nuts, washers, and drilled plated to make shouldered eyebolts.
- Only shoulder eyebolts shall be used for angular lifting. When used for angular lifting, the shoulder shall be flush and securely tightened against the load. The working load limit (WLL) must be reduced as shown in Table 12.3.
- When using shoulder eyebolts for angular lifts, the plane of the eye shall be aligned with the direction of loading. Flat washers may be used under the shoulder to position the plane of the eye (see Fig. 12.5).
- When more than one eyebolt is used in conjunction with multiple-leg rigging, spreader bars, lifting yokes, or lifting beams should be used to eliminate angular lifting. However, where spreaders, yokes, or beams cannot be used, eyebolts may be used for angular lifting, provided that the limiting conditions in Table 12-3 are considered. An angular lift is any lift in which the lifting force is applied at any angle to the centerline of the shank of the eyebolt.
- Shock loading should be avoided.
- Where non-shouldered eyebolts must be used for a critical lift, ensure that an engineering analysis of the loading and load vectors is made and approved before use. Minimize the angle between the sling and the eyebolt axis. In no case shall the eyebolt loading exceed the values shown in Table 12-3.

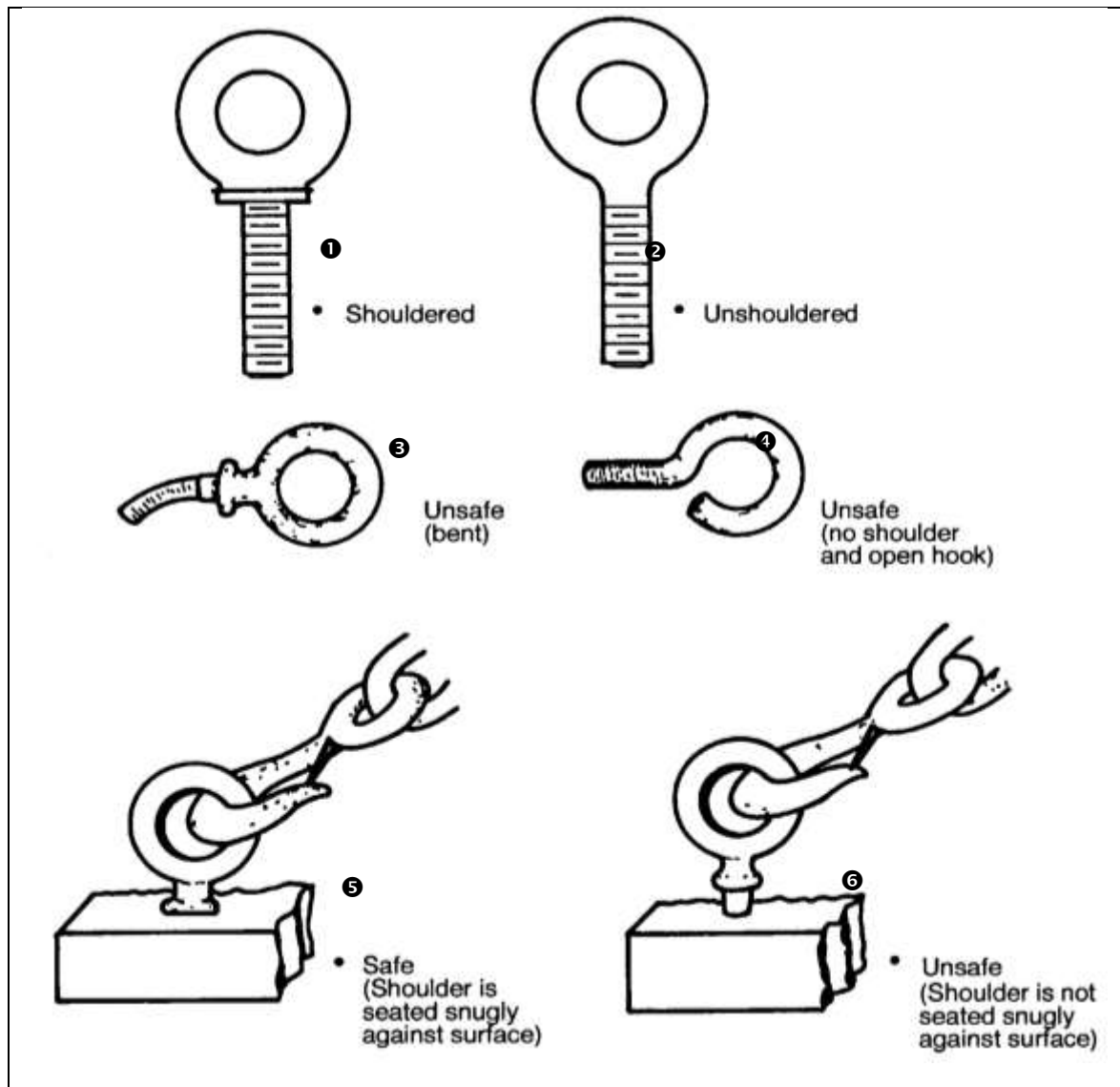


Figure 12-4. Eyebolts

Table 12-3. Safe Loading of eyebolts

<div style="display: flex; justify-content: space-between; align-items: center;"> <div> EYEBOLTS Shoulder Type Only Forged Carbon Steel </div> <div> </div> </div>					
Stock Diameter (in.)	SAFE WORKING LOADS CORRESPONDING TO ANGLE OF PULL				
	Vertical	75°	60°	45°	Less than 45°
¼	500	Reduce vertical loads by 45%	Reduce vertical loads by 65%	Reduce vertical loads by 75%	NOT RECOMMENDED
5/16	800				
3/8	1,200				
½	2,200				
5/8	3,500				
¾	5,200				
7/8	7,200				
1	10,000				
1 ¼	15,200				
1 ½	21,400				

NOTE: The safe working loads for plain (shoulder-less) eyebolts is the same as for shoulder bolts under vertical load. Angular loading is not recommended.

12.4.10.4.3 Swivel Hoist Rings

- Carefully inspect each swivel hoist ring before use (see Figure 12-6). Visually inspect the hole to ensure that there has been no deformation. Components shall be in good working condition prior to use. Alterations or modifications shall comply with paragraph 12.4.9.5.
- Attach lifting device ensuring free fit to the hoist ring bail (see Figure 12-6).
- Install hoist ring to recommended torque with a calibrated torque wrench making sure the bushing flange meets the load (work piece) surface.
- Unless specific torque requirements are specified for the load (work piece) being lifted, the minimum recommended torque shall be as specified by the hoist ring manufacturer.
- Maximum recommended torque requirements specified by the manufacturer should not be exceeded.

- When load is applied to the hoist ring, there should be no interference between the load (work piece) and the hoisting ring (see Figure 12-6).
- Check the condition of the threads in the hole to ensure that the hoist ring will secure and the bushing can be brought down snug.
- Destroy hoist rings that are cracked, bent, have damaged threads, or do not operate freely.
- Permanently installed hoist rings shall be inspected before each use to ensure free movement of bail and swivel. Refer to specific requirements for load (work piece) with permanently installed hoist rings, before checking or retorquing.
- When used in a threaded-hole, the effective thread length shall be 1-1/2 times the diameter of the bolt for steel (see Fig. 12.6). For other thread engagements or engagement in other materials, contact the swivel hoist ring manufacturer or a qualified person.
- When used in a through-hole application, a nut and washer shall be used. The washer and nut shall be in accordance with the swivel hoist ring manufacturer's recommendations. The nut shall be fully engaged (see Fig. 12.6).
- The bushing flange (see Fig. 12.6) shall fully contact the load surface.
- Spacers or washers shall not be used between the bushing flange and the mounting surface of the load being lifted.
- The load applied to the swivel hoist ring shall be centered in the bail to prevent side loading.
- Any attached lifting component shall be narrower than the inside width of the bail to avoid spreading (see Fig. 12.6).
- Ensure that the swivel hoist ring WLL meets or exceeds the anticipated angular rigging tension.
- Shock loading should be avoided.

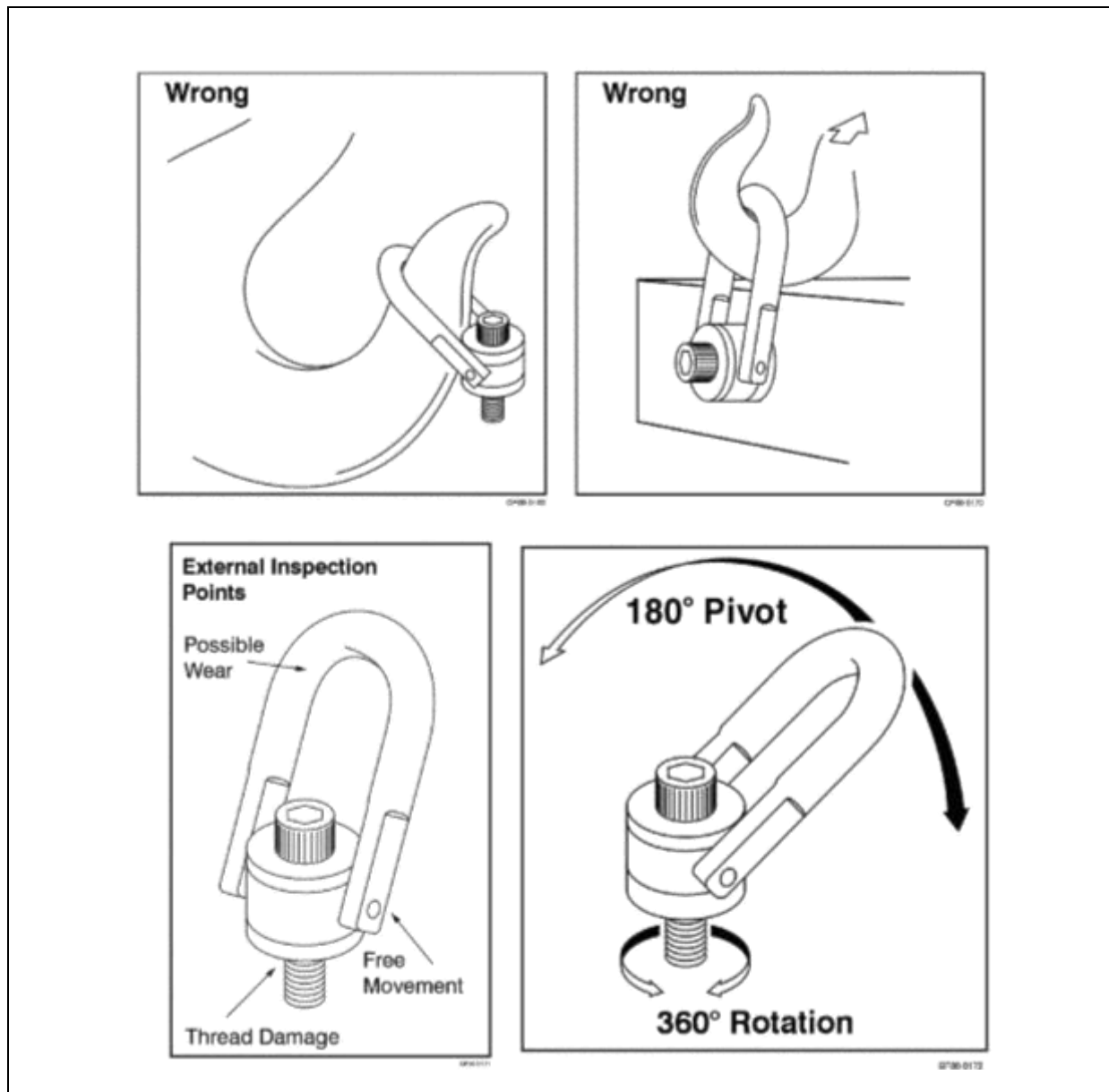


Figure 12-6. Swivel Hoist Rings

12.4.10.4.4 Eye Nuts

- Eye nuts should be secured against rotation during the lift.
- The threads of the eye nut shall be fully engaged.
- Eye nuts shall only be used for in-line loads.
- The plane of the eye may be positioned with a flat washer(s) or lock nut.
- Components shall be in good working condition
- Shock loading should be avoided.

12.4.11 Critical Lifts

See Chapter 2, “Critical Lifts,” for critical lift requirements.

Adjustable hardware used for critical-lift service shall have an initial proof load test of 200% of the rated capacity. Test weights shall be accurate to within -5%, +0% of stipulated values. If proof testing cannot be verified, the Eyebolts shall be proof tested before being used to make a critical lift.

12.5 LINKS AND RINGS

12.5.1 General

Links and rings are usually designed and manufactured as a part of the lifting hardware for a specific purpose, such as the peak link on multiple-leg slings. However, the rings and links may also be found on the load-attachment end of slings. Figure 12-7 shows typical rings and links. Table 12-4 a , b and c provide safe loads for weldless rings and links.

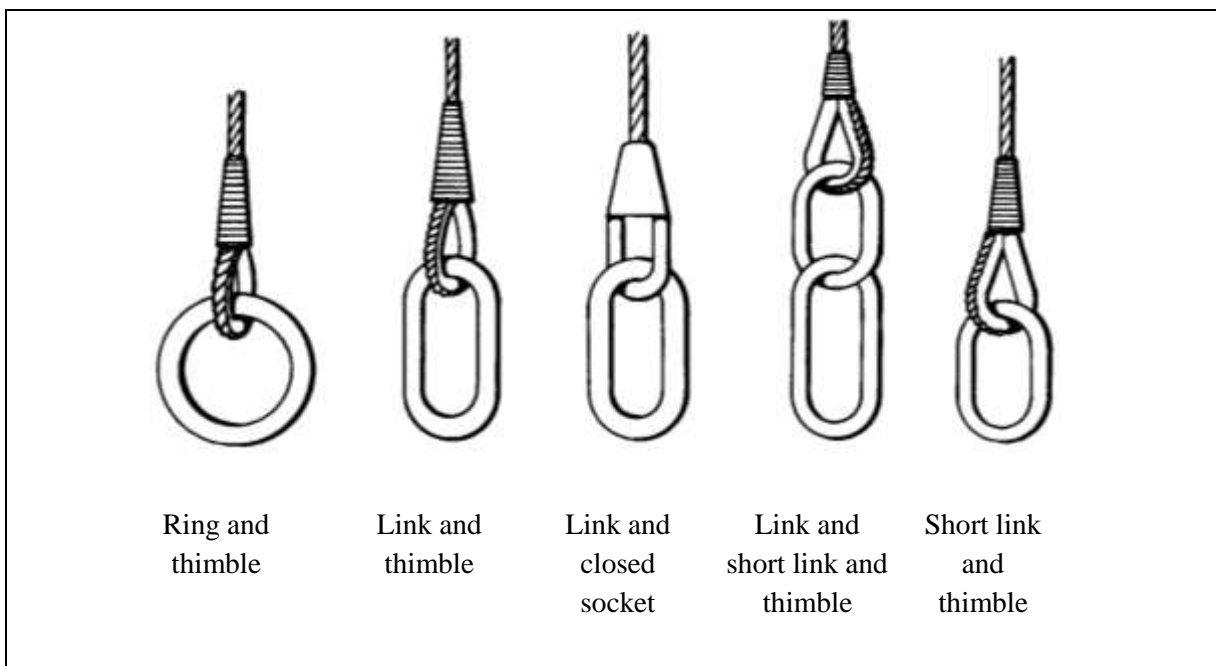


Figure 12-7 Rings and links

Table 12-4. Safe loads for weldless rings and links.
(a. Rings; b. Sling links; c. End links)




Table 12-4a. Rings				
	Dimensions Diameter (Inches)		Estimated Weight Each	Safe load, Single pull
	Stock	Inside	(lb)	(lb)
	7/8	4	2 3/4	7,200
	7/8	5 1/2	3 1/2	5,600
	1	4	3 5/8	10,800
	1 1/8	6	6 1/2	10,400
	1 1/4	5	7	17,000
	1 3/8	6	10	19,000

Table 12-4b. Sling Links

Diam., stock (in.)	Length, inside (in.)	Inside width, small end	Inside width, large end	Est. wt. Per 100 (lb)	Safe load, single pull (lb)	
3/8	2 1/2	3/8	1 1/4	23	1,800	
1/2	3	1/2	1 5/8	50	3,200	
*5/8	3 3/4	1 1/4	2 1/2	110	4,200	
*3/4	4 1/2	1 1/2	3	190	6,000	
*7/8	5 1/4	1 3/4	3 1/2	285	8,300	
*1	6	2	4	430	10,800	
1 1/4	6	1 1/4	3 3/4	700	22,000	
*1 3/8	8 1/4	2 3/4	5 1/2	1125	20,500	

*Sizes of sling links denoted by the asterisk are new and have the larger inside dimensions needed for 2-leg slings.

Table 12-4c. End Links

	Diam., Stock (in.)	Inside length (in.)	Inside width, (in.)	Est. wt. Per 100 (lb)	Suggested Safe loads (lb)
	5/16	1 3/4	1/2	14	2,500
	3/8	1 7/8	9/16	21	3,800
	1/2	2 3/8	3/4	48	6,500
	5/8	3 1/4	1	92	9,300
	3/4	3 1/2	1 1/8	137	14,000
	7/8	5 1/8	2	275	12,000
	1	5 1/8	2	360	17,000
	1 1/4	6 7/16	2 1/4	700	28,000
	1 3/8	7 3/4	2 3/4	1000	30,000

12.5.2 Critical Lifts

See Chapter 2 for critical lift requirements.

Links and rings used for critical-lift service shall have an initial proof load test of 200% of the rated capacity. Test weights shall be accurate to within -5%, +0% of stipulated values. If proof testing cannot be verified, the links and/or rings shall be proof tested before being used to make a critical lift.

12.6 LOAD-INDICATING DEVICES

12.6.1 Load-indicating devices are not required in routine operations where loads of known and essentially consistent weight are to be handled. Rather, load-indicating devices are required for use with loads of uncertain weight that could be within 90-100% of the rated capacity of the equipment or maximum working load of any part of the tackle. Use load-indicating devices where the equipment/tackle configuration could result in binding or friction of the load that could cause a greater stress in the hoist or tackle than would result from the apparent hook load.

12.6.2 The accuracy of load-indicating devices shall depend on the requirements of the load system planned and shall not restrict the system requirements; an accuracy of 2% of full-scale reading within 10-70% of instrument range is recommended. The device should be selected so that the estimated hook load lies between 10 and 70% of the instrument range.

12.6.3 Load-indicating devices shall have a design factor of not less than 3:1

12.7 PRECISION LOAD POSITIONERS

12.7.1 General

12.7.1.1 A precision load positioning device in the load path shall have a design factor of no less than 5:1, based on ultimate strength of the device's load bearing components.

12.7.1.2 Critical Lifts

See Chapter 2 for critical lift requirements.

12.8 COMPRESSION HARDWARE

12.8.1 General

12.8.1.1 Compression Hardware includes forged wire rope clips and wedge sockets.

12.8.1.2 Types cover by this section include:

12.8.1.2.1 U-bolt and double saddled. (see Fig 12-8)

12.8.1.2.2 Wedge sockets. (see Fig 12-9)

12.8.1.2.3 4 Other compression hardware shall be used only in accordance with recommendations of the manufacturer or a qualified person.

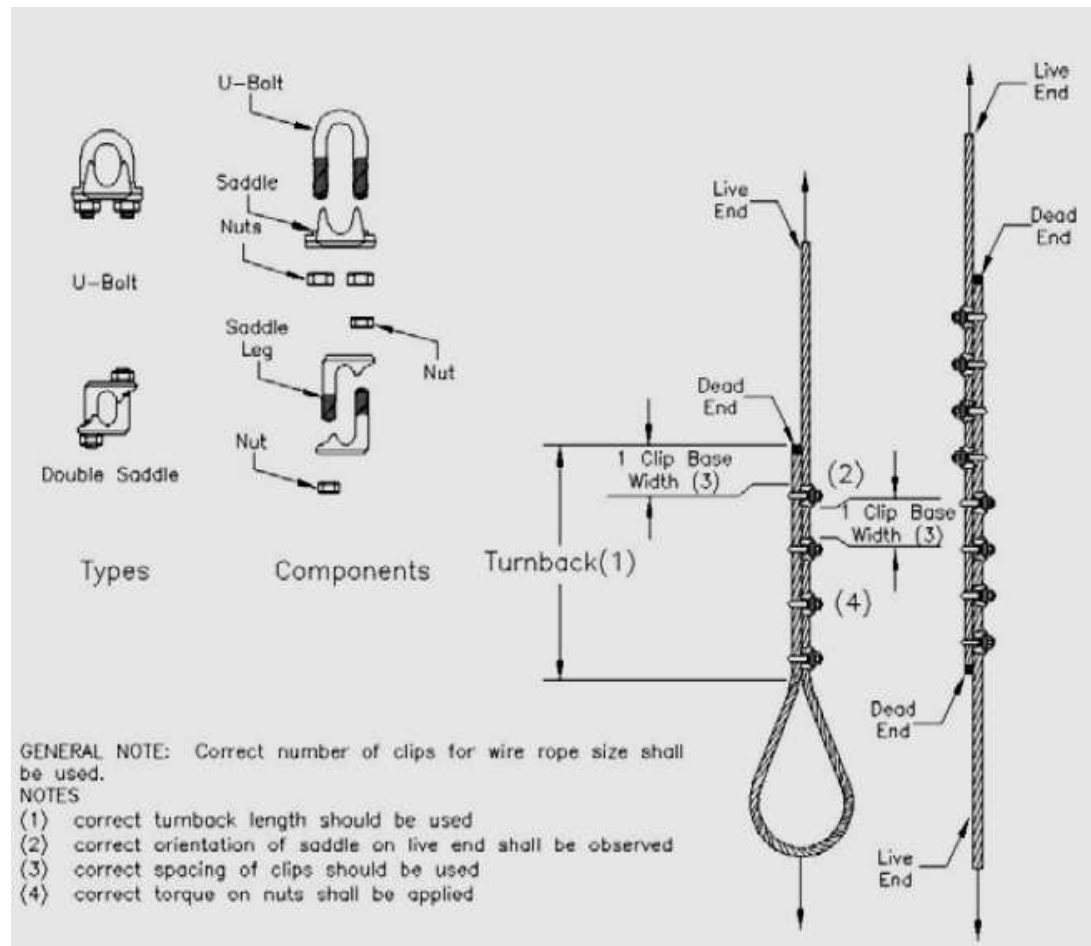


Figure 12-8 U-Bolt and Double Saddle Clips

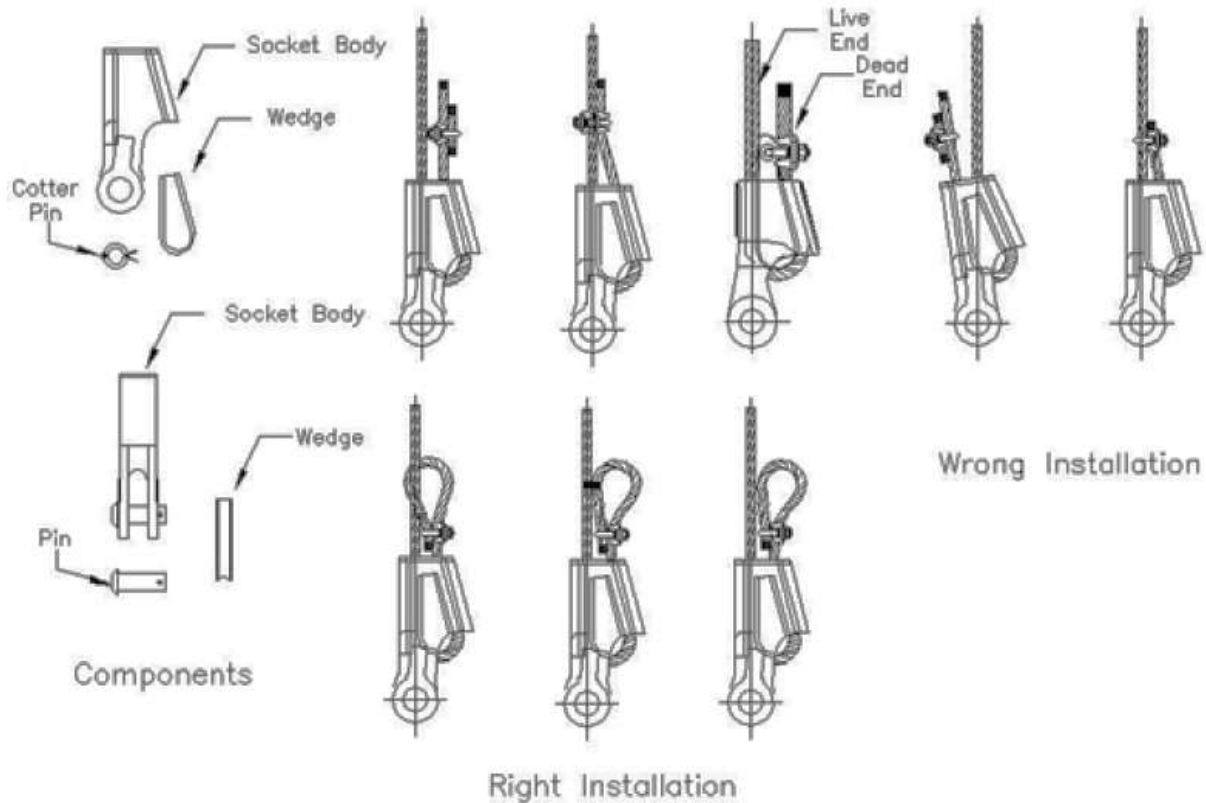


Figure 2-9 Wedge Socket

12.8.1.3 Materials

12.8.1.3.1 Wire rope clip materials shall be of sufficient strength such that failure of the wire rope will occur before failure of the wire rope clip at the temperatures that the manufacturer has specified for use. Saddles shall be forged steel.

12.8.1.3.2 Wedge socket materials shall be of sufficient strength such that failure of the wire rope will occur before failure of the wedge socket at the temperatures, specified for use by the manufacturer.

12.8.1.4 Design Factor

12.8.1.4.1 The rated load for wire rope assemblies using compression hardware is based on the wire rope minimum breaking force, 80% minimum connection efficiency, and the design factor of the wire rope application. The rated load shall not be exceeded.

12.8.1.4.2 Compression hardware is not required to be proof tested unless specified by the purchaser. If a proof test is specified, the load shall be applied to the wedge socket or the connection made by the wire rope clips after the assembly is complete.

- The proof load shall be at least 40%, but not exceed 50% of the minimum breaking force unless approved by the compression hardware manufacturer or a qualified person.
- After proof testing, wire rope clips on a finished assembly shall be re-tightened to the torque recommended by the wire rope clip manufacturer or a qualified person.
- The compression hardware shall then be inspected in accordance with paragraph 12.8.5

12.8.1.5 Identification

12.8.1.5.1 Wire rope clips shall have the manufacturer's name or trademark and the saddle size either forged or die-stamped into the saddle.

12.8.1.5.2 Wedge sockets shall have the manufacturer's name or trademark, the size and model (if required to match the wedge to the body) either forged, cast or die stamped into the wedge and socket body.

12.8.1.6 Use

12.8.1.6.1 Compression hardware should not be in contact with the load or any obstruction during the lift.

12.8.1.6.2 Rigging using compression hardware should not be dragged on an abrasive surface or in contact with sharp edges.

12.8.1.6.3 Wedge sockets should not be side loaded. Impacts can dislodge the wedge from the body and should be avoided.

12.8.2 Assembly

12.8.2.1 Wire Rope Clips

12.8.2.1.1 Before installing a wire rope clip on plastic coated or plastic impregnated wire rope, consult the wire rope clip manufacturer, wire rope manufacturer, or a qualified person.

12.8.2.1.2 For U-bolt clips used to create end terminations, the saddle shall be placed on the live end of the wire rope, with the U-bolt on the dead end side (see Fig. 12-8).

12.8.2.1.3 The minimum number of clips, spacing, turn back, and torque values shall be as recommended by the manufacturer or a qualified person.

12.8.2.1.4 After assembly, the connection shall be loaded to at least the expected working load. After unloading, wire rope clips shall then be retightened to the torque recommended by the manufacturer or a qualified person.

12.8.2.2 Wedge Sockets

12.8.2.2.1 The wedge socket shall be assembled as recommended by the manufacturer or a qualified person.

12.8.2.2.2 Before installing a wedge socket on plastic coated or plastic impregnated wire rope, consult the wedge socket manufacturer, wire rope manufacturer, or a qualified person.

12.8.2.2.3 The live end of the wire rope in the wedge socket cavity shall be in alignment with the socket's pin (see Fig. 12-9).

12.8.2.2.4 The assembler shall match the proper wedge with the socket for the wire rope to be installed.

NOTE: Wedges shall not be interchanged between different manufacturers' sockets or models.

12.8.2.2.5 The length of the dead end tail of the wire rope shall be as required by the manufacturer or a qualified person.

12.8.2.2.6 The dead end tail of the wire rope extending beyond the wedge socket shall be secured in a manner recommended by the wedge socket manufacturer or a qualified person (see Fig. 12-9).

12.8.2.2.7 The dead end of the wire rope shall not be secured to the live end of the wire rope such that it restricts the movement of the live end (see Fig. 12-9).

12.8.2.2.8 After assembly, the connection shall be loaded to fully seat the wedge before use.

12.8.3 Effects of Environment

12.8.3.1 Compression hardware are to be used at temperatures above 400°F (204°C) or below -40°F (-40°C), the compression hardware manufacturer or a qualified person should be consulted.

12.8.3.2 The strength of compression hardware can be affected by chemically active environments such as caustic or acid substances or fumes. The compression hardware manufacturer or a qualified person should be consulted before compression hardware is used in chemically active environments.

12.8.4 Training

Compression hardware users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this standard.

12.8.5 Inspections

12.8.5.1 Initial Inspection

12.8.5.1.1 Prior to use, all new, altered, modified, or repaired compression hardware shall be inspected by a designated person to verify compliance with the applicable provisions of this chapter.

12.8.5.1.2 Written records are not required.

12.8.5.2 Frequent Inspection

12.8.5.2.1 A visual inspection shall be performed by the user or other designated person each shift before the compression hardware is used. Semi-permanent and inaccessible locations where frequent inspections are not feasible shall have periodic inspections performed.

12.8.5.2.2 Conditions such as those listed in paragraph 12.11.7 or any other condition that may result in a hazard shall cause the compression hardware to be removed from service. Compression hardware shall not be returned to service until approved by a qualified person.

12.8.5.2.3 Written records are not required.

12.8.5.3 Periodic Inspection:

12.8.5.3.1 A complete inspection of the compression hardware shall be performed by a designated person. The compression hardware shall be examined for conditions such as those listed in paragraph 12.11.7 and a determination made as to whether they constitute a hazard.

12.8.5.3.2 Periodic inspection intervals shall not exceed one year. The frequency of periodic inspections should be based on:

- Frequency of use.
- Severity of service conditions.
- Nature of lifts being made.
- Experience gained on the service life of compression hardware used in similar circumstances.

12.8.5.3.3 Guidelines for the time intervals are:

- Normal service – yearly.
- Severe service – monthly to quarterly.
- Special service – as recommended by a qualified person.

12.8.5.3.4 Written records are not required.

12.8.6 Removal Criteria

Compression hardware shall be removed from service if damage such as the following is visible, and shall only be returned to service when approved by a qualified person:

12.8.6.1 Missing or illegible manufacturer's name or trademark and/or rated load identification.

12.8.6.2 Indications of heat damage including welding spatter or arc strikes.

12.8.6.3 Excessive pitting or corrosion.

12.8.6.4 Bent, twisted, distorted, stretched, elongated, cracked, or broken components.

12.8.6.5 Excessive nicks or gouges.

12.8.6.6 A 10% reduction of the original or catalog dimension at any point.

12.8.6.7 Evidence of unauthorized welding or modification

12.8.6.8 Unauthorized replacement components

12.8.6.9 Insufficient number of wire rope clips

12.8.6.10 Improperly tightened wire rope clips

12.8.6.11 Indications of wire rope slippage

12.8.6.12 Indications of wire rope damage

12.8.6.13 Improper assembly of other conditions, including visible damage, that cause doubt as to continued use.

NOTE: Exhibit 12.1 is intended to be a sample form only. The equipment manufacturer's inspection/testing criteria supersede any other criteria. In cases where the equipment manufacturer does not include inspection/testing criteria, other forms developed to facilitate required inspection/testing are acceptable.

Exhibit 12.1 Rigging Accessories Load Test and Inspection (Hooks, Shackles, Rings, Etc.) (SAMPLE FORM)

RIGGING ACCESSORIES LOAD TEST AND INSPECTION
(HOOKS, SHACKLES, RINGS, ETC.)

INSPECTOR: _____ INSPECTION DATE: _____

NOTES: 1. Proof test to 200% of rated capacity for critical life service to certify new equipment procured without manufacturer's certification. Test loads shall be accurate to within -5%, +0% of the stipulated values.

_____ 2. Qualified inspector shall witness all steps below.

_____ 3. Accept/reject data should be to manufacturer's specifications. Hooks, shackles, rings, and the like, shall be removed from service and discarded if any of the following conditions are present that would cause doubt of the integrity of the accessories:

A. Corrosion, damage, or undue wear

B. Cracks, twists, or significant change in openings

(1) 5% more than normal opening, not to exceed ¼ inch

(2) Any visibly apparent bend or twist from the plane of the bent hook

(3) 10% wear

(4) 5% elongation of the hook shank.

C. Heat damage.

4. Shackles, rings, etc.

A. Wear, corrosion, spreading, and deformation

(1) 15% deformation of their new condition

(2) Shackle pins – any sign of incipient failure in shear.

Type _____ Size _____ Rated Capacity (SWL) _____

Tested to _____

Serial Numbers _____

Qualified inspector shall perform a nondestructive test by visual examination, liquid penetrant examination, or magnetic particle examination.

Acceptance: No cracks, linear indications, laps, or seams.

QUALIFIED INSPECTOR VERIFY _____ DATE _____

13.0 CHAPTER 13 - LOAD HOOKS

This chapter provides safety standards for the inspection, testing, and maintenance of load hooks installed on cranes or hoists and implements the requirements of ASME B30.10. See Chapter 12 for rigging hook requirements.

13.1 GENERAL

13.1.1 Marking

The manufacturer's identification shall be forged, cast, or die-stamped on a low-stress and non-wearing area of the hook.

13.1.2 Attachments

Hoisting hooks shall be fitted with a latch to bridge the throat opening to prevent the accidental release of slings or attachments. Hooks without latches may be used in special applications where the latch would interfere with the proper use of the hook, providing that (1) the use of the hook is restricted to the application for which it is approved, and (2) in questionable cases, concurrence is obtained from the appropriate safety organization.

13.1.3 Throat Latches

13.1.3.1 A latch or mousing, bridges the throat opening of the hook for retaining slings, chains, or similar parts under slack conditions and is not intended to support the load. Mousing shall not be used to secure the hook throat in manlift operations.

13.1.3.2 Latch equipped hooks shall be used for all hoisting and rigging (H&R) operations unless the application makes use of the latch impractical, or unsafe. The absence of a hook throat latch is not allowed. Unless a specific impractical or unsafe situation can be substantiated, the hook latch is mandatory.

13.1.3.3 Questions concerning requirements for throat latches shall be resolved by the AEDC Crane System Engineer.

13.1.3.4 If a handle or latch support whose design requires heat-treating is welded to the hook, welding shall be done prior to final heat-treating.

13.1.4 Load Limits

Hooks shall not be loaded beyond rated capacity except during load tests of equipment of which they are a part.

13.1.5 Hook Standards

13.1.5.1 Hook design shall meet generally accepted hook design standards and be compatible with the requirements of ASME B30.10.

13.1.5.2 The hook material shall have sufficient ductility to permanently deform before failure at the ambient temperatures at which the hook will be used.

13.1.5.3 When a latch is provided, it shall be designed to retain such items as slings under slack conditions. The latch is not intended to support the load.

13.1.5.4 The bearing surfaces of new hooks shall be the arc of a circle. Gauge points, or hook gauges, for measuring spread after load testing should be provided.

13.1.5.5 Field-fabricated hooks shall meet the requirements of this section and shall be approved by the cognizant engineering and safety organizations.

13.2 INSPECTIONS

13.2.1 Hook Service

Hook service is defined as follows:

13.2.1.1 Normal service – operation at less than 85% of rated capacity except for isolated instances.

13.2.1.2 Heavy service – operation at 85 to 100% of rated capacity as a regular specified procedure.

13.2.1.3 Severe service – operation at heavy service coupled with abnormal operating conditions, (i.e., extreme temperatures, corrosive atmospheres, etc.).

13.2.2 Initial Inspection

13.2.2.1 Prior to initial use, all new and repaired hooks shall be inspected by a qualified inspector to ensure their compliance with the applicable provisions of ASME B30.10, paragraph 10-1.2. Dated and signed inspection records shall be kept on file and shall be readily available.

13.2.2.2 Inspection procedure and record keeping requirements for hooks in regular service shall be governed by requirements for the kind of equipment in which they are used. When such requirements are stated in standards for the specific equipment, they shall take precedence over the requirements of this section.

13.2.2.3 Operators or other designated personnel shall visually inspect hooks for deficiencies such as the following each day or prior to use if the hook has not been in regular service (records are not required):

13.2.2.3.1 Cracks, nicks, and gouges.

13.2.2.3.2 Deformation.

13.2.2.3.3 Damage from chemicals.

13.2.2.3.4 Latch engagement, damage to or malfunction of latch (if provided).

13.2.2.3.5 Evidence of heat damage.

13.2.2.4 A designated person shall examine deficiencies and determine whether they constitute a safety hazard and whether a more detailed inspection is required.

13.2.3 [Deleted]

13.2.4 Frequent Inspection

13.2.4.1 Operators or other designated personnel shall visually inspect the hook at the following intervals (records are not required):

13.2.4.1.1 Normal service – monthly. Operation at less than 85% of rated capacity except for isolated instances.

13.2.4.1.2 Heavy service - weekly to monthly. Operation at 85 to 100% of rated capacity as a regular specified procedure.

13.2.4.1.3 Severe service – daily to weekly. Operation at heavy service coupled with abnormal operating conditions, (i.e., extreme temperatures, corrosive atmospheres, etc.).

13.2.4.2 These inspections shall, in addition to the requirements of 13.2.3, include wear and hook attachment and securing means.

13.2.4.3 A designated person shall examine deficiencies and determine whether they constitute a safety hazard and whether a more detailed inspection is required.

13.2.5 Periodic Inspection

13.2.5.1 A qualified inspector shall perform a complete inspection at the following intervals:

13.2.5.1.1 Normal service – yearly.

13.2.5.1.2 Heavy service - semiannually.

13.2.5.1.3 Severe service – quarterly.

13.2.5.2 A qualified person shall examine deficiencies and determine whether they constitute a safety hazard.

13.2.5.3 The inspection shall include the requirements of paragraph 13.2.4, “Frequent Inspection.”

13.2.5.4 Hooks having any of the following conditions shall be removed from service until repaired or replaced:

13.2.5.4.1 Deformation; any visibly apparent bend or twist from the plane of the unbent hook.

13.2.5.4.2 Any distortion of throat opening causing an increase in throat opening exceeding 5% not to exceed ¼ inch (or as or as recommended by the manufacturer).

13.2.5.4.3 Any wear exceeding 10% (or as recommended by the manufacturer) of the original section dimension of the hook or its load pin.

13.2.5.4.4 Cracks

13.2.5.4.5 If a latch is provided and it becomes inoperative because of wear or deformation or fails to fully bridge the throat opening, the hook shall be removed from service until the device has been repaired or replaced and the throat opening has been assessed as described above.

13.2.5.4.6 Missing or illegible hook manufacturer’s identification or secondary identification and rate load identification.

13.2.5.4.7 Excessive pitting or corrosion.

13.2.5.4.8 Inability to lock any self-locking hook

13.2.5.4.9 Evidence of unauthorized alterations such as drilling, machining, grinding, or other modifications.

13.2.5.5 If hooks are painted, a visual inspection should take the coating into consideration. Surface variations can disclose evidence of heavy or severe service. The surface condition may call for stripping the paint in such instances.

13.2.5.6 Dated and signed inspection records shall be kept on file and shall be readily available.

13.2.5.7 A sample load test and inspection form is included at Exhibit 12.1 in Chapter 12, “Rigging Accessories.” This form is intended to be a sample only and is not intended to be mandatory.

13.3 LOAD HOOKS

13.3.1 Each new or replacement hook of 150-ton capacity or greater and a prototype of each hook design of less than 150-ton capacity shall be proof-tested by the manufacturer in accordance with Table 13-1.

- 13.3.2 When proof tests are used, the hooks shall withstand the proof load application without permanent deformation when the load is applied for a minimum of 15 seconds. This condition is considered satisfied if the permanent increase in the throat opening does not exceed 0.5% or 0.01 in. (0.25 mm), whichever is greater.
- 13.3.3 For a duplex (sister) hook having a pin eye, the proof load for the eye shall be in accordance with Table 13-1. The proof load shall be shared equally between the two prongs of a sister hook, unless the hook is designed for unbalanced loading.
- 13.3.4 Hooks that have been proof-tested shall be inspected by the magnetic-particle method in accordance with ASTM E-709 ("Standard Practice for Magnetic Particle Examination") and shall show no cracks, inclusions, or other relevant discrepancies; casting shall be evaluated in accordance with ASTM E-165 ("Standard Practice for Liquid Penetrant Inspection Method").
- 13.3.5 Performance testing of hooks shall not be required except where necessary to conform to the requirements for the equipment of which they are part. When testing is specified, documentation shall be uniquely identified to the hook by serial number or other identifier.

Table 13-1. Proof test load

Rated load, tons (2,000 lb)	kg	% rated load	Proof load (minimum), tons (2,000 lb)	kg
0.5	453.6	200	1	907.2
1	907.2	200	2	1,814.40
5	4,536	200	10	9,072
10	9,072	200	20	18,144
15	13,608	200	30	27,216
20	18,144	200	40	36,288
25	22,680	200	50	45,360
30	27,216	200	60	54,432
35	31,752	200	70	63,504
40	36,288	200	80	72,576
45	40,824	200	90	81,648
50	45,360	200	100	90,720
60	54,432	193	116	105,235
75	68,040	183	137	124,286
100	90,720	166	166	150,595
125	113,400	150	188	170,554
150	136,080	133	200	181,440
175	158,760	133	233	211,378
200	181,440	133	266	241,315
250	226,800	133	333	302,098
300	272,160	133	399	361,973
350	317,520	133	465	421,848
400	362,880	133	532	482,630
450	408,240	133	598	542,506
500	453,600	133	665	603,288
Above 500	453,600	133		

NOTES:

1 ton (short, 2,000 lb) = 907.2 kg

2. For hooks with load ratings not shown above, use the next lower load rating for determining the % of rated load to be applied.

13.4 NONDESTRUCTIVE TESTING (NDT)

13.4.1 NDT Requirements

13.4.1.1 Hooks in normal service shall receive NDT for site-specific reasons if deemed appropriate by facility management, the **asset owner**, a qualified inspector, or another designated person.

- 13.4.1.2 New crane/hoist hooks that will be assigned to critical lift service should receive an NDT by the hook manufacturer. New crane/hoist hooks that will be assigned to heavy or severe service should receive an NDT by the hook manufacturer. The NDT method, acceptance criteria, and documentation requirements should be determined before the hook is purchased and specified on the purchase requisition.
- 13.4.1.3 Existing crane/hoist hooks with a rated load greater than or equal to 10 tons and assigned to heavy or severe service shall receive an NDT by a qualified inspector at the following intervals:
- 13.4.1.3.1 Heavy service – Annually. Service that involves operating at 85% to 100% of rated load as a regular specified procedure.
- 13.4.1.3.2 Severe service – Semi-annually (every 6 months). Heavy service coupled with abnormal operating conditions.
- 13.4.1.4 If visual examination reveals a surface intersecting discontinuity, twist, increased throat opening, or any other potential defect, NDT shall be employed to further evaluate the hook, regardless of the hook's service classification or rated load.
- 13.4.1.5 If detailed inspections are performed (refer to paragraphs 13.2.3.2., 13.2.4.3, and 13.2.5.2.), the results shall be evaluated by a qualified person to determine the need for subsequent NDT.
- 13.4.1.6 If NDT is deemed necessary, it shall be performed in accordance with paragraph 13.4.3.

13.4.2 NDT Records

Dated and signed NDT records, traceable to the hook by a serial number or other identifier, shall be kept on file as long as the hook remains in service and shall be retained in a master equipment maintenance file which shall be maintained by the AEDC Crane System Engineer. A secondary file may be centrally located or proportioned into satellite holding areas.

13.4.3 NDT Methods

- 13.4.3.1 Use magnetic-particle testing or liquid-penetrant testing methods to inspect for surface intersecting discontinuities.
- 13.4.3.2 A qualified inspector or designated person shall perform NDTs in accordance with the following ASTM E-709 and ASTM E-165.
- 13.4.3.3 For magnetic-particle testing, a coil, yoke, or wet technique should be used to eliminate the possibility of prod burns or arc strikes.
- 13.4.3.4 Perform an NDT with the hook in place unless conditions indicate that disassembly for thread or shank inspection is necessary.

13.4.4 Acceptance Criteria

A designated person shall document and resolve the following relevant indications:

- 13.4.4.1 Arc strikes (welding or electrical).
- 13.4.4.2 Surface intersecting discontinuities 0.25 in. long or longer.

13.4.5 Discontinuity Removal

- 13.4.5.1 Two directions of discontinuity, "P" and "T," are shown on Figure 13-1. Discontinuity "P" parallels the contour of the hook, is considered nonserious, and does not require removal.

Discontinuity “T,” on the other hand, is transverse to the contour of the hook and is more serious; when occurring in zones B, C, or D, discontinuity “T” may reduce the longevity of the hook.

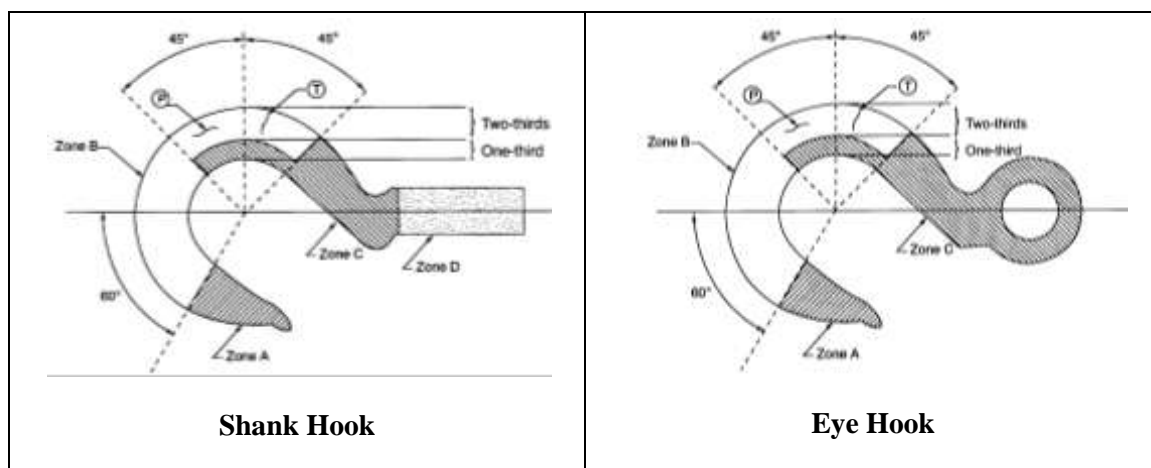


Figure 13-1. Shank and Eye Hooks

13.4.5.2 Discontinuities may be removed by grinding longitudinally following the contour of the hook to produce a smooth, gently undulating surface. In zones B and D, such grinding shall not reduce the original hook dimension by more than 10%. Such a reduction will not affect the working load limit rating or the ultimate load rating of the hook. In zone C, grinding shall not reduce the original dimension by more than 5%.

13.4.5.3 Under normal and proper application, zone A is an unstressed zone. Therefore, it is not required that discontinuities in that zone be ground out.

13.4.5.4 The hook shall be reexamined by performing an NDT after grinding to verify removal of relevant discontinuities.

13.5 MAINTENANCE

13.5.1 A hook latch that is inoperative or missing shall be replaced.

13.5.2 A hook with a latch that does not bridge the throat opening shall be removed from service until the latch is replaced or repaired and the hook is examined for deformation with special attention to the throat opening.

13.5.3 A designated person shall repair cracks, nicks, and gouges by grinding longitudinally, following the contour of the hook, provided no dimension is reduced more than 10% (or as recommended by the manufacturer) of its original value.

13.5.4 All other repairs shall be performed by the manufacturer or a qualified person.

13.6 OPERATION

Hook users shall do the following:

13.6.1 Determine that the weight of the load to be lifted does not exceed the load rating of the hook.

13.6.2 Avoid shock loading.

13.6.3 Center the load in the base (bowl or saddle) of the hook to prevent point loading of the hook.

13.6.4 Do not use hooks in such a manner as to place a side- or backload on the hook.

13.6.5 When using a device to bridge the throat opening of the hook, ensure that no portion of the load is carried by the bridging device.

13.6.6 Keep hands and fingers from between the hook and the load.

13.6.7 Load duplex (sister) hooks equally on both sides, unless the hook is specifically designed for single loading.

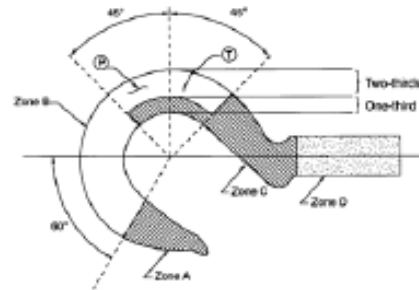
13.6.8 Do not load the pinhole in duplex (sister) hooks beyond the rated load of the hook.

NOTE: Exhibit 13.1 is intended to be a sample form only. The equipment manufacturer's inspection/testing criteria supersedes any other criteria. In cases where the equipment manufacturer does not include inspection/testing criteria, other forms developed to facilitate required inspection/testing are acceptable.

Exhibit 13.1 Hook Periodic Inspection Report (SAMPLE FORM)**Hook Periodic Inspection Report (SAMPLE FORM)**

DEVICE: _____ DEVICE NO.: _____

SERVICE CLASSIFICATION: _____ LOCATION: _____



Two directions of discontinuities are labeled on the drawing above as "P" and "T." discontinuity P parallels the contour of the hook and is considered non-serious in nature and does not require removal from service. Discontinuity T is transverse to contour of the hook and is more serious in nature. Discontinuity T, when occurring in Zones B, C, or D, may reduce longevity of the hook. If the inspection identifies discontinuities, NDT should be considered.

	Original Measurements				
Date					
Throat Opening					
Tram AA					
Tram BB					
Twist Angle					
Crack					
Wear					
Hook Latch					
NDT Performed					
Pass/Fail					
Inspector					
COMMENTS:					
NOTES ON RESULTS:					

14.0 CHAPTER 14 - BELOW-THE-HOOK LIFTING DEVICES

This chapter provides the requirements for below-the-hook lifting devices used in hoisting and rigging, such as spreader bars, lifting yokes, and lift fixtures. This section implements the requirements of ASME B30.20, “Below-the-Hook Lifting Devices.”

14.1 GENERAL

14.1.1 Below-the-hook lifting devices are arranged in the following groups because of the diversity of types:

14.1.1.1 Structural and mechanical lifting devices.

14.1.1.2 Vacuum lifting devices.

14.1.1.3 Close-proximity-operated magnets.

14.1.1.4 Remote-operated magnets.

14.1.2 Slings and rigging accessories that may be components in a below-the hook lifting device are covered in Chapters 11 and 12 (“Wire Rope and Slings,” and “Rigging Accessories,” respectively) of this manual.

14.2 STRUCTURAL AND MECHANICAL LIFTING DEVICES

Structural and mechanical lifting devices are often one-of-a-kind designs. Typical devices are shown in the illustrations below (Figures 14-1 – 14-6).

14.2.1 Design/Fabrication

Structural and mechanical lifting devices shall be designed and fabricated according to the provisions of ASME B30.20, 20-1.2.2.

14.2.2 Marking

14.2.2.1 The rated capacity load of the lifting device shall be legibly marked on its main structure or on a tag attached to its main structure where it is visible. If the lifting device comprises several items, each detachable from the assembly, each lifting device shall be marked with its rated capacity. At a minimum, a nameplate, name tag, or other permanent marker shall be affixed displaying the following data. If nameplate data is not available, device is not to be used until certified and labeled by a qualified engineer or the manufacture of the lifting device.

14.2.2.1.1 Manufacturer’s name (contractor’s name if fabricated onsite).

14.2.2.1.2 Lifting device weight (if over 100 lb).

14.2.2.1.3 Serial number (if applicable).

14.2.2.1.4 Rated capacity.

14.2.2.2 A rerated lifting device shall be relabeled with the new rated capacity.

14.2.3 Modification/Rerating

14.2.3.1 Structural and mechanical lifting devices may be modified or rerated if the changes are analyzed by a qualified engineer or the manufacturer of the lifting device.

14.2.3.2 Rerated or modified lift fixtures shall be load-tested as described in paragraph 14.2.6.2, “Rated Load Test,” below.

14.2.4 Guarding

Exposed moving parts or pinch points, such as gearing, chain drives, and rotating shafts, that may be a hazard to personnel during lifting operations if feasible, shall be guarded.

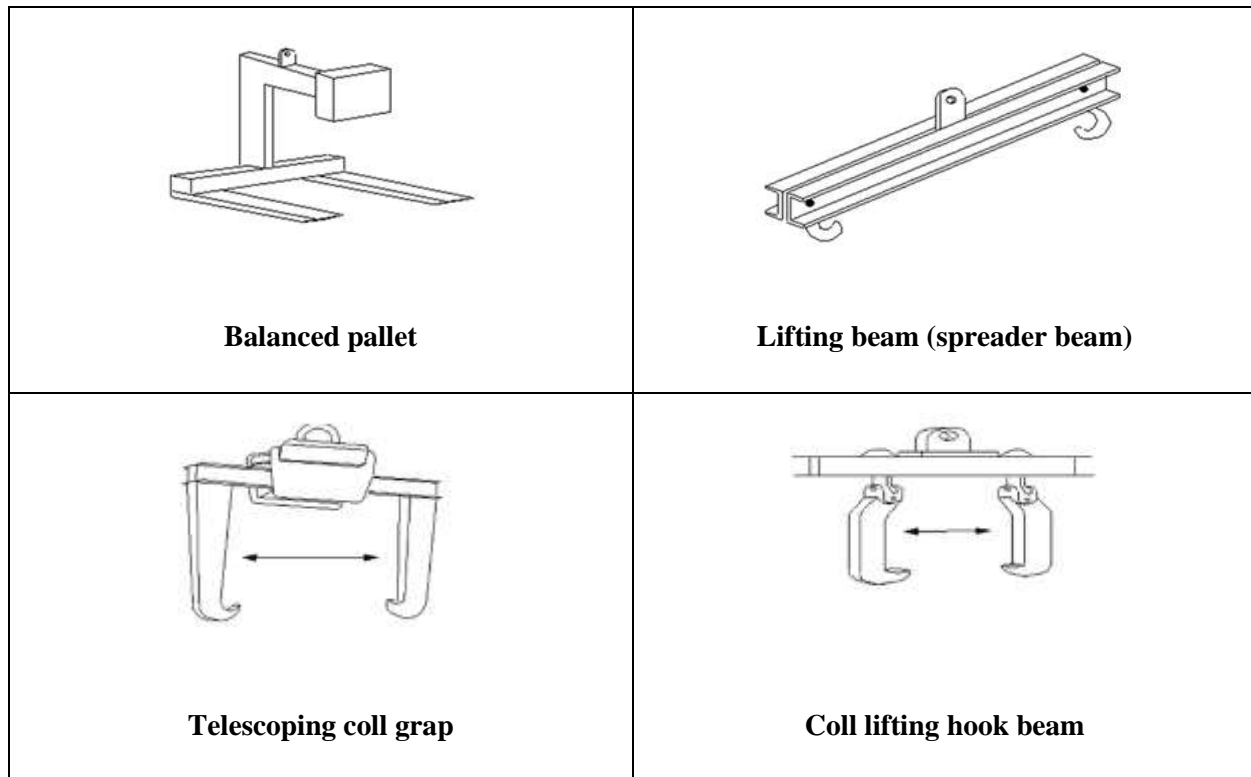


Figure 14-1. Load-supporting lifting devices

14.2.5 Inspections

14.2.5.1 Initial Inspection

Prior to their initial use, a qualified inspector shall inspect all new, modified, or required lifting devices to ensure compliance with paragraph 14.2.5.3, “Periodic Inspection.”

14.2.5.2 Frequent Inspection

14.2.5.2.1 The operator or other designated person shall visually inspect each lifting device at the beginning of each shift or prior to use, if it has not been in regular service, for the following items or conditions (records are not required):

- Structural deformation, cracks, or excessive wear on any part.
- Loose or missing guards, fasteners, covers, stops, or nameplates.
- All operating mechanisms and automatic hold-and-release mechanisms for maladjustments interfering with operation.

14.2.5.2.2 Determine whether they constitute a hazard. Deficiencies noted during the inspection shall be corrected before the lifting device is used.

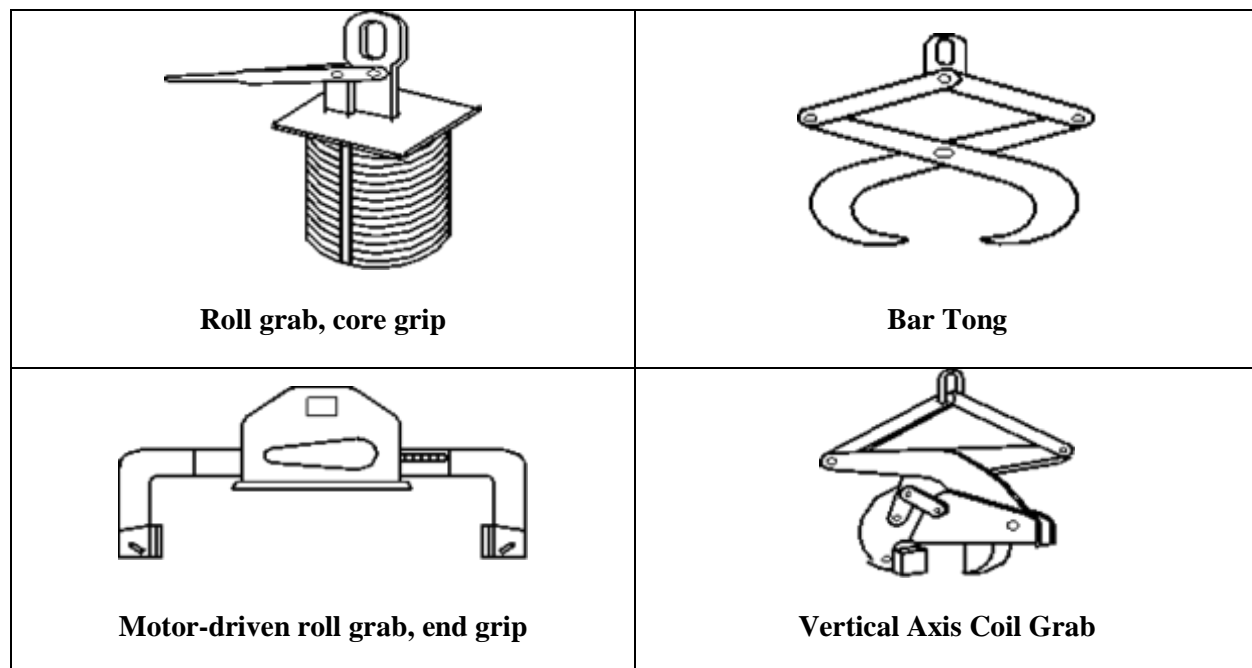


Figure 14-2. Friction-type pressure gripping lifting devices

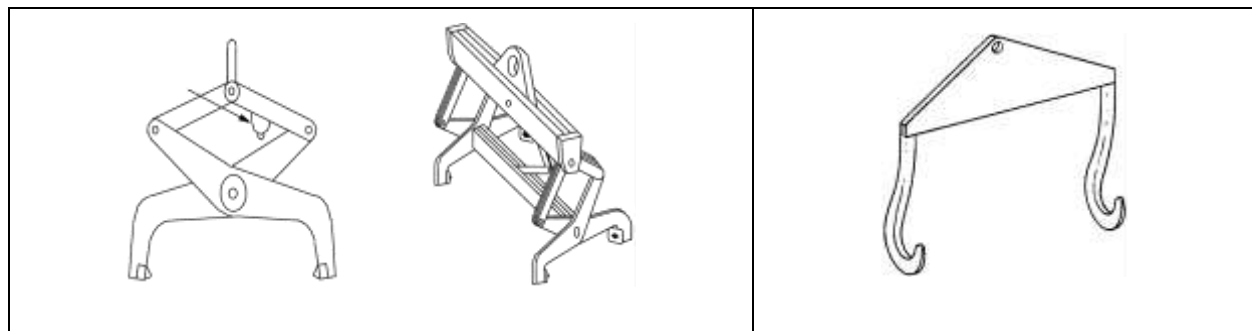


Figure 14-3. Indentation-type gripping lifting devices

Figure 14-4. Typical cask lift fixture

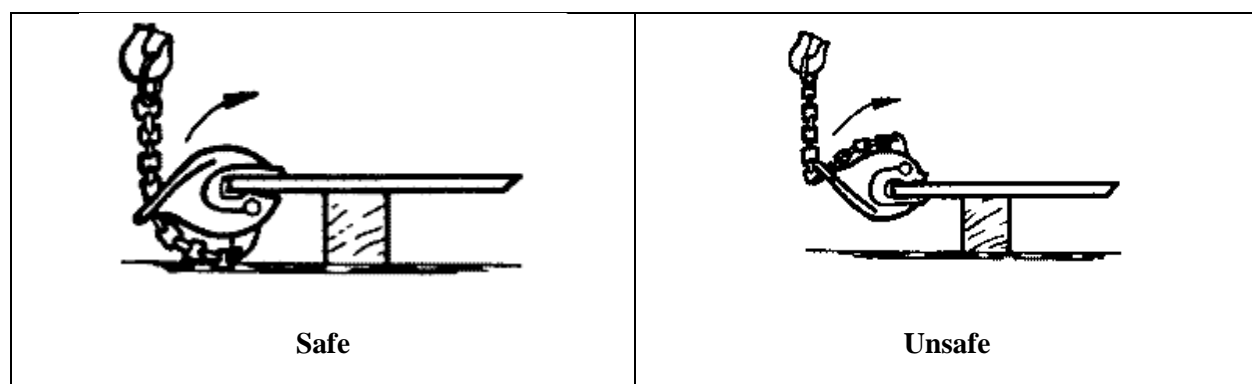
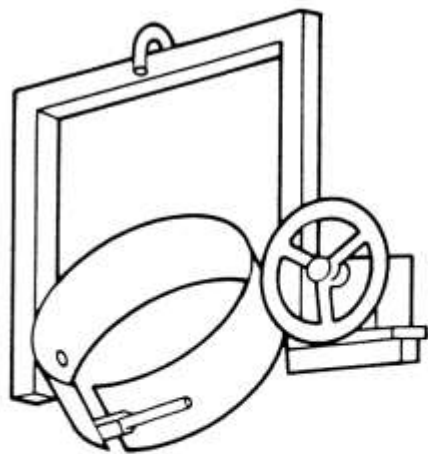
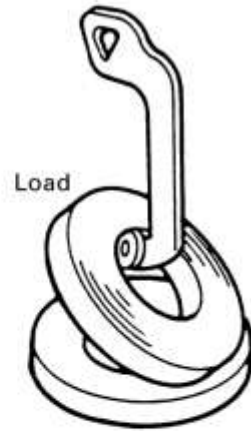


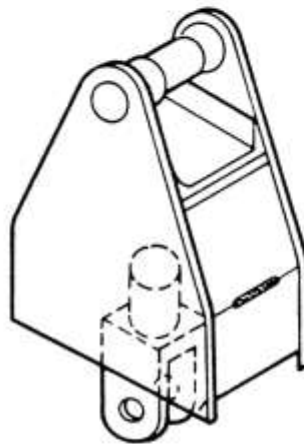
Figure 14-5. Metal-plate clamps



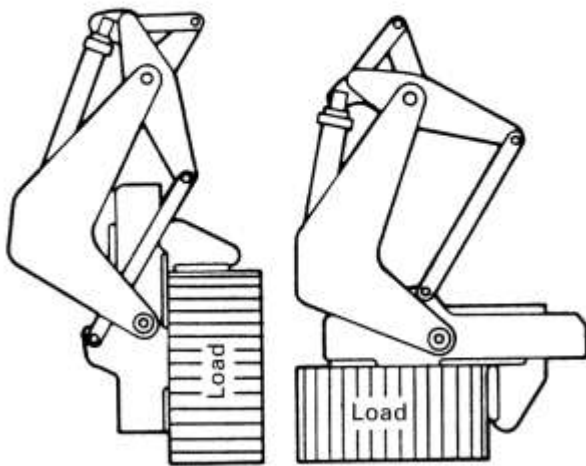
(a) Drum Turner



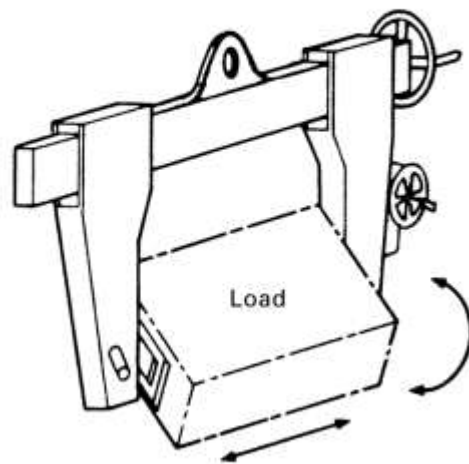
(b) Coil Positioning Hook



(c) Power Rotator



(d) Crane Suspended Coil Positioner



(e) Ingot Turner Grab

Figure 14-6. Manipulating Lifters

14.2.5.3 Periodic Inspection

14.2.5.3.1 A qualified inspector shall perform a complete inspection at the following intervals:

- Normal service – yearly. Inspect equipment at site of use.
- Heavy service – semiannually. Inspect equipment at site of use unless external conditions indicate that disassembly should be done to permit detailed inspection.
- Severe service – quarterly. Inspect equipment at site of use unless external conditions indicate that disassembly should be done to permit detailed inspection.
- Special or infrequent service – as recommended by a qualified person before the first such use and as directed by the qualified person for any subsequent uses.

14.2.5.3.2 Lifting device service is defined as follows:

- Normal – operation with various weights within the rated load limit, or uniform loads less than 65% of rated load.
- Heavy – operation within the rated load limit that exceeds normal service.
- Severe – operation at normal or heavy service under abnormal operating conditions.

14.2.5.3.3 This inspection shall include the items listed in paragraph 14.2.5.2, “Frequent Inspection,” in addition to the following:

- Loose bolts or fasteners.
- Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).
- Cracked or worn gears, pulleys, sheaves, sprockets, bearings, chains, and belts.
- Excessive wear of friction pads, linkages, and other mechanical parts.
- Excessive wear at hoist-attaching points and load-support shackles or pins.
- External evidence of damage to motors or controls.

14.2.5.3.4 A qualified inspector shall inspect fixtures not in regular use according to periodic inspection requirements before placing them in service.

14.2.5.3.5 Dated reports of each periodic inspection shall be prepared. They shall be kept on file and shall be readily available. A sample load test and inspection form is included as Exhibit 1 at the end of this section. This form is intended to be a sample only and is not intended to be mandatory.

14.2.6 Testing

14.2.6.1 Operational Test

Modified or repaired lifting devices shall be tested before initial use to ensure compliance with the requirements of this section (test reports kept on file). Testing shall include the following:

14.2.6.1.1 Lifting devices with moving parts shall be tested to confirm that the lifting device operates in accordance with manufacturer’s instructions.

14.2.6.1.2 Lifting devices with manually operated or automatic latches shall be tested to verify that the latches operate in accordance with manufacturer’s instructions.

14.2.6.2 Rated Load Test

14.2.6.2.1 All new, altered, modified, or repaired lifting devices shall be tested and inspected before use. The results of the test and inspection shall be documented in the equipment history file.

14.2.6.2.2 The rated capacity shall not be more than 80% of the maximum load sustained during the test. Test loads shall not be more than 125% of the rated capacity unless otherwise recommended by the manufacturer. Test weights shall be accurate to within -5%, +0% of stipulated values.

14.2.6.2.3 The rated load test shall consist of the following:

- Hoist the test load a sufficient distance to ensure that it is supported by the lifting device, or apply the required load if the test is made using a testing machine. Personnel shall remain clear of suspended loads.
- Visually inspect the lifting device for deformation, cracks, or other defects after the load test is completed.

14.2.7 Maintenance

14.2.7.1 A preventive maintenance program shall be established based upon manufacturer's recommendations. If equipment maintenance procedures deviate from published manufacturer's recommendations, the alternate procedures shall be approved in advance by the manufacturer or another qualified person and be kept readily available.

14.2.7.2 Replacement parts shall be equivalent to the original specifications.

14.2.8 Training/Qualification

14.2.8.1 Below-the-hook lifting device operators shall be trained and qualified as required in Chapter 6. At a minimum, instruction should include the following:

14.2.8.1.1 Application of the lifting device to the load and adjustments to the device, if any, that adapt it to various sizes or kinds of loads.

14.2.8.1.2 Any special operations or precautions.

14.2.8.1.3 Condition of the load itself required for operation of the lifting device such as balance,^o of order of stacked loads, surface cleanliness, bending, and load thickness.

14.2.8.1.4 Procedure for storage of lifting device to protect it from damage.

14.2.8.1.5 Instructions for not exceeding the rated capacity of the lifting device or the capacity of the hoisting equipment by the combined weight of the load, the lifting device, and the rigging.

14.2.8.2 Operators shall demonstrate the ability and competence to operate the lifting device as instructed before assuming responsibility for using it.

14.2.9 Operation

14.2.9.1 Only the following personnel shall operate structural and mechanical lifting devices:

14.2.9.1.1 Qualified operators or riggers.

14.2.9.1.2 Trainees under the direct supervision of a qualified operator.

14.2.9.1.3 Maintenance and test personnel, when it is necessary in the performance of their duties.

14.2.9.1.4 Inspectors of lifting devices.

14.2.9.2 The following shall apply to all personnel who operate structural and mechanical lifting devices:

- 14.2.9.2.1 Observe the condition of the lifting device before use and during operation. If you observe a defect that affects the continued safe use of the lifting device, remove it from service.
- 14.2.9.2.2 Place any attached load on the floor or ground and, after use, properly store the lifting device before leaving.
- 14.2.9.2.3 Before they are used on each shift, test the lifting device controls. If any controls do not operate properly, adjust or repair them before operations begin.
- 14.2.9.2.4 Do not load the lifting device in excess of its rated capacity (except for test loads) or handle any load for which it is not designed.
- 14.2.9.2.5 Apply the lifting device to the load in accordance with established procedures.
- 14.2.9.2.6 Before lifting, ensure that lifting-device ropes or chains are not kinked and multiple-part lines are not interwoven.
- 14.2.9.2.7 Ensure that the load is correctly distributed for the lifting device being used.
- 14.2.9.2.8 Do not use the lifting device for side pulls or sliding the load unless specifically authorized by a qualified person or by an approved procedure.
- 14.2.9.2.9 Do not use a lifting device that is tagged “Danger – Do Not Operate” or otherwise designated as nonfunctional.
- 14.2.9.2.10 Do not remove “Danger – Do Not Operate” tags from lifting devices without the approval of the person who placed them or an authorized person.
- 14.2.9.2.11 Store the lifting device in a dry, inside location when not in use
- 14.2.9.2.12 Ensure that markings or tags are not removed or defaced. Replace missing or defaced markings or tags.

14.2.10 Critical Lifts

See Chapter 2, “Critical Lifts,” for critical lift requirements. Structural and mechanical lifting devices for critical-lift service shall have an initial proof-load test of not more than 125% of its rated capacity. If proof-testing cannot be verified, the lifting device shall be proof-tested before being used to make a critical lift.

14.3 VACUUM LIFTING DEVICES

Typical power-operated and mechanically operated vacuum lifting and manipulating devices are shown in Figures 14-6 and 14-7. This section does not cover devices used to handle porous materials, which requires special design and construction.

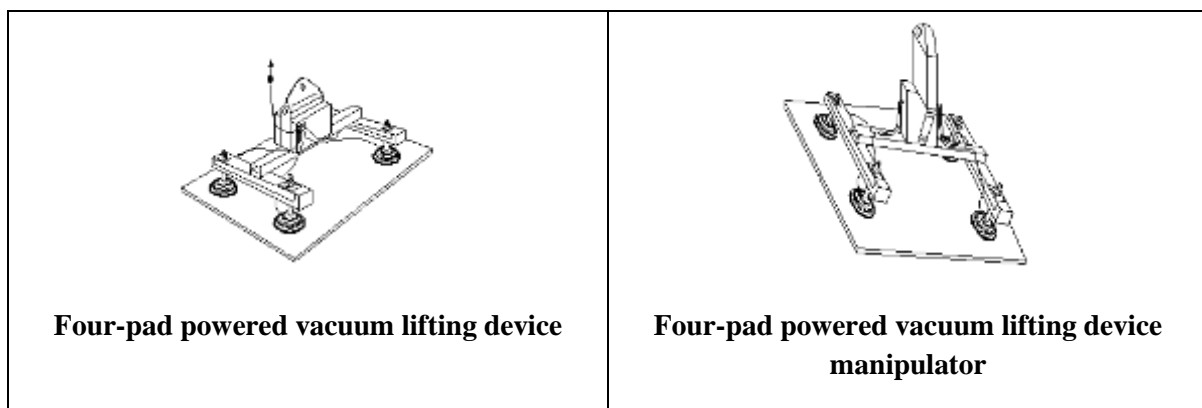


Figure 14-6. Powered vacuum lifting devices.

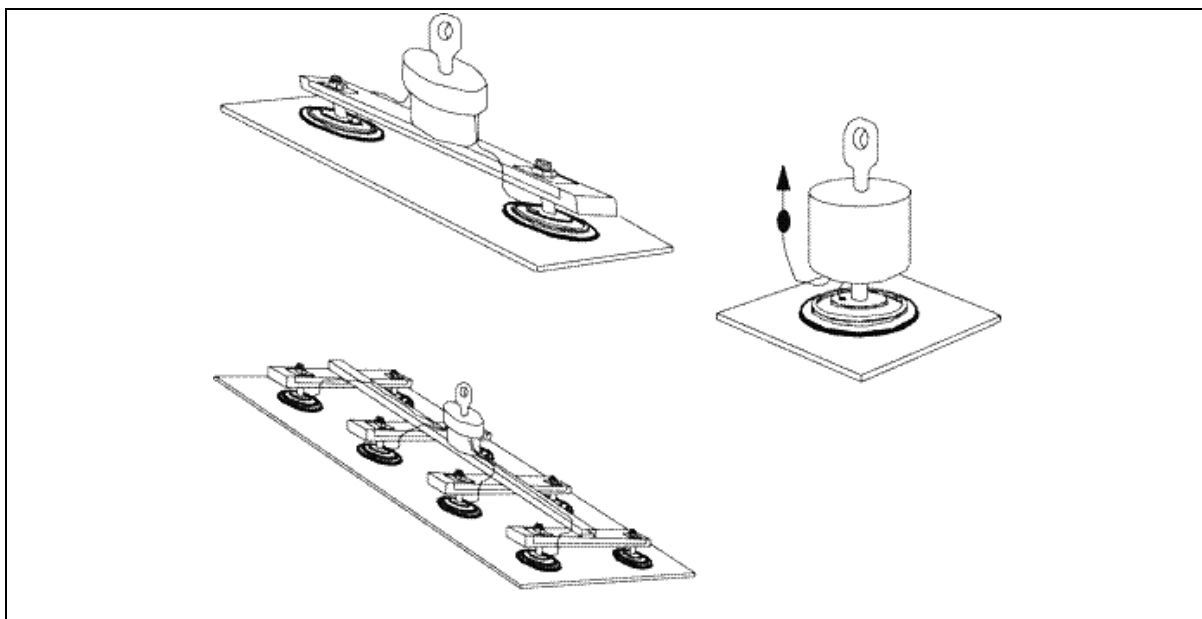


Figure 14-7. Mechanical vacuum lifting devices.

14.3.1 Design/Fabrication

Power- and mechanically-operated vacuum lifting devices shall be designed and fabricated according to the provisions of ASME B30.20, 20-2.2.2.

14.3.2 Marking

14.3.2.1 The rated load of the lifter and each pad shall be legibly marked on its main structure or on a tag attached to its main structure where it is visible.

14.3.2.2 Individual pads or groups of pads, controlled by shutoff valves, shall be marked with the rated capacity of each pad or group of pads.

14.3.2.3 At a minimum, a nameplate, name tag, or other permanent marker shall be affixed to each lifter displaying the following data:

14.3.2.3.1 Manufacturer's name.

14.3.2.3.2 Model number or unit identification.

14.3.2.3.3 Weight of lifting-device.

14.3.2.3.4 Electric power (when applicable).

14.3.2.3.5 Pressure and volume of compressed air (when applicable).

14.3.2.3.6 Rated capacity.

14.3.2.4 Manual shutoff valves on individual pads or groups of pads shall be marked to show operating position.

14.3.2.5 A label or labels shall be affixed to each vacuum lifting device in a readable position that displays the word "WARNING" or other legend designed to bring the label to the attention of the operator. The label shall also contain information cautioning against:

14.3.2.5.1 Exceeding the rated capacity or lifting loads not specified in the manufacturer's instruction manual.

14.3.2.5.2 Operating a damaged or malfunctioning unit or a unit with missing parts.

14.3.2.5.3 Operating when vacuum indicators show insufficient vacuum.

14.3.2.5.4 Operating the unit when vacuum pads are not spaced for equal loading.

14.3.2.5.5 Incorrect positioning of the lifting device on the load.

14.3.2.5.6 Lifting people.

14.3.2.5.7 Moving loads above people.

14.3.2.5.8 Removing/obscuring warning labels.

14.3.2.5.9 Operating the lifting device when the rated capacity, lifting-device weight, or safety markings are missing (except in cases where the device cannot, for security or other reasons, be marked).

14.3.2.5.10 Making alterations or modifications to the lifting device.

14.3.2.5.11 Lifting loads higher than necessary and leaving suspended loads unattended.

14.3.2.6 A label shall be affixed to each unit that directs the user to consult the manufacturer's manual if the size or shape of the unit prohibits the inclusion of the above markings.

14.3.3 Installation

14.3.3.1 Vacuum lifting devices shall be assembled and installed in accordance with the manufacturer's instructions.

14.3.3.2 The power supply to the vacuum lifting device shall be the same as that shown on the nameplate and shall be connected to the line side of the crane disconnect or to an independent circuit.

14.3.3.3 The user shall check for correct rotation of all pumps.

14.3.4 Inspections

14.3.4.1 Initial Inspection

Prior to their initial use, a qualified inspector shall inspect all new or repaired vacuum lifting devices to ensure their compliance with paragraph 14.3.4.3, “Periodic Inspection.”

14.3.4.2 Frequent Inspection

14.3.4.2.1 The operator or other designated person shall inspect each vacuum lifting device at the beginning of each shift or prior to use, if it has not been in regular service.

14.3.4.2.2 The inspection shall be for the following (records are not required):

- Deformation, cracks, and excessive wear of load-bearing parts.
- Adequate vacuum generator output
- Cuts, tears, excessive wear, and foreign particles at vacuum pad seal rings.
- Leakage, cuts, kinks, and collapsed areas of vacuum lines/connections.
- Leaks or damage to the vacuum reservoir.
- Failure of the entire vacuum system to function properly by attaching a non-porous, clean test plate to the vacuum pads and then stopping the vacuum source. Vacuum levels in the system shall not decrease by more than the manufacturer’s specified rate.

14.3.4.3. Periodic Inspection

14.3.4.3.1 A qualified inspector shall perform a complete inspection at the following intervals:

- Normal service – yearly. Inspect equipment at site of use.
- Heavy service – semiannually. Inspect equipment at site of use unless external conditions indicate that disassembly should be done to permit detailed inspection
- Severe service – quarterly. Inspect equipment at site of use unless external conditions indicate that disassembly should be done to permit detailed inspection.
- Special or infrequent service – as recommended by a qualified person before the first use and as directed by the qualified person for any subsequent occurrences.

14.3.4.3.2 Lifting device service is defined as follows:

- Normal – operation with various weights within the rated load limit, or uniform loads less than 65% of rated load.
- Heavy – operation within the rated load limit that exceeds normal service.
- Severe – operation under normal or heavy service with abnormal operating conditions

14.3.4.3.3 This inspection shall include those conditions or items specified in 14.3.4.2, “Frequent Inspection,” in addition to the following:

- External evidence of looseness, wear, deformation, cracking, or corrosion.
- External evidence of damage to supporting structure, motors, controls, and other auxiliary components.
- Check for suspect/counterfeit parts (see Chapter 1).
- Presence of warning label required in 14.3.2.

14.3.4.3.4 A qualified inspector shall inspect fixtures not in regular use according to periodic inspection requirements before placing them in service.

14.3.4.3.5 Dated inspection reports shall be prepared for each inspection. Inspection records shall be kept on file and shall be readily available.

14.3.5 Testing

14.3.5.1 Operational Test.

14.3.5.1.1 All new, reinstalled, modified, or repaired vacuum lifting fixtures shall be tested prior to use. Tests shall be performed by a qualified inspector or under the direction of that inspector to ensure compliance with the requirements of this section. Dated reports shall be kept on file.

14.3.5.1.2 Testing shall include the following:

14.3.5.1.3 Seals and connections shall be tested for leaks by attaching a nonporous, clean test plate to the vacuum pads and then stopping the vacuum source. Vacuum level in the system shall not decrease by more than the rate specified by the manufacturer.

14.3.5.1.4 Test indicator lights, gauges, horns, bells, pointers, or other warning devices and vacuum level indicators for proper operation.

14.3.5.2 Rated Load Test

14.3.5.2.1 All new, reinstalled, repaired, or modified vacuum lifting devices shall be tested and inspected before use. Tests and inspections shall be performed by a qualified inspector or under the direction of that inspector. Test and inspection results shall be documented and kept on file.

14.3.5.2.2 The rated capacity shall not be more than 80% of the maximum load sustained during the test. Test loads shall not be more than 125% of the rated capacity unless otherwise recommended by the manufacturer. Test weights shall be accurate to within -5%, +0% of stipulated values.

14.3.5.2.3 The rated load test shall consist of the following steps at a minimum:

- Attach pads to the designated test load.
- Raise the test load a minimum distance to ensure that it is supported by the vacuum lifting device, and hold it for 2 minutes.
- Remain clear of the suspended load.
- Lower and release the load.
- Visually inspect the vacuum lifting device for defects, and correct any deficiencies prior to returning the device to service.

14.3.6 Maintenance

14.3.6.1 A preventive maintenance program shall be established and be based on recommendations made by the vacuum lifting device manufacturer or a qualified person.

14.3.6.2 Replacement parts shall be equivalent to the original specifications.

14.3.6.3 The vacuum generator, vacuum pads, sealing rings, mufflers, and filters should be maintained and cleaned according to the manufacturer's specifications.

14.3.7 Training/Qualification

14.3.7.1 Vacuum lifting device operators shall be trained and qualified as specified in Chapter 6, "Personnel Qualification and Training." At a minimum, instruction should include the following (as applicable):

- 14.3.7.1.1 Application of the lifting device to the load and adjustments of the device, if any, that adapt it to various sizes or kinds of loads.
- 14.3.7.1.2 Any special operations or precautions.
- 14.3.7.1.3 Condition of the load itself required for operation of the lifting device such as balance, ° of order of stacked loads, surface cleanliness, bending, and load thickness.
- 14.3.7.1.4 Procedure for storage of lifting device to protect it from damage.
- 14.3.7.1.5 Instructions for not exceeding the rated capacity of the lifting device or the capacity of the hoisting equipment by the combined weight of the load, the lifting device, and the rigging.
- 14.3.7.1.6 Charging of the battery (if required).
- 14.3.7.1.7 The purpose of indicators, meters, or alarms on the vacuum lifting device.
- 14.3.7.1.8 The proper attachment of adaptors to vacuum lifting devices for handling of special loads.
- 14.3.7.2 Users shall demonstrate the ability and competence to operate the lifting device as instructed before assuming responsibility for using it.

14.3.8 Operation

- 14.3.8.1 Only the following personnel shall operate vacuum lifting devices:

- 14.3.8.1.1 Qualified operators or riggers.
- 14.3.8.1.2 Trainees under the direct supervision of a qualified operator.
- 14.3.8.1.3 Maintenance and test personnel, when it is necessary in the performance of their duties.
- 14.3.8.1.4 Inspectors of lifting devices.

14.3.8.2 Operating

- 14.3.8.2.1 Before starting the lift, verify that the “vacuum on” indicator has reached the required level. Also, verify that the vacuum lifting device has been correctly applied and a stable vacuum level exists by lifting the load a few inches and observing conditions
- 14.3.8.2.2 Observe the condition of the lifting device before use and during operation. If you observe a defect that affects the continued safe use of the lifting device, remove it from service.
- 14.3.8.2.3 Place any attached load on the floor or ground and, after use, properly store the lifting device before leaving.
- 14.3.8.2.4 Before they are used on a shift, test the lifting device controls. If any do not operate properly, adjust or repair them before operations begin.
- 14.3.8.2.5 Do not load the lifting device in excess of its rated capacity (except for test loads) or handle any load for which it is not designed.
- 14.3.8.2.6 Apply the lifting device to the load in accordance with established procedures.
- 14.3.8.2.7 Before lifting, ensure that lifting-device ropes or chains are not kinked and multiple-part lines are not interwoven.
- 14.3.8.2.8 Ensure that the load is correctly distributed for the lifting device being used.
- 14.3.8.2.9 Do not use the lifting device for side pulls or sliding the load unless specifically authorized by a qualified person or by an approved procedure.

- 14.3.8.2.10 Warn all personnel near the lifting device and place the load on the floor or ground, if possible to do so, if electrical power goes off while a load is being lifted.
- 14.3.8.2.11 Do not leave your position at the controls.
- 14.3.8.2.12 Do not use a lifting device that is tagged “Danger – Do Not Operate” or otherwise designated as nonfunctional.
- 14.3.8.2.13 Do not remove “Danger – Do not Operate” tags from lifting devices without the approval of the person who placed them or an authorized person
- 14.3.8.2.14 Store the lifting device in a dry, inside location when not in use.
- 14.3.8.2.15 Ensure that markings or tags are not removed or defaced. Replace missing or defaced markings or tags.

14.3.9 Critical Lifts

See Chapter 2 for critical lift requirements. Vacuum lifting devices for critical-lift service shall have an initial proof-load test of not more than 125% of its rated capacity. If proof-testing cannot be verified, the lifting device shall be proof-tested before being used to make a critical lift.

14.4 MAGNETS, CLOSE-PROXIMITY OPERATED

Close-proximity-operated magnetic lifting devices are used for single- or multiple-steel-piece handling operations in which the operator of the magnet is required to manually guide the load during its movement. They are also used in situations where remotely operated magnets are operated close to people. Typical close-proximity-operated magnetic lifting devices are shown in Figure 14-8.

14.4.1 Design/Fabrication

Close-proximity-operated magnetic lifting devices shall be designed and fabricated in accordance with the provisions of ASME B30.20, 20-3.2.2 and 20-3.2.3.

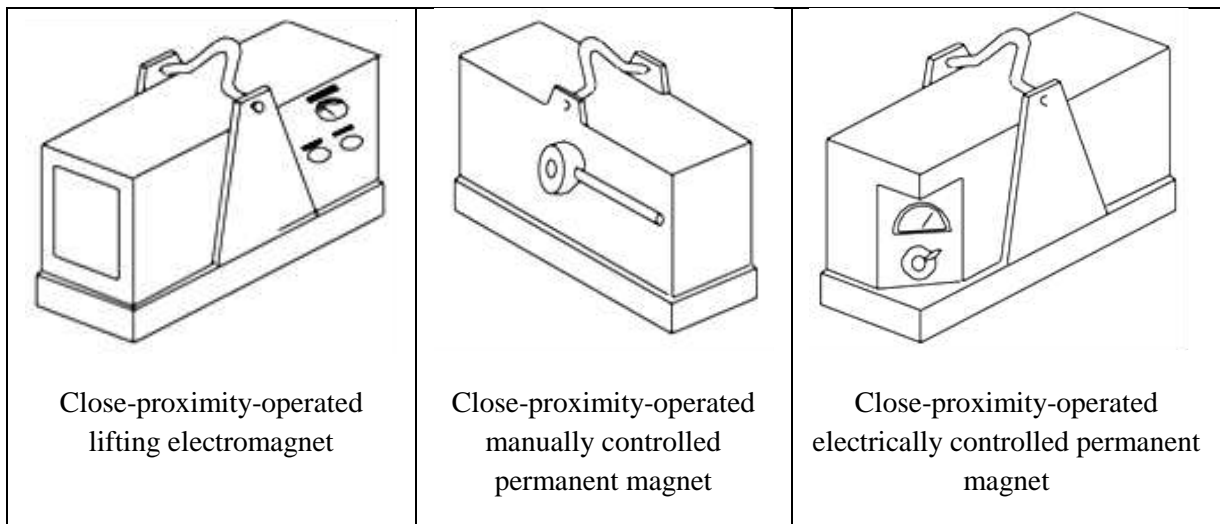


Figure 14-8. Close-proximity-operated magnetic lifting devices.

14.4.2 Marking

14.4.2.1 General

14.4.2.1.1 At a minimum, a nameplate, name tag, or other permanent marker shall be affixed to each lifting magnet, and shall display the following data:

- Manufacturer's name, or if the magnet has been repaired or modified, the name and address of the repairer/modifier.
- Model or unit identification.
- Weight.
- Duty cycle, if applicable.
- Cold current.
- Rated capacity.

14.4.2.1.2 Also, battery-powered and external-powered lifting electromagnets and electrically controlled permanent-magnet lifting magnets shall be marked with:

- The voltage of the battery or primary power supply.
- The cold current or watts at 68° F (20° C) and rated voltage.

14.4.2.1.3 A label or labels shall be affixed to each lifting magnet in a readable position that displays the word "CAUTION" or other legend designed to bring the label to the attention of the operator. The label shall also contain information cautioning against:

- Operating when the battery capacity is inadequate.
- Exceeding magnet duty cycle and disconnecting the magnet with the power on (for externally powered electromagnets).
- Operating if the internal control function indicator, where applicable, does not indicate a complete cycle (on electrically controlled permanent magnets).

14.4.2.1.3 Operating with the control handle not fully in the "Lift" position (on manually controlled permanent magnets)

14.4.2.2 Rated Load (Capacity)

14.4.2.2.1 General-application magnets shall include the rated load (capacity) of the magnet on the lifting magnet or on a tag attached to it. This capacity rating shall refer to the instruction manual for information relating to decreases in rating due to the load surface condition, thickness, percentage of contact with magnet, temperature, metallurgical composition, and deflection.

14.4.2.2.2 Specified-application magnets shall include the application load (capacity) of the magnet on the lifting magnet or on a tag attached to it. This capacity rating shall refer to the specific loads for which it applies.

14.4.2.3 Controls

The position of the control switch or handle of a lifting magnet shall be marked with "Lift," "Off," and "Drop," or equivalent terms indicating the mode of operation of the lifting magnet.

14.4.3 Installation

14.4.3.1 Close-proximity-operated magnetic lifting devices shall be installed according to the manufacturer's recommendations

14.4.3.2 Users shall ensure that:

14.4.3.2.1 External power input is the correct voltage and amperage.

14.4.3.2.2 Power conductors and controls are of adequate rating and are insulated or otherwise protected against accidental interruption or damage.

14.4.4 Inspections

14.4.4.1 Initial Inspection

Prior to their initial use, a qualified inspector shall inspect all new, modified, or repaired lifting magnets to ensure compliance with paragraph 14.4.4.3, "Periodic Inspection."

14.4.4.2 Frequent Inspection

14.4.4.2.1 The operator or other designated person shall visually inspect each magnetic lifting device at the beginning of each shift or prior to use, if it has not been in regular service.

14.4.4.2.2 The inspection shall be for the following (records are not required):

- Lifting magnet face for freedom from foreign materials and for smoothness.
- Lifting bail or sling suspension for proper condition.
- Control handle for proper condition and operation.
- Current indicator, where applicable, for proper condition and operation.
- Labels, markings, and indicators or meters for legibility.
- Electrical conductors, if applicable, for loose connections, continuity, corrosion, and damage to insulation.
- Battery for correct electrolyte level and lack of corrosion of battery posts or connectors, if applicable.

14.4.4.3 Periodic Inspection

14.4.4.3.1 A qualified inspector shall perform a complete inspection with the equipment in place at the following intervals:

- Normal service – yearly.
- Heavy service – semiannually.
- Severe service – quarterly.

14.4.4.3.2 Lifting device service is defined as:

- Normal – operation with various weights within the rated load limit, or uniform loads less than 65% of rated load.
- Heavy – operation within the rated load limit that exceeds normal service.
- Severe – operation under normal or heavy service with abnormal operating conditions.

14.4.4.3.3 This inspection shall include those items specified in paragraph 14.4.4.2, "Frequent Inspection," in addition to the following:

- Deformation, wear, and corrosion of all members, fasteners, locks, switches, warning labels, and lifting parts.
- Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).
- Operation and condition of electrical components (i.e., meters, indicators, and alarms).
- Magnet coil tested for ohmic/ground readings and readings compared to manufacturer's standards.

14.4.4.3.4 A qualified inspector shall inspect a lifting magnet that has been idle for 1 month or more according to periodic inspection requirements before placing it in service.

14.4.4.3.5 Dated inspection reports shall be prepared for each inspection. Inspection records shall be kept on file and shall be readily available.

14.4.5 Testing

14.4.5.1 Operational Test

14.4.5.1.1 All new, modified, or repaired lifting magnets shall be tested prior to their initial use. Tests shall be performed by a qualified inspector or under the direction of that inspector. Dated reports shall be kept on file.

14.4.5.1.2 Testing shall include the following:

- A check to ensure that the lifting magnet contains no visible defects.
- A check for proper operation of all electrical protective equipment, meters, indicators, alarms, etc.

14.4.5.2 Rated Load Test

14.4.5.2.1 All new, modified, or repaired lifting magnets shall be tested and inspected before initial use. Tests and inspections shall be performed by a qualified inspector or under the direction of that inspector. Test and inspection results shall be documented and kept on file.

14.4.5.2.2 General-application magnets are required to satisfy the rated breakaway-force test. The breakaway force measured in this test must exceed the rated load (capacity) by a factor of at least 2.

14.4.5.2.3 Specified-application magnets are required to comply with the application breakaway-force test. The breakaway forces measured in this test must exceed the specified application load (capacity) by a factor of at least 2.

14.4.5.2.4 The rated breakaway-force test shall establish the breakaway force required to vertically remove the lifting magnet from a low-carbon rolled-steel plate of the minimum thickness stated by the magnet manufacturer. The portion of this plate in contact with the magnet shall have a 125- μ in. (3.2×10^{-3} mm) finish and be flat within 0.002 in./ft (0.05 mm/m), but not exceeding 0.005 in. (0.127 mm) total. The full operating face of the lifting magnet shall be in contact with the steel plate, which shall be between 60° F (15° C). Battery-operated electromagnets and external-powered lifting electromagnets shall be operated at the manufacturer's recommended current.

14.4.5.2.5 The application breakaway-force test shall establish the application breakaway forces of the lifting magnet under the variety of loading conditions for which the magnet is specified. The details of this test should be supplied by the manufacturer of the lifting magnet.

14.4.6 Maintenance

- 14.4.6.1 A preventive maintenance program shall be established and be based on recommendations made by the manufacturer or a qualified person.
- 14.4.6.2 Replacement parts shall be equivalent to the original specifications.
- 14.4.6.3 Before adjustment and repairs are started on a lifting magnet or its controls, maintenance personnel shall take the following precautions:
 - 14.4.6.3.1 Ensure that all sources of magnet power are disconnected and locked out, tagged out, or flagged.
 - 14.4.6.3.2 Ensure that a magnet removed for repair is tagged as defective.
- 14.4.6.4 Only qualified personnel shall work on equipment when adjustments and tests are required.
- 14.4.6.5 After adjustments and repairs have been made, the lifting magnet shall not be returned to service until it has been inspected according to paragraph 14.4.4.3.
- 14.4.6.6 Dated records of repairs and replacements should be available.
- 14.4.6.7 Maintenance personnel shall ensure that any defective condition disclosed by the inspection is corrected before operation of the lifting magnet is resumed. Repairs shall be done only by designated persons.

14.4.7 Training/Qualification

- 14.4.7.1 Magnetic lifting device operators shall be trained and qualified as specified in Chapter 6, “Personnel Qualification and Training.” At a minimum, instruction should include the following:
 - 14.4.7.1.1 Application of the lifting device to the load and adjustments of the device, if any, that adapt it to various sizes or kinds of loads.
 - 14.4.7.1.2 Any special operations or precautions.
 - 14.4.7.1.3 Condition of the load itself required for operation of the lifting device such as balance, degree of order of stacked loads, surface cleanliness, bending, and load thickness.
 - 14.4.7.1.4 Procedure for storage of lifting device to protect it from damage.
 - 14.4.7.1.5 Instructions for not exceeding the rated capacity of the lifting device or the capacity of the hoisting equipment by the combined weight of the load, the lifting device, and the rigging.
 - 14.4.7.1.6 Charging of the lifting magnet battery (if required).
 - 14.4.7.1.7 The purpose of indicators, meters, or alarms on the lifting magnet.
 - 14.4.7.1.8 The proper attachment of adaptors to lifting magnets for handling of special loads.
- 14.4.7.2 Operators shall demonstrate the ability and competence to operate the lifting device as instructed before assuming responsibility for using it.

14.4.8 Operation

14.4.8.1 Personnel Operating Lifting Devices

Only the following qualified personnel shall operate lifting devices:

- 14.4.8.1.1 Designated persons.
- 14.4.8.1.2 Trainees under the direct supervision of a designated person.
- 14.4.8.1.3 Maintenance and test personnel, when it is necessary in the performance of their duties.

14.4.8.1.4 Inspectors of lifting devices.

14.4.8.2 Personnel Using Close Proximity-Operated Magnets

The following shall apply to personnel who use close-proximity-operated magnets:

14.4.8.2.1 Place any attached load on the floor or ground and, after use, properly store the lifting device before leaving it.

14.4.8.2.2 Before they are used during a shift, test all controls. If any do not operate properly, adjust or repair them before operations begin.

14.4.8.2.3 Do not load the lifting device in excess of its rated capacity or handle any load for which it is not designed.

14.4.8.2.4 Apply the lifting device to the load in accordance with established procedures.

14.4.8.2.5 Before lifting, ensure that lifting-device ropes or chains are not kinked and that multiple-part lines are not interwoven.

14.4.8.2.6 Ensure that the load is correctly distributed for the lifting device being used.

14.4.8.2.7 Ensure that the temperature of the load does not exceed the maximum allowable limits of the lifting device.

14.4.8.2.8 Do not use the lifting device for side pulls or sliding the load unless specifically authorized by a qualified person.

14.4.8.2.9 Keep the lifting magnet face and the magnet contact area clean.

14.4.8.2.10 Ensure that the load to be lifted is within the magnet's rated capacity or application capacity and lifting equipment rated capacity.

14.4.8.2.11 Observe all meters and indicators on the lifting magnet to confirm proper operation prior to making a lift.

14.4.8.2.12 Before starting the lift, lift the load a few inches to establish that it is securely attached to the magnet.

14.4.8.2.13 Do not use a lifting magnet that is tagged "Danger – Do Not Operate" or otherwise designated as nonfunctional.

14.4.8.2.14 Do not remove "Danger – Do Not Operate" tags from magnetic lifting devices without the approval of the person who placed them or an authorized person.

14.4.8.2.15 Store the lifting device in a dry, inside location when not in use.

14.4.8.3 External-Powered Electromagnets

Before raising the load more than 2 in (50 mm), ensure that any adjustable input control is switched to the "FULL POWER" or "FULL ON" position and remains in this position until the load is removed from the magnet.

14.4.8.4 Battery-Operated Electromagnets

14.4.8.4.1 Before lifting, confirm that the device indicating correct current flow remains stable for a minimum of 5 seconds.

14.4.8.4.2 For a lift of extended duration, observe the device indicating correct current flow every 5 minutes.

14.4.8.4.3 Open the ventilation lid before charging the battery.

14.4.8.4.4 Before raising the load more than 2 inches (50 mm), ensure that any adjustable input control is switched to the “FULL POWER” or “FULL ON” position and remains in this position until the load is removed.

14.4.8.5 Electrically Controlled Permanent Magnets

Before raising the load, check the internal control function indicator, where applicable, to confirm proper operation of the lifting magnet.

14.4.8.6 Manually Controlled Permanent Magnets

Before raising the load, confirm that the control handle is in the “LIFT” or “ON” position and the control handle latch is operating.

14.4.9 Critical Lifts

See Chapter 2 for critical lift requirements.

14.4.9.1 General-application magnets are required to satisfy the rated breakaway-force test. The breakaway force measured in this test must exceed 200% of the rated load. If the rated breakaway-force test cannot be verified, the lifting device shall be required to satisfy the rated breakaway-force test before being used to make a critical lift.

14.4.9.2 Specified-application magnets are required to satisfy the rated breakaway-force test. The breakaway force measured in this test must exceed 200% of the rated load. If the rated breakaway-force test cannot be verified, the lifting device shall be required to satisfy the rated breakaway-force test before being used to make a critical lift.

14.5 MAGNETS, REMOTE-OPERATED

Typical remote-operated magnetic lifting devices are shown in Figure 14-9.

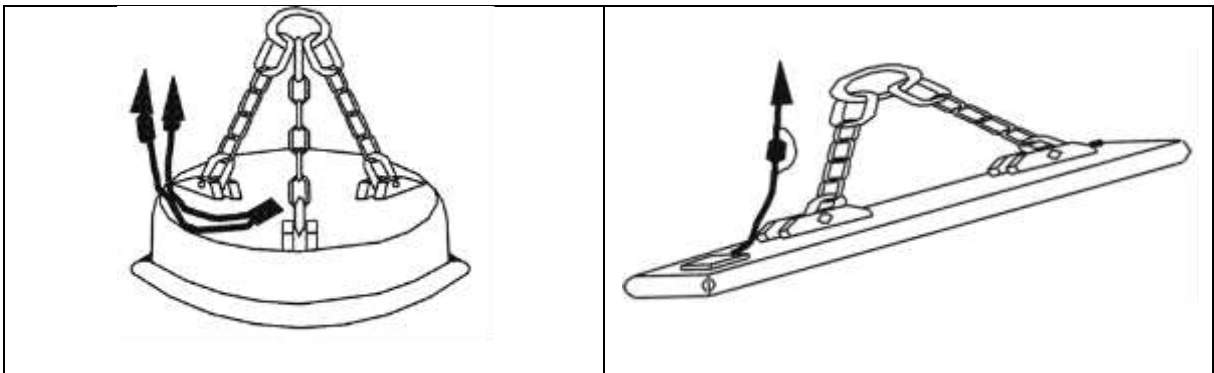


Figure 14-9. Remote-operated magnetic lifting devices.

14.5.1 Design/Fabrication

Remote-operated magnetic lifting devices shall be designed and fabricated in accordance with the provisions of ASME B30.20, 20-4.2.2.

14.5.2 Marking

At a minimum, all new lifting magnets shall be provided with a nameplate, name tag, or other permanent marker displaying the following information

14.5.2.1 Manufacturer's name and address, or if the magnet has been repaired or modified, the name and address of the repairer/modifier.

14.5.2.2 Manufacturer's model or unit identification.

14.5.2.3 Weight.

14.5.3.4 Duty cycle, if applicable.

14.5.3.5 Cold current.

14.5.3 Installation

14.5.3.1 Remote-operated magnets shall be installed according to the manufacturer's recommendations.

14.5.3.2 Operators shall ensure that:

14.5.3.2.1 External power input is of the correct voltage and amperage.

14.5.3.2.2 Power conductors and controls are of adequate rating and are insulated or otherwise protected against accidental interruption or damage.

14.5.4 Inspections

14.5.4.1 Initial Inspection

Prior to their initial use, a qualified inspector shall inspect all new, modified, or repaired lifting magnets to ensure compliance with paragraph 14.5.4.3, "Periodic Inspection."

14.5.4.2 Frequent Inspection

14.5.4.2.1 The operator or other designated personnel shall visually inspect each magnetic lifting device at the beginning of each shift or prior to use, if it has not been in regular service.

14.5.4.2.2 The inspection shall be for the following (records are not required):

- Lifting magnet face for smoothness or presence of foreign materials, if applicable.
- Magnet suspension system.
- All visible electrical conductors (without disassembly).

14.5.4.3 Periodic Inspection

14.5.4.3.1 A qualified inspector shall perform a complete inspection of the lifting device with the equipment in place at the following intervals:

- Normal service – yearly.
- Heavy service – quarterly.
- Severe service – quarterly.
- Special or infrequent service – as authorized by a qualified person before the first use and as directed by the qualified for any subsequent occurrences.

14.5.4.3.2 Lifting device service is defined as follows:

- Normal – operation with various weights within the rated load limit, or uniform loads less than 65% of rated load.
- Heavy – operation within the rated load limit that exceeds normal service.
- Severe – operation under normal or heavy service with abnormal operating conditions.

14.5.4.3.3 This inspection shall include those items specified in paragraph 14.5.4.2, “Frequent Inspection,” in addition to the following:

- Deformation, wear, and corrosion of all members, fasteners, and lifting parts.
- Check for suspect/counterfeit parts (see Terminology and Definitions, Chapter 1).
- Proper operation and condition of electrical components.
- Magnetic coil tested for ohmic/ground readings and compared to manufacturer’s standards.

14.5.4.3.4 Dated inspection reports shall be prepared for each inspection. Inspection records shall be kept on file and shall be readily available.

14.5.5 Operational Testing

14.5.5.1 All new, modified, or repaired lifting magnets shall be tested prior to initial use. Tests shall be performed by a qualified inspector or under the direction of that inspector. Dated reports shall be kept on file.

14.5.5.2 Testing shall include the following:

14.5.5.2.1 A check for proper operation of all electrical equipment.

14.5.5.2.2 A visual inspection of the lifting magnet for visible defects.

14.5.6 Maintenance

14.5.6.1 A preventive maintenance program shall be established and be based on the recommendations of the manufacturer or a qualified person.

14.5.6.2 Replacement parts shall be equivalent to original specifications.

14.5.6.3 Before maintenance is started on a lifting magnet or controls, maintenance personnel shall take the following precautions:

14.5.6.3.1 Ensure that all sources of magnet power are disconnected and locked out, tagged out, or flagged.

14.5.6.3.2 Ensure that a magnet removed for repair is tagged as defective.

14.5.6.4 Only qualified personnel shall work on equipment when maintenance and test are required.

14.5.6.5 After repairs have been made, the lifting magnet shall not be returned to service until it has been inspected according to paragraph 14.5.4.3, “Periodic Inspection.”

14.5.6.6 Dated records of repairs and replacements should be available.

14.5.6.7 Any defective condition disclosed by the inspection shall be corrected before the lifting magnet is returned to service.

14.5.7 Training/Qualification

14.5.7.1 Operators shall be trained and qualified as specific in Chapter 6, “Personnel Qualification and Training.” At a minimum, instruction should include the following:

14.5.7.1.1 Application of the lifting device to the load and adjustments of the device, if any, that adapt it to various sizes or kinds of loads.

14.5.7.1.2 Any special operations or precautions.

14.5.7.1.3 Condition of the load itself required for operation of the lifting device, such as balance,^o of order of stacked loads, surface cleanliness, bending, and load thickness.

14.5.7.1.4 Procedure for storage of the lifting device to protect it from damage.

14.5.7.1.5 Instructions for not exceeding the rated capacity of the lifting device or the capacity of the hoisting equipment by the combined weight of the load, the lifting device, and the rigging.

14.5.7.1.6 Charging of the lifting magnet battery (if required).

14.5.7.1.7 The purpose of indicators, meters, or alarms on the lifting magnet.

14.5.7.1.8 The proper attachment of adaptors to lifting magnets for handling of special loads.

14.5.7.2 Operators shall demonstrate the ability and competence to operate the lifting device as instructed before assuming responsibility for using it.

14.5.8 Operation

14.5.8.1 Only the following qualified personnel shall operate lifting devices:

14.5.8.1.1 Designated persons.

14.5.8.1.2 Trainees under the direct supervision of a designated person.

14.5.8.1.3 Maintenance and test personnel, when it is necessary in the performance of their duties.

14.5.8.1.4 Inspectors of lifting devices.

14.5.8.2 The following shall apply to all personnel who operate remote-operated magnets:

14.5.8.2.1 Place any attached load on the floor or ground and, after use, properly store the lifting device before leaving it.

14.5.8.2.2 Before they are used during a shift, test all controls. If any do not operate properly, adjust or repair them before operations begin.

14.5.8.2.3 Do not load the lifting device in excess of its rated capacity or handle any load for which it is not designed.

14.5.8.2.4 Apply the lifting device to the load in accordance with established procedures.

14.5.8.2.5 Before lifting, ensure that lifting-device ropes or chains are not kinked and that multiple-part lines are not interwoven.

14.5.8.2.6 Ensure that the load is correctly distributed for the lifting device being used.

14.5.8.2.7 Ensure that the temperature of the load does not exceed the maximum allowable limits of the lifting device.

14.5.8.2.8 Do not use the lifting device for side pulls or sliding the load unless specifically authorized by a qualified person.

- 14.5.8.2.9 Do not use a lifting magnet that is tagged “Danger – Do Not Operate” or otherwise designated as nonfunctional.
- 14.5.8.2.10 Do not remove “Danger – Do Not Operate” tags without the approval of the person who placed them or an authorized person.
- 14.5.8.2.11 Store the lifting device in a designated location when not in use.

14.5.9 Critical Lifts

See Chapter 2 for critical lift requirements.

Remote-operated magnets for critical-lift service shall have been tested for proper operation of all electrical equipment and a visual inspection of the lifting device for defects. If testing and inspection cannot be verified, the lifting device shall be tested and inspected before being used to make a critical lift.

NOTE: Exhibit 14.1 is intended to be a sample form only. The equipment manufacturer’s inspection/testing criteria supersede any other criteria. In cases where the equipment manufacturer does not include inspection/testing criteria, other forms developed to facilitate required inspection/testing are acceptable.

Exhibit 14.1 Lifting Bars And Spreaders Load Test (Sample Form)LIFTING BARS AND SPREADERS LOAD TEST

INSPECTOR: _____ INSPECTION DATE: _____

NOTES: 1. Proof-test to not more than 125 % of rated capacity for critical lift service. The test load shall be accurate to within -5%, +0% of stipulated values.

2. Qualified inspector shall witness all steps below.

INSPECTION

Lifting bars and spreaders shall be checked for signs of incipient failure in bending and shall be replaced if permanently bent more than 1/8 inch in 10 feet, or twisted more than 5 degrees out of the original plan. Hook attachment welds shall be examined for cracks and signs of failure in tension.

Qualified inspector shall perform test by visual examination, liquid-penetrant examination, or magnetic-particle examination.

Acceptance: No cracks, linear indication, laps, or seams.

STATIC TEST: Hold weight for 10 minutes and visually inspect for deformation.

Type _____ Size _____

Rated Capacity (SWL) _____ lb Actual Load Test _____ lb

Serial Number _____

Qualified Inspector Verify (Load Test) _____

Remarks

15.0 CHAPTER 15 – Deleted - See Chapter 9.**16.0 CHAPTER 16 - MISCELLANEOUS LIFTING DEVICES**

This chapter provides safety standards designated to verify, based on personal observations, certified records, or direct reports, that a specific action has been performed in accordance with specified requirements. It provides requirements for the operation, inspection, testing, and maintenance for miscellaneous lifting devices, including self-contained shop cranes (see Figure 16-1) as addressed by ASME PALD (Portable Automotive Lifting Devices.); truck mounted cranes (See Figure 16-2) with a capacity of 1 ton or less not covered in ASME B30.5 (Mobile and Locomotive Cranes.); and portable “A” frames (sometimes referred to as portable gantries) (see Figure 16-3),

16.1 GENERAL**16.1.1 Operator Training/Qualification**

- 16.1.1.1 Operators of self-contained shop cranes and portable “A” frames shall be familiar with, understand and follow the operating instructions provided by the equipment manufacturer.
- 16.1.1.2 Operators of truck mounted cranes with capacities of 1 ton or less shall be trained as required in Chapter 6.

16.1.2 Rated Load Markings, Safety Markings, and Operating Instructions

- 16.1.2.1 Safety markings shall be legible and conform to the ANSI Z535.
- 16.1.2.2 Markings, or decals, etc. must be provided and affixed by the use of durable materials in a location visible to the operator in order to provide a clear understanding of any special warning, capacity information, etc.
- 16.1.2.3 Shop cranes shall have the rated capacity for each specified boom and leg position marked in a prominent location on the equipment.
- 16.1.2.4 Small cranes 1 ton or less shall have a durable rating chart with legible letters and figures attached in a location accessible to the operator.
- 16.1.2.5 Each portable “A” frame shall have its rated capacity legibly marked on the structure on each side of the primary beam.
- 16.1.2.6 The manufacturers name, product serial number, and model number must be permanently and legibly marked on each portable “A” frame.
- 16.1.2.7 Operating instructions developed by the original manufacturer or supplier shall be maintained and readily available to the operator.
- 16.1.2.8 For small cranes 1 ton or less, operating instructions may be maintained on the vehicle on which the crane is installed.
- 16.1.2.9 Safety instructions for shop cranes and portable “A” frames should include the following:
 - 16.1.2.9.1 Study, understand, and follow all instructions before operating this device.
 - 16.1.2.9.2 Do not exceed rated capacity.

16.1.2.9.3 Use only on hard level surface.

16.1.2.9.4 Before moving, lower the load to the lowest possible point.

NOTE: For hoists used in conjunction with portable “A” frames, see Chapter 8 for hoist requirements.

16.1.3 Modifications

16.1.3.1 Miscellaneous lifting devices may be modified or re-rated provided that the modifications of supporting structures are analyzed thoroughly by a qualified engineer or by the manufacturer of the lifting device.

16.1.3.2 A re-rated lifting device, or one whose load-supporting components have been modified, shall be tested per 16.3. The new rated capacity shall be displayed per 16.1.2.”

16.1.4 Load Limits

Miscellaneous lifting devices shall not be loaded beyond its rated capacity, except for test purposes, as described in 16.3.

16.1.5 Operating Controls

16.1.5.1 Operating controls shall be readily visible and accessible to the operator and shall not subject the operator to pinch points, sharp edges, or snagging hazards.

16.1.5.2 The release system for shop cranes shall require intentional positive action by the operator for release to prevent accidental lowering.

16.1.6 Load Hook

16.1.6.1 Shop cranes shall be equipped with load hooks and/or chain capable of sustaining the proof load of the crane.

16.1.6.2 Latch-equipped hooks shall be used for all operations unless the application makes using the latch impractical, unnecessary, or unsafe. The absence of a hook-throat latch is not indiscriminately allowed.

16.1.7 Wire Rope

16.1.7.1 Wire rope, (single line capacity) used on small cranes 1 ton or less shall have a minimum design factor of 3.5:1, based upon breaking strength.

16.1.7.2 Small cranes 1 ton or less shall be equipped with properly sized wire rope sheaves in lieu of flat spools.

16.1.8 Assembly

16.1.8.1 Portable A frames shall only be assembled by qualified personnel. Manufacturer’s instructions shall be adhered to regarding setup and assembly.

16.1.8.2 Portable “A” frame components from different manufacturers shall not be intermixed with components from other A frames regardless of similarities in manufacturers or rated capacities.

- 16.1.8.3 Only manufacture-approved methods of attaching a hoist to the A frame structure such as approved beam clamp or trolley shall be used. Trolleys or beam clamp working load limits shall not exceed the capacity rating of the A frame and must be designed for the type frame flange (see Figures 16-4 and 16-5). Hoists attached to the A frame must have a rated capacity equal to or less than all supporting components. [Down rating of hoist to A frame capacity is acceptable with administrative controls and markings in place)
- 16.1.8.4 Load-carrying trolleys must suit the shape and weight of the specific load. Trolley wheel design must be matched properly to the rail shape and size to ensure that trolleys do not slip off the track and drop the load.
- 16.1.8.5 If a new or replacement trolley is installed on a monorail, the qualified person installing the trolley shall ensure by actual operational verification or measurement that the installed trolley stops on the system are compatible with the new trolley, thereby preventing trolley travel past a point where it could fall from the rail. On those systems where a series of monorails may be connected by a bridge or turntable, verification of functional trolley stops on all accessible rails must be established or administrative controls placed limiting access to a specific work area during the period the trolley is in service.

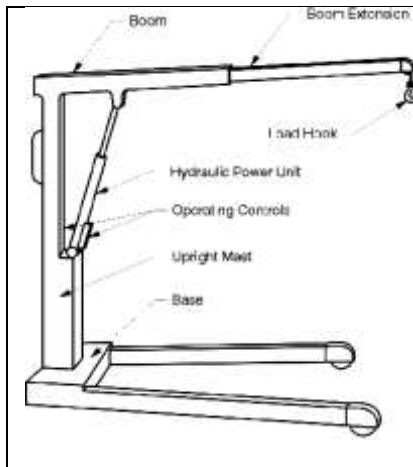


Figure 16-1. Self-Contained Shop Crane.

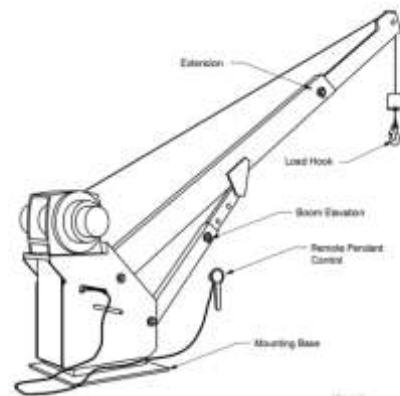


Figure 16-2. Truck Mounted Crane – Capacity 1 Ton or Less.

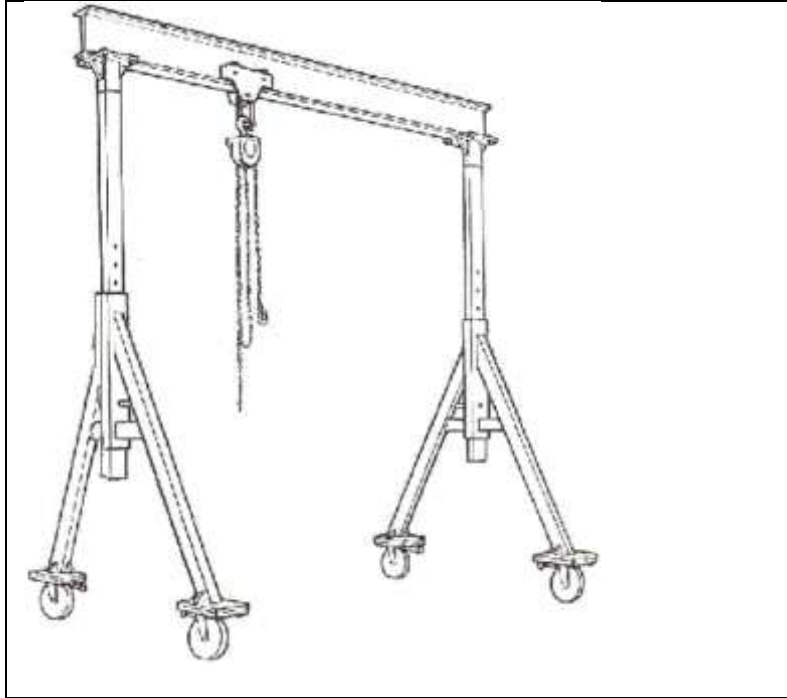


Figure 16-3 Portable A Frame.

16.2 INSPECTIONS

16.2.1 General

Equipment shall operate with a smooth, regular motion without any hesitation, abnormal vibration, binding, or irregularity. There shall be no apparent damage, excessive wear, or deformation of any load-bearing part of the equipment. All safety devices, controls, and other operating parts of the equipment shall be checked during each inspection and shall be in good working order.

16.2.2 Initial Inspection

A qualified inspector shall inspect all miscellaneous lifting devices prior to initial use, after disassembly and reassembly, and after load testing. The inspection shall be performed in accordance with manufacturer's requirements. If manufacturer's instructions are not available, an engineering evaluation of the equipment shall be performed to establish necessary inspection procedures. Dated and signed inspection reports shall be kept on file and shall be readily available.

16.2.3 Daily Preoperational Check

16.2.3.1 Operators or other designated personnel shall visually inspect miscellaneous lifting equipment each day or prior to use if the equipment has not been in regular service (records are not required). The inspection shall include, but not be limited to inspecting the following:

- 16.2.3.1.1 All control mechanisms for maladjustment interfering with proper operation.
- 16.2.3.1.2 Hook and latch for deformation, cracks, and wear.
- 16.2.3.1.3 Hydraulic systems for proper operation.
- 16.2.3.1.4 Wire rope for kinking, crushing, bird caging, and corrosion.
- 16.2.3.1.5 Chain for bent links, stretched links, cracks, scores, abrasions or heat damage.
- 16.2.3.1.6 All safety devices for malfunction
- 16.2.3.1.7 Inspection items identified in manufacturer's operating instructions.
- 16.2.3.1.8 Visually inspect for bent, broken, damaged, corroded, cracked, or missing parts.
- 16.2.3.1.9 Verify the hoist and all components installed on portable "A" frames do not exceed the rated capacity of the unit
- 16.2.3.1.10 Verify required markings are installed and legible.
- 16.2.3.1.11 Perform a function test of trolley and hoist installed on portable "A" frames to ensure proper operation.
- 16.2.3.2 Operators or other designated personnel shall examine deficiencies and determine whether they constitute a safety hazard.

16.2.4 Periodic Inspection

- 16.2.4.1 Miscellaneous lifting equipment should be thoroughly inspected on a periodic basis in accordance with manufacturer's instructions. If manufacturer's instructions are not available, an engineering evaluation of the equipment should be performed to establish the necessary inspection frequency and procedures.
- 16.2.4.2 The qualified inspector shall evaluate identified deficiencies and determine whether they constitute a hazard.
- 16.2.4.3 Dated and signed inspection records shall be kept on file and shall be readily available.
- 16.2.4.4 The following is a list of items frequently included in manufacturer's inspection instructions. If manufacturer's instructions are unavailable, these inspection items should be considered in the engineering evaluation used to establish inspection procedures.
 - 16.2.4.4.1 Inspecting for bent, broken, damaged, corroded, cracked, or missing parts.
 - 16.2.4.4.2 Verifying required markings are installed and legible.
 - 16.2.4.4.3 Ensuring that each lifting device has its rated capacity legibly marked on the structure on each side of the primary beam.
 - 16.2.4.4.4 Ensuring that the manufacturer's name and model number are permanently and legibly marked on each lifting device.
 - 16.2.4.4.5 Ensuring trolley or beam clamp working load limits do not exceed the capacity rating of the A frame. Hoists attached to the A frame must have a rated capacity equal to or less than all

supporting components and be inspected to requirements of Chapter 8. (Down rating of hoist to “A” frame capacity is acceptable with administrative controls and markings in place).

16.2.4.4.6 Ensuring “A” frame components from different manufacturers are not inter-mixed or with components from other A frames regardless of similarities in manufacturers or rated capacities.

16.2.4.4.7 Validating the proper dimensional relationship between trolley wheels and rail when installed on portable A frames (Refer to Figures 16-4 and 16-5)

16.2.4.4.8 Observing trolley side plates for any bending or distortion

16.2.4.4.9 Checking for missing or loose bolts, nuts and retaining pins or retaining devices.

16.4.4.5 In the event any required information is missing or illegible, an attempt shall be made via engineering drawings, prints, evaluations, etc. to establish the lifting device’s manufacturer, rated capacity and other pertinent data. If this attempt is unsuccessful, the lifting device shall be removed from service until engineering personnel have thoroughly evaluated the design and adequacy of the structure. Engineering calculations must support all conclusions. The lifting device shall be identified, load tested and marked accordingly.

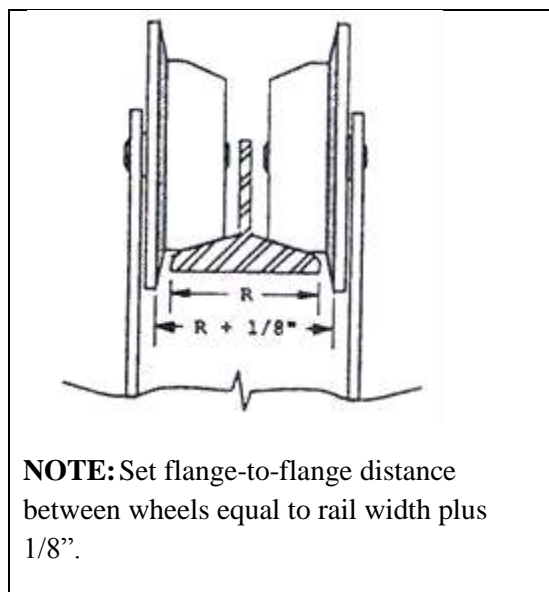


Figure 16-4. Trolley Flange Distance.

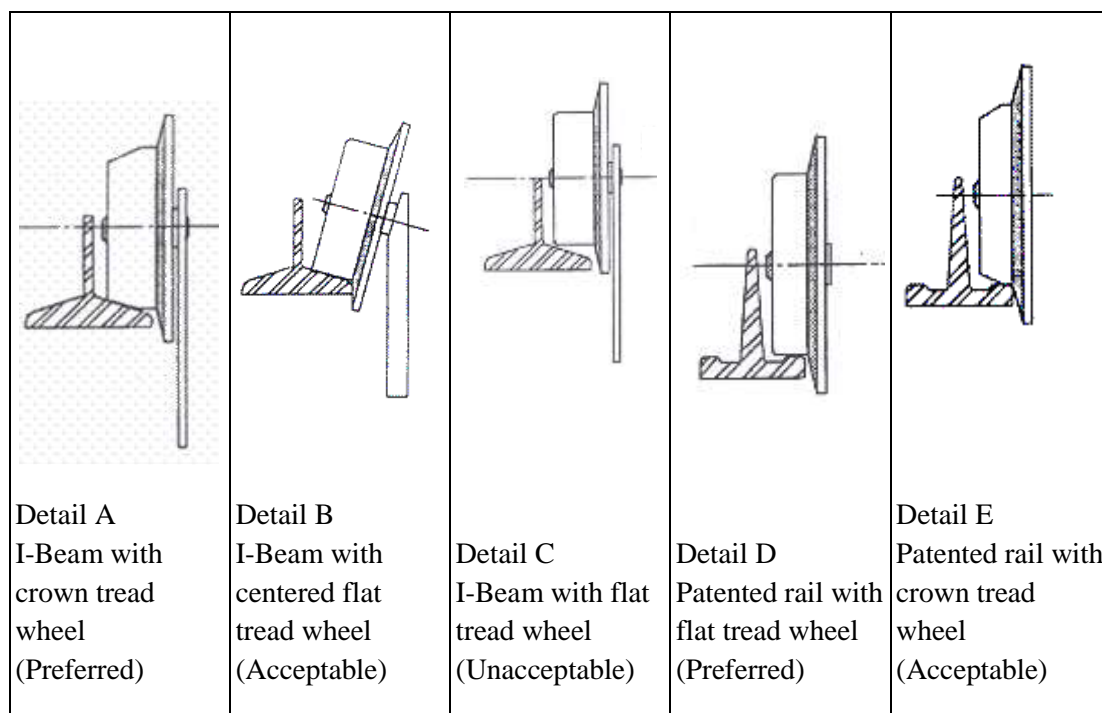


Figure 16-5 Trolley and Rail Compatibility

16.3 TESTING

16.3.1 Operational Test

The load lifting and lowering mechanisms shall be tested during an initial test and after load testing.

16.3.2 Rated Load Test

16.3.2.1 Prior to initial use, all new portable “A” frames and small cranes (1 ton or less) and those upon which load-sustaining parts have been modified, replaced, or repaired shall be load-tested by a qualified inspector or under the direction of that inspector.

16.3.2.2 A written report shall be furnished by the inspector showing test procedures and confirming the adequacy of repairs or alterations. Test reports shall be kept on file and shall be readily available to appointed personnel.

16.3.2.3 Test loads shall not be less than 100% or more than 125% of the rated capacity, unless otherwise recommended by the manufacturer or a qualified person.

16.3.2.4 Shop cranes built to design specifications are proof-tested by the manufacturer in accordance with ASME PALD, Part 12. After repair or modification, a qualified engineer shall determine if testing is required.

16.4 MAINTENANCE

16.4.1 Maintenance Program

A preventive maintenance program based on the manufacturer's recommendations should be established. Dated records should be made available.

16.4.2 Replacement Parts

Replacement parts shall be at least equal to the original manufacturer's specifications.

16.5 OPERATIONS: CONDUCT OF OPERATOR

16.5.1 Before operating, operators shall have an understanding of the lifting device's operating safety instructions.

16.5.2 Operators shall not:

16.5.2.1 Engage in any practice that will divert their attention while operating miscellaneous lifting devices.

16.5.2.2 Operate the lifting device beyond its rated capacity (except for rated load tests).

16.5.2.3 Operate miscellaneous lifting devices when physically or mentally unfit.

16.5.3 Operators shall:

16.5.3.1 Before moving the load, lower the load to the lowest possible point.

16.5.3.2 Only operate shop cranes on hard, level surfaces capable of sustaining the load.

16.5.3.3 Ensure the load does not drop suddenly or swing during transportation.

16.5.3.4 Whenever there is doubt as to safety, consult with the responsible management before operating miscellaneous lifting devices.

16.5.3.5 If adjustment or repairs are necessary, or any other defects are known, report the potential problem promptly to responsible management.

16.5.3.6 Ensure inspections are current and required markings are clearly labeled on the A frame and all hoisting components.

16.5.3.7 Always push the portable "A" frames, not the load when movement of the "A" frame is required.

16.5.3.8 Ensure the load is not attached to the floor or any other component prior to hoisting. Remove all obstacles that impede lifting.

16.5.3.9 When moving a load, keep it as close to the floor as possible. Make sure that no part of the body is placed under the load at any time.

16.5.3.10 Not allow the load to swing or roll against support members.

16.5.3.11 Not adjust the height of portable A frames when the unit is under load.

16.5.3.12 Secure trolley and hoist on portable A frames in center of I beam when adjusting height.

16.5.4 If necessary to leave a shop crane or a portable A frame with a suspended load unattended, the immediate area (about 30 inches) around the shop crane or portable A frame should be posted or barricaded to restrict entry of unauthorized personnel.

17.0 CHAPTER 17 - REFERENCES

American Institute of Steel Construction

AISC Specifications for the Design, Fabrication, and Erection Of Structural Steel for Buildings

American Iron and Steel Institute

AISI Standards for Type-302 or Type-304 Stainless Steel

American National Standards Institute and American Society of Mechanical Engineers

ANSI A10.28, Work Platforms Suspended From Cranes or Derricks

ANSI A10.18, Floor and Wall Openings, Railings and Toe Boards

ANSI/ASME HST-3M, Performance Standard for Manually Lever Operated Chain Hoists

ANSI/ASME HST-4M, Performance Standard for Electric Wire Rope Hoists

ANSI/ASME HST-5M, Performance Standard for Air Chain Hoists

ANSI/ASME HST-6M, Performance Standard for Air Wire Rope Hoists

ANSI/ASTM Specification A391, Specification for Alloy Steel Chain

ANSI/ASTM Specification E-165, Standard Practice for Liquid Penetrant Inspection Method

ANSI/ASTM Specification E-709, Standard Practice for Magnetic Particle Examination

ANSI/AWS D14.1, Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

ANSI/ITSDF B56.1, Safety Standard for Powered Industrial Trucks – Low Lift and High Lift Trucks

ANSI/ITSDF B56.6, Rough Terrain Fork Lift Trucks

ANSI/ITSDF B56.10, Safety Standard For Manually Propelled High Lift Industrial Trucks

ANSI/ITSDF B56.11.4, Hook-Type Forks and Fork Carriers for Powered Industrial Forklift Trucks

ANSI MH 27.1, Specifications for Underhung Cranes and Monorail Systems

ANSI N14.6, Standard for Special Lifting Devices for shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials

ASME B30.2, Overhead and Gantry Cranes (Top-Running Bridge, Single or Multiple Girder, Top-Running Trolley Hoist)

ASME B30.5, Mobile and Locomotive Cranes

ASME B30.6, Derricks.

ASME B30.7, Base-Mounted Drum Hoists.

ASME B30.9, Slings

ASME B30.10, Hooks

ASME B30.11, Monorail Systems and Underhung Cranes

ASME B30.12, Handling Loads Suspended from Rotorcraft

ASME B30.14, Side Boom Tractors

ASME B30.16, Overhead Hoists (Underhung)

ASME B30.17, Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)

ASME B30.20, Below-The-Hook Lifting Devices

ASME B30.21, Manually Lever Operated Hoists

ASME B30.22, Articulating Boom Cranes

ASME B30.23, Personnel Lifting Systems

ASME B30.26, Rigging Hardware, Safety Standard for Cableways, Cranes, Derricks, Hoist, Hooks, Jacks, and slings

ASME PALD, Portable Automotive Lifting Devices

ASME HST-1M, Performance Standard for Electric Chain Hoists

ASME HST-2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.

ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities

American Society for Nondestructive Testing

Recommended Practice No. ASNT-TC-1A

American Welding Society

ANSI/AWS D1.1 Structural Welding Code – Steel

Crane Manufacturers' Association of America

CMAA No. 70, Specification for Electric Overhead Traveling Cranes

CMAA No. 74, Specification for Top Running and Under Running, Single Girder, Electric Overhead Traveling Cranes

Department of Energy

DOE 440.1A, Worker Protection Management for Federal and Contractor Employees.

DOE 440.1-6, Suspect Counterfeit Items Guide

DOE 1090 Hoisting and Rigging Standard

Department of Labor

29 CFR 1910, Occupational Safety and Health Standards for General Industry

29 CFR 1926, Occupational Safety and Health Regulations for Construction

Department of Transportation

49 CFR 391.41, physical Qualification for Drivers

National Fire Protection Association

NFPA 505, Powered Industrial Trucks, Type Designation and Areas of Use.

NFPA 70, National Electrical Code

Power Crane and Shovel Association

PCSA-4, Mobile Power Crane and Excavator Standards and Hydraulic Crane Standards

Society of Automotive Engineers

SAE J376-85, Load-Indicating Devices in Lifting Crane Service

Code.SAE J765, Crane Load Stability Test

SAE J874, Center of Gravity Test Code

SAE J987, Crane Structure, Method of test.

Underwriters' Laboratories

UL 558, Internal-Combustion-Engine-Powered Industrial Trucks

UL 583, Electric-Battery-Powered Industrial Trucks